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Post Hip Fracture in Older Adults: Interventions and Strategies for Improving Outcomes

The Role and Function of the CNS and Bone Health Unit in the Management of Hip Fracture Patients

A Thesis Presented in the University of Dublin for the Degree of

Doctor in Philosophy, Nursing & Midwifery

Niamh Maher. RGN, MSc.

This work was carried out in St James's Hospital, Dublin 8, Ireland.

Declaration

I declare that the work contained in this thesis is my own and has not been submitted as an exercise for a degree to any other university. I agree that the library of the University of Dublin may lend or copy this thesis on request.

Niamh Maher

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Summary

Introduction

Hip fractures are a major cause of burden in terms of mortality, disability, and cost. With ageing of the population, a marked increase in the number of fractures is anticipated. They are the most common osteoporotic fracture in older adults and are due to reduced bone strength and a propensity to falling. In most populations, hip fracture increases with age with women two to three times more likely than men to sustain a hip fracture. Previous studies have shown that one year after a hip fracture, up to 50% of individuals have permanent functional disability, 20-25% will require long term care and between 20%-30% will have died. In Ireland the rates of hip fracture for the total population aged 50 years and over are 407 and 140 per 100,000 for females and males, respectively and is predicted to increase by 100% by the year 2026. With this increase in numbers will come an increase in cost in terms of personal health and health service utilisation

Aims

The main aim of this thesis was to assess if a multidisciplinary bone health and falls assessment and intervention, co-ordinated by a Clinical Nurse Specialist at three months following fracture could improve post hip fracture outcomes, in elderly persons, over the course of one year. The secondary aim of this thesis was to prospectively investigate outcomes of elderly hip fracture patients in regard to mortality, recovery of function, quality of life, incidence of osteoporosis, osteoporosis knowledge, medication adherence and the nutritional status in this population of patients.

Methodology

A randomised control trial was implemented to address the research question. The sample comprised two independent groups of 112 patients each (power 80%, CI 95%). This was calculated to detect a 15% reduction in fear of falling in the treatment group. All consecutive patients attending the study site for hip fracture repair were prospectively recruited between June 2008 and June 2010. Patients under 60 years of age, with metastatic disease or cognitive impairment as measured by a score of ≤18 on the MMSE were excluded.

Results

Three hundred and ninety six hip fracture patients were admitted to the study site during the study period. Of these 226 were recruited into the study. A significant reduction in mobility and ability to self care at 15 months post fracture was noted. Quality of life in the study population was below the norm based values in most domains of the SF-36. A mortality rate of the hip fracture population attending the study site of 14% at 1 year was identified. Men had a higher mortality rate than females with 21% dying within 12 months of fracture compared to 11% of women. A falls rate of 38% was reported in the study population with a 32% reduction in moderate to severe fear of falling in the intervention group identified. Seventy percent of participants were diagnosed with osteoporosis while 38% had vertebral fractures. A high risk of malnutrition at 15 months (39%) post fracture was reported The intervention group had better outcomes in some areas of recovery including mobility, fear of falling, anxiety, risk of malnutrition, quality of life and mortality than the control group.

Conclusions

This study highlights the devastating effect hip fracture can have on the life of an older person. From the results of this study, an early review of hip fracture patients by the clinical nurse specialist with onward referral to a consultant led bone clinic can improve outcomes in some areas of recovery for elderly hip fracture patients. However, continuing efforts in preventing fractures with more research and improved treatment strategies for those who fracture is imperative. While there are some positive results from this study much is still needed to be done to improve outcomes for elderly people following hip fracture.

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Abbreviations

25(OH)D	Serum 25-hydroxyvitamin D
6CIT	Six Item Cognitive Impairment Test
ABC	Activities-specific Balance Confidence scale,
ABS	Amended Barthel Scale
ADL	Activities of Daily Living.
AMT	Abbreviated Mental test
ANOVA	Analysis of variance.
BAI	Becks Anxiety Inventory
BDI	Beck Depression Index.
BDI-SF	A short form of the BDI .
BGS	British Geriatric Society.
BHC	Bone Health Clinic
BI	Barthel Index,
BIMC	Blessed Information Memory Concentration Scale.
BMD	Bone Mineral Density
BMQ	Brief Medication Questionnaire.
BNF	British Nutrition Foundation.
BOA	British Orthopaedic Association.
BP	Bodily Pain in SF-36
CCF	Congestive Cardiac Failure
CDT	Clock Drawing Test
CNS	Clinical Nurse Specialist.
COPD	Chronic Obstructive Pulmonary Disease.
CTX	Carboxy-Terminal Collagen Crosslink.
CVA	Cerebral Vascular Accident.
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders 4THEd
DXA	Dual Emission Xray Absorptiometry
EQ-5D	Euroqol EQ-5D.
FAI	Frenchay Activities Index.
FES-I	Falls Efficacy Scale International.
FIM	Functional Independence Measure.

FOF	Fear of Falling.
FoF	Fear of Falling.
FOOQ	Facts on Osteoporosis Questionnaire.
GDS	The Geriatric Depression Scale.
GFFM	Geriatric Fear of Falling Measures.
GH	General Health in SF-36
GHQ	General Health Questionnaire
GHQ-12	General Health Questionnaire with 12 items
GHQ-28	General Health Questionnaire with 28 items
GHQ-30	General Health Questionnaire with 30 items
GHQ-60	General Health Questionnaire with 60 items
GPCOG	General Practitioner Assessment of Cognition.
HADS	The Hospital Anxiety and Depression Scale
HBM	Health Belief Model.
HeSSOP	Health and Social Services for Older People
HIV	Human Immunodeficiency Virus
HR-QOL	Health Related Quality of Life
HRT	Hormone Replacement Therapy.
HUI	Health Utility index.
IADLs	Instrumental Activities of Daily Living.
LOS	Length of Stay.
LTC	Longterm care
LVA	Lateral Vertebral Assessment.
MAQ	Medication Adherence Questionnaire.
MARS	Medication Adherence Report Scale.
MCS	Mental Componemt Score in SF-36
MH	Mental Health in SF-36
MMSE	Mini Mental State Examination
MNA	Mini Nutritional Assessment (AIDS
MST	Malnutrition Screening Too.
NEADL	Nottingham Extended Activities of Daily Living Scale.
NHFD	National Hip Fracture Database
NHP	Nottingham Health Profile.

NHS	National Health Service.
NICE	National Institute for Health and Clinical Excellence.
NIH	National Institute of Health.
NOF	National Osteoporosis Foundation.
NOGG	National Osteoporosis Guideline Group
NRI	Nutritional Risk Index
NRS	Numerical Rating Scale
NRS	Nutritional Risk Screening
NTX	N-terminal telopeptide.
OC	Osteocalcin.
OKAT	Osteoporosis Knowledge assessment Tool.
OKT	Osteoporosis Knowledge test
OPQ	Osteoporosis Questionniare.
P1NP	Procollagen type 1 N-terminal propeptide.
PAC	Pre Assessment Clinic.
PCS	Physical Component Score in SF-36
PF	Physical Function in SF-36
ProFane.	The Prevention of Falls Network Europe
PTH	Parathyroid Hormone.
QALYs	Quality Adjusted Life Years
QOL	QUALITY of Life.
RANKL	Receptor activator of nuclear factor kappa-B ligand
RCP	Royal College of Physicians.
RCT	Randomised Control Trial.
RE	Role of Emotional Limitations in SF-36
RIP	Rest In Peace
RMI	The Rivermead Mobility Index.
RP	Role of Physical Limitations in SF-36
SAFE	Survey of Activities and Fear of Falling in the Elderly.
SEAMS	Self Efficacy for Appropriate Medication Use Scale
SERMs	Oestrogen Receptor Modulators.
SF	Social Functioning in SF-36
SF36	Short Form 36 Health Survey.

SGA	Subjective Global Assessment.
SIGN	Scottish Intercollegiate Guidelines Network.
SPSS	Statistical Package for Social Science
UK	United Kingdom.
VAS	Visual Analogue Scale.
WHO	World Health Organisation.
WHOQOL	World Health Organisation Quality of Life.
WHOQOL-BREF	World Health Quality of Life Brief version.
$\chi 2$	Chi Square Test.

Post Hip Fracture in Older Adults: Interventions and Strategies for Improving Outcomes

The Role and Function of the CNS and Bone Health Unit in the Management of Hip Fracture Patients

Chapter 1

1.1: Introduction

Hip fractures are an increasingly common, serious problem that occurs mainly in older people (Scottish Intercollegiate Guidelines Network 2002). They account for nearly 10% of all non vertebral fractures and for a much higher proportion of fractures in the elderly (Eastell et al 2001). Hip fracture constitutes a major clinical and financial burden to health services accounting for 20% of orthopaedic bed stays worldwide (Roche et al 2005).Over 180,000 Osteoporotic fractures occur annually in the UK, of which 7O,000 are hip fractures, costing an estimated £340 million. In the Republic of Ireland, 2935 hip fractures occurred in 2004 with an average length of stay of 18.6 days in hospital as recorded by the Central Statistics office.

Hip Fractures are also costly for the patients, with up to half suffering long-term disability, 25% requiring long-term nursing care while up to 25% dying in the first year following hip fracture. Survivors of hip fracture have between 5 and 10 fold increased risk of second hip fracture (Harwood et al 2004) usually within the first year. The probability of sustaining a second hip fracture in the course of an individual's life could reach 20% (Segal et al 2005). This risk becomes increasingly important in the light of increased longevity of the older population. Bearing in mind the exponential increase in hip fractures with advancing age in women and men over the age of 75 years the number of second hip fractures is expected to increase with the increase of first hip fractures. The worldwide incidence of hip fracture is expected to increase from approximately 1.5 million in 1990 to 4.5–6.3 million in 2050 (Gullberg 1997).

Most hip fracture result from falls however the role of fall related factors has seldom been examined (Dargent-Molina et al 1996). One in three adults over the age of 65 years fall at least once a year. This risk increases with advancing age.

It is well documented that Osteoporosis is deemed to be an important factor contributing to hip fracture (Cummings et al 1995, Porthouse et al 2004). Burge et al (2007) states that of 297,000 hip fractures in 2005 in over 45 year olds, osteoporosis was the underlying cause in most of these injuries. The objective of treating osteoporosis is to prevent the occurrence of fracture. Among the fractures attributable to osteoporosis, hip fracture has the most important influence on survival, quality of life, and medical costs (Osaki et al 2012) hence the importance of assessing and treating for osteoporosis in all hip fractures patients.

1.2: Rationale for Study

Hip fractures are a major health problem in older adults and an important cause of mortality and morbidity in the elderly (Meyer et al 2000, Cree et al 2001). It is well recognised that hip fracture incidence increases exponentially with age above the age of 50 years (Marks 2010) hence as the world population ages the prevalence of osteoporosis and the incidence of hip fractures will subsequentially increase (Kannus et al 1996, Gullberg et al 1997). Dodds et al (2009) predict that hip fracture rates in the Republic of Ireland will increase by 100% by the year 2026. This has major implications for the planning, allocating and delivery of health care resources and services for the older adult population.

It is important that preventative measures are put into practice following first hip fracture in the hope of reducing subsequent hip fracture. The identification of falls risk factors, bone health status, and ability to self care, post hip fracture, can have implications for the setting up of services post discharge. As seen in previous studies (Magaziner et al 1990, Van

Balen et al 2001, Shyu et al 2003) most recovery in activities of daily living, mobility and quality of life occur within the first six months post fracture which may indicate the need for an early assessment following discharge to allow continuation of the rehabilitation process and assessment of problems experienced since fracture.

This assessment should incorporate referrals to other healthcare professionals to enable a multidisciplinary approach to be implemented.

1.3: Purpose Statement

- A Clinical Nurse Specialist will carry out a falls risk assessment within 3 months following a hip fracture on all patients attending the study site for treatment of hip fracture.
- Will assess the bone health of these patients using biochemical markers and radiographic and ultrasonic analysis.
- Will compare the quality of life of these patients post hip fracture to that prior to the fracture at 3 and 12 month post fracture.
- Will assess the dietetic index of these patients.
- Will compare outcomes of these patients with outcomes of patients who did not receive a 3 month appointment with the Clinical Nurse Specialist post hip fracture.

1.4: Theoretical Framework

A theory is a systematic way of understanding events or situations. It is a set of concepts or definitions that explain or predict these events or situations by illustrating the relationship between variables (Gantz 1997). While not every study is underpinned by an actual formal theory every study has a framework, a theoretical framework. A theoretical framework is described as a brief explanation of a theory or those portions of a theory to be tested in a quantitative study (Burns and Grove 2007 p171). Theoretical framework and conceptual frameworks are terms which are commonly interchanged in the literature. However Parahoo (2006 p156) differentiates between the two describing the term 'theoretical framework' as more appropriate for research underpinned by one identified theory, while a conceptual framework' identifies concepts from various theories and research findings to guide the study.

Effective public health, chronic disease management and health promotion programs help people maintain and improve health, reduce disease risks, and manage chronic illnesses. Usually these programs require some behavioural change on the individual's part. Rimer and Ganz (2005) state that using theory provides a foundation for studying problems, developing appropriate interventions and evaluating their success. It allows for the identification of most suitable target audiences and methods for fostering change successfully.

There are many health behaviour theories which draw upon many different disciplines, including psychology, sociology, anthropology, consumer behaviour, and marketing. The use of theory in answering the questions of why a person practices the health related behaviours that they do allows for the development of an evidence base on which to identify practises that will improve such engagements. Theories are at the heart of practice, planning, and research and as such are integral to healthcare practice, promotion, and research (Burns and Grove 2007 p171). As the choice of theory can shape the way practitioners and researchers collect, interpret and use evidence it is important and practical that theories are examined and understood.

Chapter 2

Literature Review

2.1: Introduction

Hip fracture is a major healthcare problem in terms of cost and suffering for both the sufferer and the healthcare system. It is a commonly encountered problem particularly in the elderly and associated with substantial morbidity and mortality. For many years hip fracture has been identified as one of the most serious healthcare problems affecting older people hence much attention and research has been conducted to reduce the incidence and severity of this condition (Marks 2010). While the lifetime risk for hip fracture for a white woman of 50 years is about 15%, equivalent to the risk of developing breast cancer (Sambrook and Cooper 2006) the vast majority of hip fractures occur in the older age group.

2.2: Prevalence of Hip Fractures

Several epidemiological studies have highlighted a wide geographical variability in hip fracture incidence. Data published since the early 1990s relating to the incidence of hip fracture have generally shown the incidence to be increasing. Global numbers have been reported at 1.3 million hip fractures in 1990, with an increase in this, depending on secular trends, to between 7 and 21 million by 2050 (Gullberg et al 1997). This may be explained by the increasing life expectancy and rising proportion of the elderly throughout the world. However, while some countries have reported an increase in age adjusted hip fracture incidence (Iga et al 1999, Kannus et al 1999, Hasino et al 2005) others have suggested a decrease in fracture rates (O Lofman et al 2002, Change et al 2004, Jaglal et al 2005, Abrahamsen and Vestergard 2010, Vanasse et al 2011). The reasons for this decrease is as yet unclear in the literature but possible explanations put forward are increased osteoporosis assessment and treatment in the elderly population, improved dietary intake and general health in the aging population, and increased Vitamin D supplementation (Abrahamsen and Vestergard 2010). Despite this leveling off or reduction in hip fractures in some geographical areas the vast majority of research on this subject predicts an increase in hip fractures particularly in elderly adults (Gullberg et al 1997, Lyons 1997, Kannis et al 1999, Lofman et al 2002, Hagino et al 2005, Marks 2010).

Between 1990 and 2000, there was nearly a 25% increase in hip fractures worldwide with the peak number of hip fractures occurring at 75-79 years of age for both sexes (Johnell and Kanis 2006). By 2050, the worldwide incidence of hip fracture is projected to increase by 310% and 240% in women and men respectively (Gullberg et al 1997). In Ireland the rate of hip fracture for the total population aged 50 years and over are 407 and 140 per 100,000 for females and males, respectively (Dodds et al 2008) who predicts this rate to increase by 100% by the year 2026. With this increase in numbers will come an increase in cost.

2.3: Types of Hip Fracture

Hip fractures occur in the proximal (upper) portion of the femur, just outside the area where the femoral head (ball) meets the acetabulum (socket) within the pelvis. They are generally classified into three major types, depending on the location of the fracture: femoral neck, intertrochanteric, and subtrochanteric fractures. Most femoral neck fractures occur within the capsule that surrounds the hip joint and are therefore termed intracapsular.

2.4: Cost of Hip Fractures

Although the economic impact of hip fracture is thought to be important and to be increasing (Cooney et al 1997), the true medical costs attributable to hip fractures remain uncertain (Johnell et al 1997). Estimation of the economic burden tends to be based on acute hospital care (Autier et al 2000). According to Laurence (2005) the mean hospital expenditure per patient in the UK was calculated to be £12,163 whilst in the US it is estimated to be $7,000 for acute care and $21,000 for the first year (Johnell et al 1997). Based on the latter cost, Johnell estimates that the total cost of hip fractures worldwide in 2050 will be $131.5billion.

In Ireland estimation of inpatient cost of hip fractures range from €9.236 to €14,339 per patient (Azhar et Al 2008, Cotter et al 2005) The total inpatient cost for fractures for the over 65 age group is €58 million with hip fractures representing two thirds of this cost (Gannon et al 2007). She also estimates long term care for hip fracture patients at €72 million.

2.5: Risk Factors for hip fractures

The aetiology of hip fractures is multifactorial, including bone and fall related risk factors (Geusens et al 2010). Various risk factors for hip fractures have been identified in the literature. Research carried out by Hayes et al (1996) demonstrated that over 90% of hip fractures occurred following a fall. Since then much research has been conducted into falls related mediators such as balance impairment (Kumala et al 2007), neuromuscular and musculoskeletal impairments (Meyers et al 1996), vision impairment, malnutrition, reduced mobility and functional status and chronic medical conditions.

2.5.1: Falls

A fall is a major event in the life of an older person which can have disastrous consequences. Each year in Ireland approximately 280 people die from accidental falls with more than 75% of these over the age of 65 years (Barry et al 2001). Falls in the elderly are a common presenting complaint to accident and emergency departments and are the most common cause of hospitalisation for older people (Cryer 1992). They account for approximately 10% of visits to the accident and emergency department (Tinetti M. 2003). Of the 8000 older people hospitalised annually due to injury in Ireland, falls account for 80% of those admissions. They are a serious problem for acute and continuing care facilities. For the person that falls the consequences can include injury such as lacerations, bruising, fracture, a fear of future falls, anxiety, depression and/or loss of confidence, all of which may lead to greater disability and increased risk of falling. Falls are multifactorial in nature. The risk of falling increases in elderly people with the number of risk factors i.e. an elderly person with no risk factors for falls has an 8% risk of falling while this increases to 78% among those with 4 or more risk factors (Tinetti 2003). Risk factors have been divided into two categories- intrinsic and extrinsic factors Intrinsic factors include age, falls history, poor muscle strength, gait disorders, impaired balance, poor nutritional status, poor vision, cognitive impairment, medications and underlying medical conditions such as Cerebral Vascular Accident, Parkinsons disease and Postural hypotension. Extrinsic factors include cluttered environment, poor lighting, slippery surface, unsuitable footwear, physical restraints and cotsides.

2.5.2: Age and gender

Almost 75% of all hip fractures occur in women with 25% occurring in men over the age of 50 years (Jordan and Cooper 2002). The risk of suffering a hip fracture rises exponentially with age (Lauritzen 1996). A 70 year old lady is five times more likely to fracture than her younger counterpart (Jonsson et al 1999). it has been reported that 48% of men and 66% of female in a white population in Australia were found to suffer hip fractures before the age of 80 and 85 years respectively (Chang and colleagues 2004). Scott (1990) claims that adults over the age of 85 years are 10-15 times more likely to fracture their hip than those younger than this age. It it has been predicted that almost a quarter of the population in Europe will be aged 65 years by 2025 resulting in a consequential increase in the number of hip fractures (Woolf et al 2003).

2.5.3: Reduced mobility and functional status

Over the past 20 years a large amount of research has shown that physical inactivity and reduced functional status can lead to hip fracture (Lyritie et al 1996, Cummins et al 1995,. Coupland et al 2003). Because of the severe negative effect physical inactivity has on muscle physiology, bone health and vitamin D synthesis, it can be offered as one of the most important explanatory factors for the increasingly high hip fracture rates reported (Marks 2010). Findings from various epidemiological studies have highlighted that past and present physical activity is protective against hip fractures, the risk reduction being between 20-70% (Joakimsen et al 1997, Kujala et al 2000, Gregg 2000, Nordstrom et a 2005, Kannus 2005). This is supported by Freskanich (2002) who found that moderately active women were substantially less likely to fracture their hip compared to more sedentary women. Hoidrup et al (2001) identified an inverse relationship between physical exercises and hip fracture risk with a causal relationship between inactivity and hip fracture. This protective influence of exercise may be due to the fact that regular exercise can increase muscle strength and endurance, and improve gait in the elderly, which results in better motor control and protective response (Wei et al 2001). Tosteson et al (2007) found that the elderly who suffered a hip fracture reported more limitations and more severe limitations in ADLS and IADLS than those who did not fracture. People who were independent in ADLs prior to fracture were 1.8 times as likely to survive as were those who were not independent (Pernod et al 2008). Likewise those who walked independently before the fracture were twice as likely to survive to 6 months as those who were not independently mobile.

Many hip fracture patients experience severe functional impairment following their fracture, and most never recover their pre-fracture level of functioning. It would appear that along with other risk factors prefracture physical ability predicts greater functional impairment following a hip fracture (OTA 1994).

2.5.4: Bone Health

The measurement of bone mineral density (BMD) is used in the diagnosing of Osteoporosis, a systematic disease characterised by low bone mass and microarchitectural deterioration in bone tissue, with a consequent increase in bone fragility and susceptibility to fracture. BMD has been identified in many studies as an independent risk factor for hip fracture. (Wei et al 2001, Kanis et al 2004,). Marshall et al (1996), in a large meta-analysis of prospective cohort studies, identified the relative risk for hip fracture at 2.6 per standard deviation of decrease in BMD. The prevalence of osteoporosis in people with hip fracture has been reported in several studies (Schott et al 1998 EPIDOS, Black et al 2001, Lyles et al 2007) with rates of between 40 -50% being reported. A relationship between bone loss in the hip and increased hip fracture in an elderly osteoporotic population has been identified

(Bruyère et al 2009). The relationship between BMD and hip fracture risk is strongly dependent on age. Bates et al (2002) reports a lifetime risk for hip fracture at any age between 50 and 80 years is 10% at a T-score of 0, 33% at T-score of -2.5 and 41-49% at a T-score of -3.5. Likewise it is significantly correlated with functional mobility and low body mass which together are predictive of falls which can result in hip fractures. While not all people who suffer a hip fracture have osteoporosis it is an important risk factor and predictor for further hip fractures.

2.5.5: Co-morbidities

Many chronic illnesses associated with aging such as arthritis, parkinsons, Stroke, Chronic Obstructive Pulmonary Disease (COPD), Chronic Cardiac Failure (CCF), arrhythmias and postural hypotension, substantially increase the risk of falling and hence hip fractures.

Falls and hip fractures in the elderly are commonly associated with the presence of multiple co-morbidities according to various studies (Roche et al 2005, Vu et al 2011,) and their negative influence on hip fracture outcomes has been studied and reported at length. Pernod et al 2008, Robbins et al 2006, DE Luise et al 2008). An increase risk of hip fracture in people who suffered from Diabetes (Schwartz et al 2001) while Sennerby et al (2009) found generalised cardiovascular disease, particularly heart failure or stroke to be an independent risk factor for hip fracture. This is reiterated by Carbone et al (2010) who determined that heart failure was a specific risk for hip fracture. Biskobing (2002) found that COPD increased the risk of osteoporosis and hence fractures while Reinmark et al (2007) identified an increase risk of fracture in patients with atrial fibrillation. Chronic conditions such as arthritis, Parkinsons and other forms of disability associated with falling may also increase the risk of sustaining a hip fracture (Cooper et al 1995, Sato et al 2000, Brent at al 2004).

Dementia and cognitive decline has also been indicated as a risk factor for hip fracture and is discussed below.

2.5.6: Impaired cognition

Patients with dementia are at increased risk of hip fractures because they may have defective neuromuscular regulation, gait apraxia, use more antidepressants and have a lower body mass index (Chen et al annals academy of medicine 2007). Dementia not only affects costs, it has a detrimental effect on post fracture mobility (Matsueda and Ishii 2000) and increases the risk of death post operatively (Muraki et al 2006). Dementia has been reported to have a significant negative impact on survival, mobility and ADL independence at 6 months (Penrod et al 2008). The presence of comorbidities particularly dementia, resulted in a longer inhospital stay and subsequent cost (Chen et al 2007).

2.5.7: Poor nutritional status

Most people who fall and fracture their hip are thin and frail (Murray et al 2001). This is in agreement with Lauritzen (1996) who also stated that hip fracture patients weigh less and have less subcutaneous tissue covering the hip.

Nutrition is one of the important modifiable factors in the development and maintenance of bone mass and the prevention of Osteoporosis (Ilich et al 2000). As calcium and phosphorus compose roughly 80-90% of the mineral content of bone they play a key role in bone health. Protein likewise is very important as it is incorporated into the organic matrix of bone for collagen structure upon which materialisation occurs and accounts for nearly 50% of bone tissue volume. As bone turn over requires a continuous supply of new protein, adequate ingestion of same is essential. Grisso 1991 and Heaney (1993) identify protein deficiency as a possible contributor to the occurrence of hip fracture by reducing muscle strength, impairing movement coordination, and diminishing the protective layer of soft tissue padding. This was reiterated by Rizzoli (2001) who also associated protein depletion with low IGF-1 levels (Insulin like growth factor-1). IGF-1 favourably influences skeletal integrity, muscle strength and immune response. It has been shown to increase bone mass (Ammann et al 1993,1996, Bonjour 2005) and have a direct effect on bone forming cells. Schurch et al (1998) found that protein supplementation in elderly persons with low protein intake increased levels of IGF-1 and decreased bone loss by approximately 50% in the first year following hip fracture. Several studies have associated protein depletion with increased bone loss at the femoral neck (Bonjour et al 1997, Hannan et al 2000). The amount of bone loss would appear to be directly related to protein intake. It has been found that persons in the lowest quartile of protein intake showed the greatest bone loss (Hannan 2000). This was highlighted by Dawson-Hughes and Harris (2002) who found that protein intake in the calcium supplemented group was positively associated with bone gain with those with the highest protein intake gaining bone and those with lowest protein intake losing bone.

Likewise adequate levels of Calcium and Vitamin D are essential components for healthy bones. Calcium has been the primary focus of nutritional research for the prevention of postmenopausal osteoporosis (Feskanich et al 2003). There are many studies that highlight the benefits of adequate calcium intake, some attributing calcium supplementation to bone loss reduction (Heaney 2000) and decreased risk of fractures (Reid et al 1995, Recker et al 1996). However as calcium is usually given with vitamin D it can be difficult to attribute such benefits to calcium alone. It was found that although vitamin D was associated with reduced risk of osteoporotic hip fracture in postmenopausal women, a high calcium intake was not (Feskanich 2003). As such Calcium and Vitamin D will be discussed at a later point in this document as part of the medical treatment for Osteoporosis.

2.5.8: Visual Impairment

With advancing age there is a generalised reduction in visual functioning. Buch et al (2001) identified age as an independent risk factor for visual impairment while Ahmed (2003) found that the prevalence of visual impairment increased significantly with age, increasing from 3.1% in the 65-74 year age group to 35.5% in the 85 years and older age group. Visual impairment includes reduced visual acuity, reduced contrast sensitivity and impaired depth perception.

Visual acuity is the measurement of spatial resolution usually at high contrast. This sort of vision is used for perceiving fine detail. Contrast sensitivity is crispness of vision, enabling us to see objects that do not stand out from their backgrounds. Contrast sensitivity is often referred to as "functional vision. It is useful for detecting large objects in a cluttered environment. It has been reported to have a significant relation with ability to perform activities of daily living (Haymes et al 2002) while Lord et al. (2000,2001) reported it to have influence on postural stability and falls in the elderly.

Visual impairment has long been recognised in various studies as a potential risk factor for falls and fractures. (Ivers RQ et al 2003, Felson DT et al 1989, Grisso et al 1991, Dargent-Molina et al 1996, Klein BE et al 1998). It has been found to be an independent risk factor for falls (Lord et al (2001) Dargent-Molina et al 1996). Likewise the Framingham study found that for women with poor or moderately impaired vision, the risk of hip fracture was doubled. This was reinforced by Dunward (1999) who reported that as visual acuity decreased the relative risk of falling and hip fracture increased. Visual impairment although highly prevalent in the elderly is commonly unreported (Keane et al 1997). Visual impairment is defined as existing when the level of vision is below that which the individual requires for his or her tasks. A common cut of point is taken as a binocular visual acuity of 6/12 as used by Evans JR et al in the MRC study. The most common cause of visual impairment are refractive errors, Cataracts, Diabetes, Glaucoma, Macular degeneration and visual field loss.

2.5.9: Consequence of hip fracture

Hip fractures are expensive not only for the healthcare services but also for the sufferer in terms of poor outcomes. They have been shown to result in excess mortality, increased morbidity and reduced quality of life (Meyer et al 2000, Cree et al 2000).

2.5.10: Increase Mortality

According to the Scottish Intercollegiate Guidelines Network (2002) hip fractures are associated with a 12 month mortality rate of 30% with the majority of patients who survive not returning to their former level of mobility or independence (Chilov et al 2003). The most important consequence of hip fracture is that of high mortality rate and reduced functional ability (Alegre-Lopez 2005). He includes reduced mobility, loss of independence and a lower possibility of returning to prefracture activities of daily living as functional ability. Various studies have deemed the mortality rate post hip fracture to be between 18-33%. (Magaziner et al 2000, Resnick et al 2002, Peterson et al 2006, Panula et al 2011). Panula et al (2011) demonstrated that the risk of mortality following a hip fracture was 3 fold higher than that in the general population and that the most common cause of death was circulatory diseases followed by dementia and Alzheimer's disease. It has been reported that only a third of hip fracture sufferers will be alive five years post hip fracture (Johansen 2010).

In Ireland, the mortality rate post fracture to be 26% (Kirke et al 2002). It has been highlighted in various studies that men with hip fractures have a higher mortality than women (Penrod et al 2008, Hawkes et al 2006, Endo et al 2005, Panula et al 2011). Male gender increases risk of death by 68% (Johansen et al 2010). The reason for this is unclear in the literature but Wehren et al (2003) suggested that men's health may be more unstable at time of fracture leaving them more vulnerable to post operative complications and infections. Similarly mortality rate post hip fracture for non white patients would appear to be higher than for whites (Jacobsen et al 1992, Lu-Yao et al 1994, Penrod et al 2008). Mortality following hip fracture would appear to be influenced by low prefracture mobility and functional status, presence of comorbidities, cognitive decline and increasing age. (Kristensen 2011, Bentler et al 2009, Penrod et al 2008). Dementia has been identified as the only comorbid condition which had a negative effect on survival, mobility and activities of daily living (ADL) independence (Pernod et al 2008)..

2.5.11: Reduced mobility and Functional Status

Reduced mobility and functional dependence is common in elderly people post hip fracture as highlighted by various studies (Magaziner et al 2000, Fredman et al 2005, Taylor et al 2010, Vochteloo et 2013). Bentler et al (2009) demonstrated that the functional decline of hip fracture sufferers was at least three times larger than that of non hip fracture patients. An estimate 25%-75% of those who are independent before their fracture can neither walk independently nor achieve their previous level of independent living within 1 year (Magaziner et al 2000). This was reiterated by Koot et al (2000) who reported that only 40%

survivors would regain their former level of mobility while only 25% would regain their former functional status. A possible reason for this rapid decline in function may be the deconditioning effect which can occur during the recuperative period due to the patient being less active while recovering (Magaziner et al 2003, Mangione et al 2005). Fredman et al (2005) reports that elderly women had a poorer performance based function over a 2 year period following hip fracture than would be expected by normal aging in same age women. Functional outcomes, i.e. mobility and ADL independence would appear to be influenced by pre fracture ability to perform these activities. People who were independent with walking and ADL activities prior to fracture were more likely to survive and regain their independence in mobility and ADLS (Pernod et al 2008). Functional disability following hip fracture is significant and can lead to the loss of independent living for a large number of hip fracture patients.

2.5.12: Institutionalisation

Survivors of hip fractures are five times more likely to require long term care than those of similar age who have not fractured (Roche et al 2005)). In Ireland, Kirke et al (2002) reports a mortality rate of 24% in hip fracture sufferers at two years with 26% of survivors residing in long term care units 2 years after the fracture. Similar results in various studies with 10-20% of formerly community dwelling patients requiring longterm care following a hip fracture (Cree et al 2000), Autier et al 2000), Kiebzak et al 2002). Both Wiktorowicz (2001) and Leibson (2002) concurred with this reporting long term care rates of 15% to 30% respectively.

2.5.13: Further falls and fracture

Recurrent and injurious falls are common during the year post hip fracture (Lloyd et al 2009). They found that while 30% of participants suffered a fall related injury in the first year post fracture, 12% of participants sustained a fall related fracture which was similar to fracture rates demonstrated by Hall et al (2001) and Berry et al (2007). People who fracture their hip are usually considered at risk of fracturing the contralateral hip (Marks 2010). A previous hip fracture increases the odds ratio of a later second fracture by 20 fold (Wiktorowicz 2001), with future bilateral hip fractures expected to rise with the rise of unilateral hip fractures. The second hip fracture usually occurs within 3 year of the first (Mitani et al 2010) and tends to be the same type (trochanteric or cervical) as that experienced in the first facture (Yamanashi et al 2005). Berry et al (2007) report that one year mortality rates can be approximately 10% higher following a second hip fracture than an initial fracture. Risk factors for second hip fracture identified in research include advancing age, respiratory problems, Parkinsons disease, pre fracture disability, dementia, blindness, malnutrition, Cerebral Vascular Accident (CVA) and syncope. (Hall et al 2001, Berry et al 2007, Bradley et al, 2009, Mitani et al 2010).

2.5.14: Fear of Falling

Fear of falling (FOF) is common in sufferers of hip fracture. It is estimated that between 40 and 73% of older fallers will experience FOF (King et al 1995) and this is seen to increase with age, is greater in women, in those living alone and those needing help with ADLs (Bertera and Bertera 2008). Tinetti describes FOF as a lasting concern about falling that leads to an individual avoiding activities that he/she is capable of doing (Tinetti and Powell 1993). Falls and particular injurious falls can cause people to lose confidence in their ability to function safely and can result in a fear of further falls (Legters 2002). It has been estimated that up to 50% of hip fracture patients can experience FOF (Visschedijk et al 2010). The prevalence of FOF appears to increase with age and is higher in women as reported by Scheffer et al (2008). The consequence of FOF is avoidance of physical activity which can lead to increased functional decline and hence increased falls. Activity restriction related to FOF can be an independent predictor of decline in physical function (Deshpande et al (2008). The Various studies have shown FOF to be associated with negative consequences such as falling, avoidance of activities, depression, decreased social interaction, reduced physical activity and lower quality of life (Suzuki et al 2002, Evitt and Quigley 2004, Jorstad et al 2005). FOF can also have a negative effect on rehabilitation as it can reduce participation in exercises during the rehabilitation process (Pettrela et al 2000, Lees et al 2005, Resnick et al 2007). It has been suggested that FOF and cognitive functioning may be more important than pain and depression in predicting functional recovery post hip surgery (Oude Voshaar et al 2006). They showed that a cognitive impairment and higher fear of falling are related to a less favourable functional recovery independent of age and pre fracture level of functioning.

FOF can also result in social isolation and depression due to the resulting decline in physical activity and social participation. Poor quality of life has been a consistent finding in studies related to fear of falling (Lach 2003).

2.6: Conclusion

Falls and fractures are common in the elderly, becoming increasingly so, with advancing age. They bring with them both psychological and physical consequences which can be detrimental to the person's ability to mobilise, perform activities of daily living independently and can reduce quality of life. One of the most serious consequence of falling is that of hip fracture. Older people who suffer a hip fracture face increased risk of death, physical disability and loss of independence. Falls and fractures are multifactorial in nature. Several risk factors for falls have been highlighted in the literature. There is a correlation between the number of risk factors and an increased risk of falling/fracturing. Identification of these factors is of the utmost importance particularly in patients who have already had a hip fracture due to their increased risk of further fracture.

The ageing population and an increasing number of hip fractures worldwide have made prevention of hip fractures a matter of importance. Many of the hip fractures, although not all, are associated with osteoporosis. Hip fracture, particularly in the elderly, result in problems that extend far beyond the orthopaedic injury, with repercussions in the area of medicine, rehabilitation, psychiatry, social work, and healthcare economics. Because osteoporosis is so prevalent in older people and can play such an important role in hip fractures it is discussed in more detail in chapter three.

Chapter 3

Bone Health

3.1: Introduction

Bone health assessment is an integral part of fracture prevention. Fractures are a result of both trauma and decreased bone strength. Trauma depends on factors related to falling and the force of the impact while bone strength depends on both the density (quantity) of the bone and on the quality of the bone. Whole bone strength is determined by bone mass, bone geometry (size and shape), microarchitecture and characteristics of bone material i.e. mineralization, collagen-characteristics and microdamage.

3.2: Composition of Bone

Bone is living tissue that is in a constant state of regeneration. It plays a structural role in the body and also acts as a reserve of calcium (BNF 2004) Ninety nine percent of calcium within the body is found in bones (Chapuy 1992). The strength of bone depends on the mineral composition and structure of the bone. Bone must be stiff and able to resist deformation, thereby making loading possible but must also be flexible. It must be able to absorb energy by deforming i.e., shorten and widen when compressed and lengthen and narrow in tension without cracking.

Two phases can be identified in the skeletal life cycle, modelling and remodelling. The modelling phase runs from birth to about the age of 30 years and consists of the laying down of bone and is outlined in figure 3.1 below. The attainment of peak bone mass is influenced by genetic factors, weight bearing exercises and a diet rich in calcium and

Vitamin D intake particularly in childhood and adolescence. After peak bone mass is reached, bone loss begins and persists until the end of life. Bone resorption predominates bone formation resulting in steady bone loss particularly pronounced in women in the first 5-15 years post menopause due to the loss of oestrogen (Jasminka et al 2000).

3.3: Bone Remodelling

Throughout life bone is constantly renewed through a two part process called remodelling. Remodelling involves the removal of old bone by special cells called osteoclasts (resorption) followed by the laying down of new bone by special calls called osteoblasts (bone formation). Physiological loading of the skeleton produces fatigue damage or microfractures in bone. It is this microdamage that would appear to initiate activation of remodelling to repair the damaged tissue.

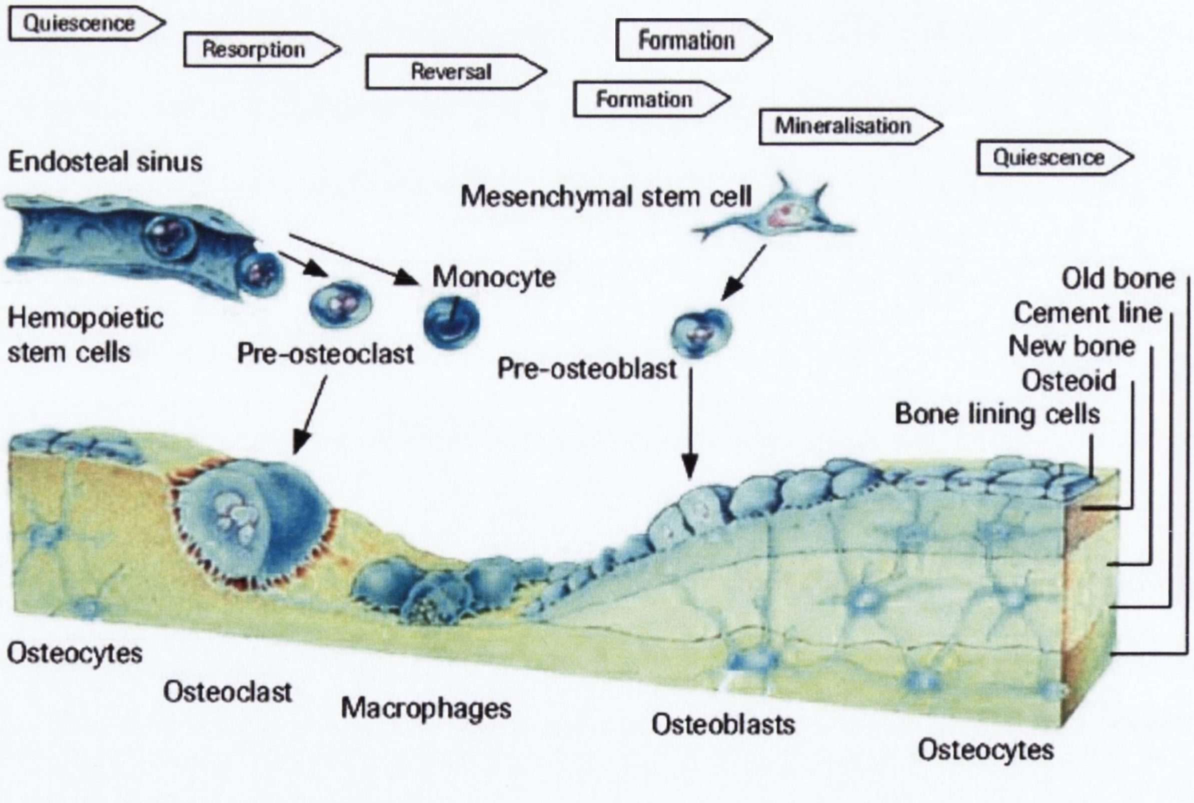

Figure 3.1: Bone Remodelling.

Bone remodelling is regulated by hormonal levels, calcium and exercise. Approximately 10% of bone mass is removed and replaced each year through bone remodelling (Watts 1999). The rate of bone resorption and formation can be monitored using biological products generated by osteoclastic and osteoblastic activity. Resorption markers are mainly degradation products of type 1 collagen peptides (CTX, NTX). Formation markers include osteocalcin (OC), bone alkaline phosphate and procollagen type 1 N-terminal propeptide (P1NP). Although bone markers are not diagnostic of osteoporosis, their use has been indicated in the prediction of bone mass, fracture risk and rate of bone loss (Garnero et al 2000, Gerdhem et al 2004). Perhaps the best and most reported use of bone markers is in monitoring the effectiveness of therapy (Weinstein et al 2003, Nenonen 2005). Bone markers can demonstrate treatment effectiveness within four weeks of therapy commencement. When bone resorption outstrips bone formation osteoporosis can occur. Age related bone loss usually occurs around 35-40 years of age and continues throughout life.

3.4: Osteoporosis

Osteoporosis literally means 'porous bones'. It is a disease which is characterised by low bone density and micro architectural deterioration in bone tissue leading to an enhancement in bone fragility and a consequent increase in fracture risk as defined in the Merck Medicus.

Bone strength incorporates the intergration of two main features: bone density and bone quality. The measurement of bone mineral density (BMD) by dual-energy x-ray absorptiometry (DXA) is used as an index of bone strength and fracture risk, and can be used to diagnose osteoporosis in some populations.

The World Health Organization (WHO) has proposed a clinical definition of osteoporosis based on epidemiological data that link low bone mass with increased fracture risk. It has defined osteoporosis in menopausal women as a BMD 2.5 or more SD below peak bone mass, osteopaenia as bone mass between 1.0 and 2.5 SD below peak, and normal as 1.0 SD below normal peak bone mass or higher. Osteoporosis is a silent disease as there are no symptoms and is usually diagnosed only following a low trauma fracture.

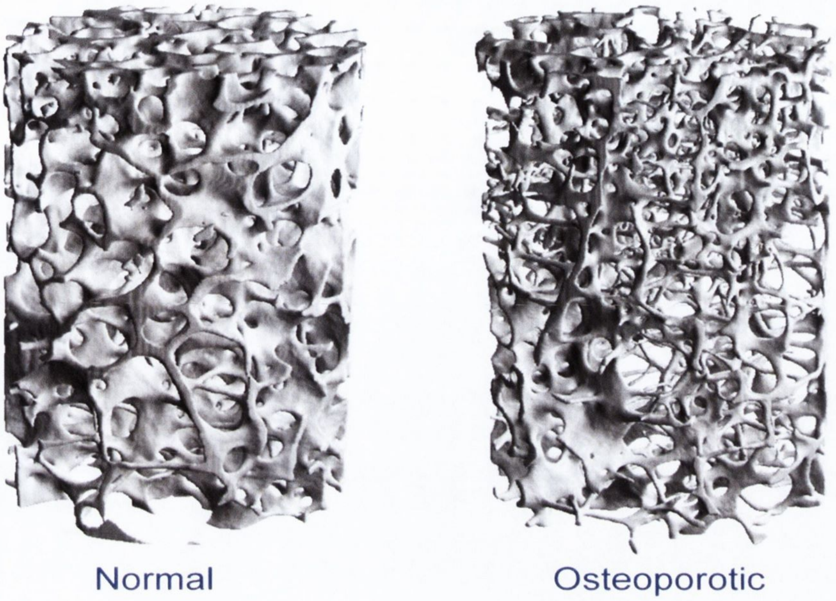

Figure 3.2: Normal Bone (on left) and Osteoporotic Bone (on right).

3.4.1: Prevalence of Osteoporosis

Osteoporosis is common particularly in post menopausal Caucasian and Asian women. The National osteoporosis Foundation has estimated that 8 million women in America has Osteoporosis with a further 2 million men suffering from the condition (i.e. 30% of all white women over the age of 50 years), with approximately 250,000 hip fractures a year. By the age of 80 years and over, 70% of people will have osteoporosis with the hip being affected in 47%. In the UK, SIGN (2003) states that while Osteoporosis affects both men and women, it is particularly common in postmenopausal women. One in three women and one in twelve men over the *age of 50* will suffer an osteoporotic fracture. Van Staa et al (2001) claim that 1 in 2 women and 1 in 5 men will suffer a fracture after the age of 50 years. The National Osteoporosis Society in the UK estimate that there are approximately 4 million people living with or at risk from Osteoporosis in the UK (2005)

A predicted global increase in the elderly population will result in a substantial increase in the prevalence of osteoporosis and subsequent increased risk of fracture. It is anticipated that there will be a 4-fold increase in the global fracture rate over the next 50 years according to Riggs and Melton (1995).

3.4.2: Cost of Osteoporotic Fractures

Osteoporosis is a major public health problem. It exerts appreciable costs both in economic terms and human suffering. Osteoporosis and its related fractures cost the NHS in the UK an estimated £1.8 billion, 87% of which is due to hip fractures (NICE 2012). The cost of treating all osteoporosis fractures in post-menopausal women has been predicted to increase to more than £2.1 billion by the year 2020 (Burge et al 2001). According to the surgeon general's report on bone health and osteoporosis (2004), osteoporotic fractures cost the American healthcare system $18 billion each year. In Ireland, it is estimated that hip fractures can cost €14,500 per admission (Cotter et al 2006). Osteoporosis fractures can have huge personal costs for the individual. The most common fractures associated with osteoporosis are fractures of the vertebrae, hip and wrist.

3.4.3: Risk factors for Osteoporosis

Osteoporosis is usually a disease of older age, although it can affect people of any age. There are several key risk factors for developing osteoporosis, including genetics, increasing age, gender, lifestyle, previous fractures, chronic diseases and medication. These are discussed below.

Genetics: A parental history of osteoporosis or/and fracture, especially a family history of hip fracture over the age of 50 years increases the risk of a person experiencing a fracture according to Kanis et al (2004).

Age: Those over 65 years of age are at particular risk for osteoporosis. Kanis et al (2005) state that changes in age is approximately 7 fold more important than changes in BMD in predicting fracture risk.

Gender: As previously stated osteoporosis is more common in women particularly post-menopausal women. It affects one in three women over the age of 50 years and one in five men. This may be due to the fact that women start out with lower bone mass and tend to live longer. They also suffer a sudden oestrogen drop during the menopause which accelerates bone loss according to Heaney et al (1978).Premature or surgical induced menopause also results in a early acceleration of bone loss and is a risk factor for osteoporosis in later life.

Lifestyle: Lifestyle behaviours that influence the development of osteoporosis include a low calcium and/or vitamin D intake, a sedentary lifestyle, excessive alcohol intake and cigarette smoking. Bone health begins in childhood. Children who are physically active and consume an appropriate calcium intake have the greatest bone density according to Ilich et al (1998) and reiterated by Nicklas (2003). Vuori (2001) reported that physical activity can delay the progression of osteoporosis by slowing the rate at which bone mineral density is reduced from the late twenties onwards. Feskanich et al (2002) identified a 55% reduction in the risk of suffering a hip fracture in women who are active for at least 6 hours a week compared to women who lead a sedentary lifestyle. An alcohol intake of 2 units a day increases the risk of osteoporotic fracture according to Kanis et al (2005) as does smoking. Kanis et al (2004) found a significant increase in the risk of osteoporotic fractures in smokers and ex-smokers compared to non smokers.

Previous fractures: A history of any kind of bone fracture as an adult (after the age of 45 years) increases the risk of osteoporosis. Klotzbuecher et al (2000) and Wu et al (2002) both reported that adults who sustain a fracture are over 50% more likely to have another one of a different type. Likewise Black (1999) identified women with one vertebral fracture as having a five fold risk of sustaining another vertebral fracture.

Chronic diseases and medication. Certain types of medications can damage bone and lead to what is called "secondary osteoporosis". This type of osteoporosis occurs in 20% of women and 40% of men with osteoporosis. Long term use of glucocorticoids (oral steroids) to treat conditions such as asthma and arthritis are particularly damaging to bone. Van Staa et al (2002) reported that patients prescribed 7.5mg or more of prednisolone daily had a 50% increase risk of sustaining a non-vertebral fracture. Other medications detrimental to bones include heparin, anti convulsants and cancer treating drugs such as methotrexate. Medical conditions such as hyperthyroidism, Cushings, Crohns, Coeliac disease, and Vitamin D deficiency, renal impairment can all increase the risk of developing osteoporosis as can reduced sunlight exposure, reduced calcium intake and Estrogen deficiency. The pathogenesis of bone loss is illustrated in figure 3.5.

3.4.4: Diagnosis of Osteoporosis

DXA or dual energy x-ray absorptiometry is the 'gold standard' method of diagnosing osteoporosis (Cook et al 2005). For the test a patient lies down on an examining table and the scanner rapidly directs x-ray energy from two different sources towards the bone being examined in an alternating fashion at a set frequency. The bone mineral density of the patient's bone prolong the transmission of these two sources of x-ray through a filter onto a photon counter. The greater the bone mineral density, the greater the signal picked up by the photon counter. The use of two x-ray energy sources rather than the more traditional radio-isotope studies greatly improves the precision and accuracy of these measurements. DXA, as seen below (figure 3.3) uses the attenuation of x-ray through bone to measure bone mineral content at a skeletal site usually the lumbar spine (Figure 3.4), hip or wrist. DXA, although reliable and safe is expensive and requires the supervision of a qualified radiographer (Cook et al 2005).

DXA scan is the most widely used and accepted method of investigation for osteoporosis. It is accurate, reproducible and uses low dose radiation. Quantitative Ultrasound on the other hand is radiation free, mobile, easy to use and a less expensive measurement of bone status. It measures bone mass and may also be useful in assessing bone micro structure (Chin and Ima-Nirwana et al 2013). The ability of Calcaneal quantitative ultrasound has been identified in various studies has having predictive qualities for hip fracture risk (Cummins et al 2002, Khaw et al 2004). Once osteoporosis is diagnosed using either DXA or calcaneal ultrasound treatment should be commenced. The various methods of treatment are discussed below.

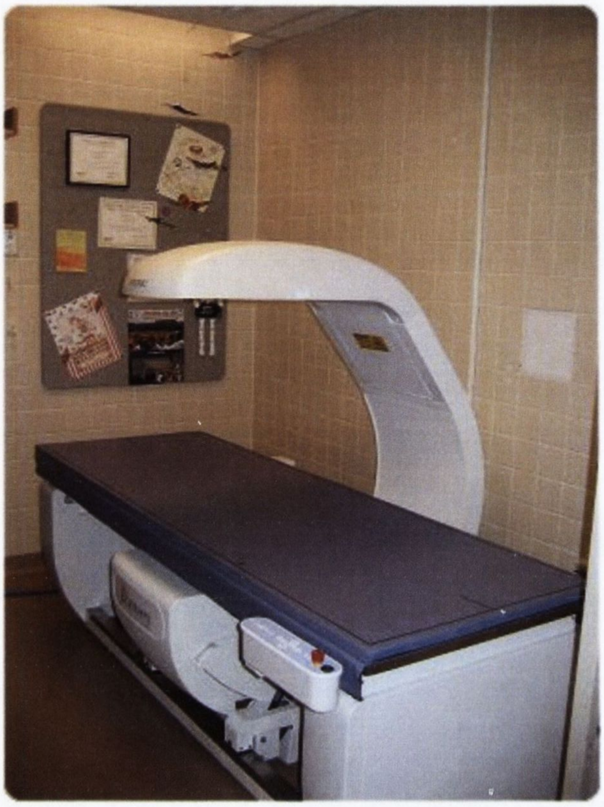

Figure 3.3: Lunar prodigy DXA scan machine

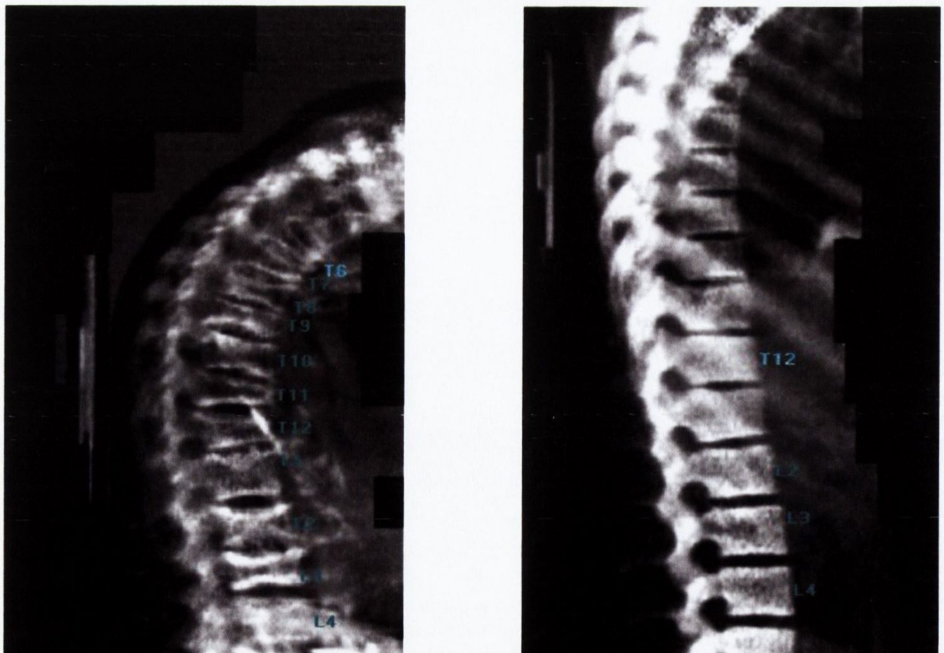

Figure 3.4: Images produced with lateral morphometry

3.4.5: Prevention and Treatment of Osteoporosis

Any osteoporosis prevention or treatment program should include weight bearing exercise, fall prevention strategies, alcohol and smoking cessation, advice and guidelines on diet, in particular calcium and Vitamin D intake and medication. An adequate supply of calcium and vitamin D not only acts as a preventative measure for the development of osteoporsis but is also the corner stone of treatment for people diagnosed with osteoporosis. Calcium intake plays an important role in bone health throughout the lifespan. There is a continuum in bone health for any given age group which is genetically determined and possibly environmentally modified. Changes in bone mass in women occur throughout the various stages of a women's life. These changes are influenced by genetics, hormonal status, mechanical loading and calcium intake (Ilich and Kerstetter 2000). Calcium requirements vary in the course of a person's life. During periods of rapid bone accretion such as pubertal period as highlighted by Molgaard et al (1999), the need for a daily positive calcium balance is of great importance.

Calcium intake can influence the risk of osteoporosis by affecting the genetically determined peak bone mass (Nicklas 2003). There is a general consensus between several organisations that low calcium intake is a major component in the development of osteoporosis (NIH 2000, 2012, BNF 2005). They report that deficiencies in calcium and vitamin D in childhood may prevent the maximum deposition of calcium in the skeleton. Most of the longitudinal studies carried out on calcium supplementation in children have shown a beneficial effect with an increase in bone mass accretion of between 1 and 5% at all sites (Bonjour et al 1997, Cadogan J et al 1998, Fischer et al 1999, Winzenberg et al 2006).

Bone density progressively decreases with age (Emaus et al 2005). This was also reiterated by Chapuy (1992) who identified mechanisms influencing bone loss as hormonal reduction associated with the menopause, low calcium intake, decreased calcium absorption in older women and vitamin D deficiency. Low calcium intake and vitamin D deficiency is particularly common in non Scandinavian countries (Chapuy 1992). The response of the body to a low calcium and vitamin D level is to increase the production of parathyroid hormone leading to hyperparathyroidism which results in an increased bone turnover and bone loss.

Nordin et al (2004) found that calcium absorption in women, 75 years and over, was reduced by nearly 30% over and above the decline that normally occurs at menopause. This has serious implications for the older female as reduced calcium absorption has been highlighted in women with fractures, particularly those of the vertebrae and hip (Ensrud 2000), Nordin 2004). In later adulthood the cessation of oestrogen production in women and testosterone in men can lead to an accelerated bone loss. Various studies have reported a positive effect of calcium supplementation on bone mineral density (BMD) in older adults. (Di Daniele et al 2004, Kärkkäinen et al 2010). It is important to note that although the effect of dietary calcium on bone is weaker than oestrogen, bisphosphates and calcitonin, it is the basis from which any other treatment should start (Ilich et al 2000). Low calcium intake and low vitamin D status result in insufficient calcium absorption.

Vitamin D is essential for ensuring dietary calcium absorption, normal mineralization of bone and prevention of secondary hyperparathyroidism (Holick MF. 1999). Humans get vitamin D from exposure to sunlight, from their diet and from dietary supplements (Holick 2007). About 90% of the daily recommended intake is obtained from the action of the sun on the skin while the other 10% is supplied by the diet. Vitamin D synthesised in the skin from sunlight and in the gut from diet, is metabolised by the liver into 25 hydroxyvitamin D which is the form used to measure levels of Vitamin D in the serum. This in turn is metabolised by the kidneys to its active form called 1 dihydroxyvitamin D. This active form of vitamin D interacts with the vitamin D receptors increasing the efficiency of intestinal absorption of calcium by about 30 -40% (Heaney 2003).The body's ability to store vitamin D is very important as the synthesis of vitamin D takes place during the summer months.

Deficiencies in Vitamin D lead to impaired mineralization of bone and the development of rickets in children and osteomalacia (soft bones) in adults. Vitamin D insufficiency, the preclinical phase of vitamin D deficiency is most commonly found in the elderly (Gennari 2001) who also identified decreased renal hydroxylation of vitamin D, poor nutrition, reduced exposure to sunlight and a decline in the synthesis of vitamin D in the skin as the major causes of vitamin D deficiency and insufficiency. Although there is no consensus on optimal levels of 25 hydroxyvitamin D as measured in serum, a level of less than 20ng per millilitre (50nmol/litre) has been identified by experts in the field as vitamin D deficiency (Malabanan et al 1998, Thomas et al 1998, Holick 2006, Biscoff-Ferrati et al 2006),.

The prevalence of vitamin D deficiency varies according to the population studied. Age, latitude, season, race, and lifestyle all play important roles in vitamin D status. MacLaughlin and Holick (1985) identified the reduction in cutaneous levels of 7- dehydrocholesterol which occurs as skin ages as causing a 4 fold decrease in vitamin D production in a 70 year old compared to a 20 year old. Studies of various populations have shown a high prevalence of vitamin D insufficency in older adults. Corless et al in 1975 identified 80-100% of elderly care home residents in Europe, Australia and north America as having vitamin D deficiency. Likewise Van der Wielen et al (1995) found that 47% of older females and 36% of older males in the community in Europe were vitamin D deficient.

Many elderly patients also have a low dietary calcium intake (McKenna et al 1985, Chapuy et al 1996, Lips et al 2001). Hypovitaminosis D and low calcium intake both cause increased secretion of the parathyroid hormone (secondary hyperparathyroidism) and bone resorption leading to bone loss, an important pathway in the pathophysiology of osteoporosis (Campbell and Allain 2006) as seen in figure 3.5.

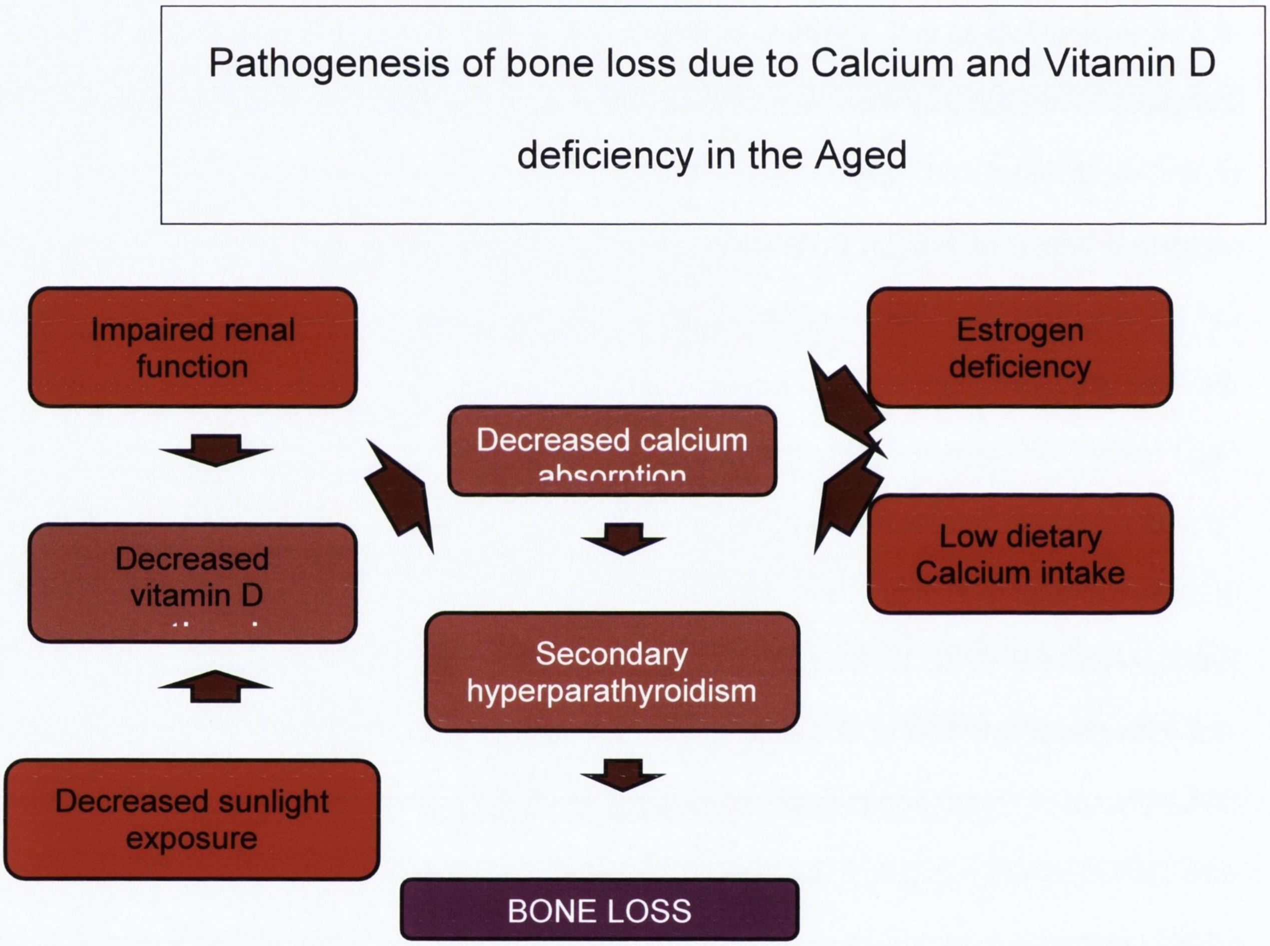

Figure 3.5: Algorithm of Pathogenesis of bone loss due to Calcium and Vitamin D deficiency in older people.

There is a general agreement that, in patients with documented osteoporosis, calcium and vitamin D supplementation should be an integral component of the management strategy, along with antiresorptive or anabolic treatment (Boonen et al 2006). In studies carried out by Chapuy et al (1992, 1994) and again in 2002 in the Decalyos II study, the benefits of vitamin D plus calcium compared to placebo were highlighted. In these studies supplementation with 800iu of vitamin D and 1200mg of calcium reduced the risk of hip fractures and other non vertebral fractures in elderly women by 43% and 32% respectively. A similar study carried out by Bischoff-Ferrari et al (2006) using doses of 700-800iu of vitamin D3 the relative risk of hip fracture was reduced by 26% while the relative risk of non vertebral fracture was reduced by 23%. Some of these studies are tabulated below (Table 3.1).

Trial	Treatment	Results
Chapuy et al. NEJM 1992. (n=3270 elderly French patients)	800 iu Vitamin D3 and 1200 mg Calcium vs placebo	Hip fractures reduced by 43% Non-vertebral fractures by 32%
Dawson-Hughes et al. NEJM, 1997. (n=389, >65)	700 iu Vitamin D3 and 500 mg Calcium vs placebo	58% reduction non-vertebral fractures
Womens Health initiative (n > 36000) 2006	400 iu Vitamin D3 and 1000 mg Calcium	No benefit in hip fracture - although compliant women had reduced hip fracture by 29% Increased risk of renal stones Little benefit if serum 25-OH Vit D <65 nmol/L
Record Trial (2004)	800 iu vitamin D3	No antifracture efficacy Mean 25-OH went from 37.9 to 61.9 nmol/L
Tang et al. Lancet, 2007. (N=63,897)	Meta-analysis of 29 randomised control trials. Patients aged >50yrs	12% risk reduction in fracture (17 trials) Treatment more effective in doses >800 iu
Porthouse et al (2005)	Nutritional assessment of Vitamin D and calcium	no evidence that calcium and vitamin D supplementation reduces the risk of clinical fractures in women with one or more risk factors for hip fracture.

Table 3.1: Below are several studies carried out on the efficacy of supplementation with calcium and vitamin D.

Pharmacological Treatment

Pharmacological treatment can be used in both the prevention and treatment of Osteoporosis. There are various published guidelines worldwide to be used by clinicians as a tool for clinical decision making in the treatment of individual patients (Royal College of Physicians and Bone and Tooth Society 2000, SIGN 2002, NOF 2008, National 2013). In addition to these guidelines the WHO introduced a tool which it developed to assess the fracture risk of patients – the Fracture Risk Assessment Tool known as Frax (WHO 2008). FRAX® is a simple web-tool that integrates clinical information in a quantitative manner to predict a 10-year probability of major osteoporotic fracture for both women and men in different countries (Kanis 2008). It was developed from studying population-based cohorts from Europe, North America, Asia and Australia. It is a web based calculation based on an individual's risk factors such as age, sex, weight, height, and femoral neck BMD if available, prior fragility fracture, parental history of hip fracture, current tobacco smoking, long-term use of glucocorticoids, rheumatoid arthritis, and daily alcohol consumption. The ten year fracture probability for that patient will be given as a percentage which gives guidance to the clinicians re the need for treatment.

The aims of osteoporosis treatment are the reduction of the incidence of fractures and the reduction of fracture related morbidity. Most of the drugs currently licensed for the treatment of Osteoporosis act by preventing further bone loss. These drugs can be divided into two categories, antiresorptives and anabolic agents. Anti-resorptives include bisphosphonates, Serms, HRT and Calcitonin. These agents reduce bone resorption and hence bone formation resulting in an increase in BMD. Anabolic agents which include full length Parathyroid Hormone (PTH1-84) and PTH 1-34.These agents increase bone formation and hence increase BMD.

Bisphosphonates are anti-resorptive agents commonly used in the treatment of Osteoporosis. The main effect of bisphosphonates is to inactivate the osteoclasts thus preventing bone loss (Papapoulos 2008). Five bisphosphonates are currently available for the treatment of Osteoporosis, Etidronate, Alendronate, Risedronate, Ibandronate and Zoledronic Acid. While all of these drugs have been shown to reduce fractures by between 30 and 50% in women with established osteoporosis (Black 1999), only alendronate and risedronate have been shown to reduce both hip and spinal fractures (Cummings et al 1998, McClung et al 2001) and are hence regarded as the first line choice for treatment of osteoporosis.

Other treatment options include Selective Oestrogen Receptor Modulators (SERMs) which are a class of drug that are similar to the hormone oestrogen. They provide the bone protection offered by oestrogen however do not have the increased risk of oestrogen related breast and uterine cancers. Raloxifene (Evista) is a SERM licensed for the treatment of osteoporosis and has been shown to reduce the risk of spinal fractures by 40-50% but not non vertebral fractures (Delmas 1997, Ettinger 1999). Its action is similar to oestrogen however unlike oestrogen there is evidence to suggest that it protects women against the development of breast cancer (Poole and Compston 2006).

Denosumab or Prolia is a monoclonal antibody used for the treatment of osteoporosis in postmenopausal women at increase risk of fracture. It is also used for the treatment of bone loss due to hormone ablation in men with prostate cancer. It inhibits bone remodeling by attaching to RANKL and is a subcutaneous injection given six monthly. It is associated with a two year sustained increase in BMD and a reduction in bone resorption markers resulting in reduced hip, vertebral and non vertebral fractures (Lewiecki et al 2007). Hormone Replacement therapy has been shown to slow bone turnover and increase BMD at all skeletal sites in early and late postmenopausal women (Bjarnason et al 1998, Torgerson and Bell-Syer 2001). It has been used for many years for the prevention and treatment of osteoporosis. Several studies have shown HRT to decrease fragility fractures by 20-35%% (Vickers et al 2007). However a large study (the Women's Health Initiative 2002) reported an increase in the rate of breast cancer, cardiovascular disease, stroke, and pulmonary embolism in women taking HRT longterm. Because of this it is viewed as a second line treatment for osteoporosis and usually used for short periods for menopausal women with menopausal symptoms. Parathyroid Hormone is a natural hormone secreted by the parathyroid gland and is an 84 amino acid peptide responsible for the modulation of calcium and phosphate homeostasis (Hodsman et al 2005). It is an anabolic therapy that stimulates bone formation and turnover unlike other treatments that are antiresorptive in nature (Riggs et al 2005). Both the entire molecule (1-84hPTH) and the amino-terminus of the molecule (1-34hPTH) have being studied in clinical trials and both have been found to decrease the risk of vertebral and non-vertebral fractures; increases vertebral, femoral, and total-body bone mineral density; and are well tolerated (Neer et al 2001, Bauer et al 2006). Both are given intermittently as a subcutaneous injection for a period of 2 years. Once the course of therapy is complete it a bisphosphonate should be prescribed to maintain the positive effect on the bones obtained by PTH treatment. As with any medication, good adherence is vitally important to gain the most benefit. Medication adherence with osteoporosis treatment is discussed below.

3.5: Medication Adherence

As stated above there are many therapies for osteoporosis with proven efficacy in randomised trials however these therapies must be taken for at least 6 months to be beneficial. Huybrechts et al (2006) reports that longer persistence with osteoporosis medication results in lower rates of fracture. While Siris et al (2006) found a reduced fracture risk of 26% in patients who were more than 80% adherent to their medication. Unfortunately this efficacy is often reduced by poor adherence. Compliance, Persistence and adherence are words commonly used and interchanged in osteoporosis literature. The Society for Pharmacoeconomics and Outcomes Research provide the definition which will be used for the purpose of this thesis. They define compliance as the extent to which a person acts in accordance with the prescribed interval and dose of a dosing regimen while persistence is defined as the length of time a person takes the prescribed medication assuming no large refill gaps. Adherence has been used as a global term which encompasses both compliance and persistence.

Medication adherence is poor in virtually all chronic illnesses but particularly in asympotomatic or silent illnesses such as hypertension and osteoporosis (Gold et al 2006). Poor adherence with osteoporosis medication has been identified in many studies (Tosteson et al 2003,Hamilton et al 2003, Ettinger et al 2004, Boccuzzi et al 2005 Solomon et al 2005), with rates of non adherence ranging from 25-75% (McCoombs et al 2004, Weycher et al 2006, Huybrechts et al 2006, Siris et al 2006). Poorer adherence to osteoporosis medications result in a less improvement in bone mineral density (BMD), less suppression in bone turn over markers, an increased risk of fractures and increased healthcare utilisation and cost.(Yood et al 2003, Caro et al 2004, McCombs et al 2004, Siris et al 2006).

Factors identified in the literature which influence osteoporosis medication adherence included, inadequate information about the disease, inadequate healthcare provider-patient interaction (Pickney and Arnason 2005, Roth and Ivey 2005), chronic and asymptomatic nature of disease, complex drug administration requirements and side effects (Lau et al 2008) and the health beliefs of the patient (Dimatteo et al 2007, Yood et al 2008, Lau et al

2008). Barriers such as belief in the presence of disease, severity of disease and effectiveness of treatment can influence adherence to medication (Cramer and Silverman 2006). They explain how people who do not believe that they have osteoporosis or who do not understand the consequences of the disease are less likely to take their medication. Likewise people who do not believe that the treatment will be beneficial are less likely to be adherent. This was reiterated by Lau et al (2008) who found that a perceived need to avoid negative consequences of osteoporosis facilitated adherence as did increased medication education. Yood et al (2008) also highlighted the importance of beliefs about medication benefits and distrust of medication in treatment initiation. Patients with a greater threat of disease severity have been shown to be more adherent with medications. (Yood et al 2008).

Strategies for improving adherence include improved patient education on osteoporosis, the need for and administration of medications and possible side effects and the effects of medication on BMD and fracture risk. The use of patient support programs and the monitoring of patients by a nurse have been shown to improve adherence (Clowes et al 2004) as has the extension of dosing intervals to once monthly (ibandronate), 6 monthly (denosumab) and yearly IV Zoledronic acid. Improved communication between healthcare provider and patient has been identified as an important contributor to medication adherence (Silverman 2006, DiMatteo et al 2007, Lau et al 2008)

3.6: Conclusion

Osteoporosis is a disease of the bone characterised by low bone mass and deterioration of bone tissue. It can result in fractures particularly of the wrist, hip and spine. It is common in both men and women with approximately 30% of women and 20% of men over the age of fifty suffering a fragility fracture in their lifetime. Various studies have highlighted the importance of identification, assessment and treatment of osteoporosis in the secondary prevention of fractures however it would appear to be a neglected area with some studies. Bone strength is related to mineral content which is assessed by bone densitometry. The risk of fracture increases with a decrease in bone density as measured by DXA. Low bone mass is the main determinant of bone fragility and it is an important risk facture for hip fracture (Dargent- Molina et al 1996). However, DXA allows for only a two dimensional representation of bone, and bone strength is directly related to its three dimensional properties i.e. its micro-architecture and the number and strength of trabeculae. Whether a fracture occurs depends on the impact of the fall and bone strength. Hence, assessing hip fracture risk requires a comprehensive and appropriate assessment of osteoporosis risk, incorporating the measurement of markers of bone turnover together with an assessment of risk factors for falls and medication adherence.

Falls are common in the older adult with a third of over sixty five year olds falling at least once a year, with approximately 10-15% of those resulting in fracture (Tinetti 2003). The risk of falling increases with age with half of eighty year ols and above falling annually. Recurrent falls increase the risk of fractures. After an initial low trauma fracture from a simple fall, there is an increased equivalent risk of all types of subsequent fractures, especially in the next 5-10 year (Center et al 2007). Hence the importance for falls risk assessment following hip fracture to reduce the incidence of future falls and fractures.

A holistic assessment and treatment of hip fracture patients for risk of future falls and fractures is equally important to reduce risk of further fractures. Physical assessment followed by treatment of deficits as well as psychological assessment is important to gain a complete picture of the consequences of hip fracture experienced by older adults. In this study a comprehensive assessment was carried out using various questionnaires to this end followed by referral to the appropriate discipline. The next chapter details the questionnaires used and the reasons for using them. It was deemed that a randomised control trial was the best research method to answer the research question. Chapter 5 details the methodological process employed in this study.

Chapter 4

Assessment Tools used in this Study

4.1: Introduction

In the previous chapter we have looked at the literature on hip fracture risk factors, consequences and outcomes and have purposed the question whether or not a coordinated follow up of these patients will lead to better outcomes. The specific outcomes of interest in this study were identified from the literature review. These include quality of life, activities of daily living, level of disability, fear of falling, nutritional status, osteoporosis knowledge, anxiety and depression status and medication adherence, all of which can be adversely affected post hip fracture.

To assess these outcomes a literature review was carried on the various scales commonly used when assessing the elderly person. The need for functional assessment of elderly people as part of routine clinical practice has been highlighted by the joint report of the Royal College of Physicians and the British Geriatrics Society (1992). This report recommended the regular use of standardized assessment scales in the activities of daily living, cognitive function and memory, depression, communication and quality of life which could be used in planning, clinical care, provision of support services, screening, outcome assessment and clinical audit. It is suggested that routine use of standard assessment scales in clinical practice will increase clinicians awareness of such problems, improve communication within the multidisciplinary team and thus improve patient care.

Rodgers et al (1993) recommends that when choosing any scale certain parameters should be considered. These include validity, reliability, sensitivity, acceptability and responsiveness to change. A scale is deemed to be ***Valid***, if it accurately assesses what it is claimed to assess. ***Reliable***, if when different assessors use it they arrive at similar answers for people with similar needs. It can also refer to the same assessor achieving the same results over time for a particular individual when needs have not changed ***Sensitive*****,** if it identifies or diagnoses a condition correctly. A measure's sensitivity is its rate of yielding 'true positives' (Polit and Beck 2008 p464). ***Responsive****,* if it identifies or measures clinical change (Wright and Young 1997).

In this study an assessment scale was chosen on the recommended parameters above.

4.2: Quality of Life Assessment

The World Health Organisation (WHO) in 1994 defined Quality of Life (QOL) as 'an individual's perception of their position in life as being in the context of culture and value systems in which they live and in relation to their goals, expectations, standards and concerns (WHOQOL 1994). It states it to be a broad ranging concept affected by a person's physical health, psychological state, level of independence, social relationships, and their relationship to salient features of their environment. Recently there has been increasing interest in the assessment of Quality of Life (QOL) issues in healthcare practice and research. Hickey et al (2005) states that QOL has emerged as a key health outcome variable over the last 3 decades while Coons et al (2000) identify the assessment of health-related quality of life (HR-QOL) as an essential element of healthcare evaluation. Testa and Simonson (1996) states that the term 'quality of life' (QOL) or 'health related quality of life' (HR-QOL) refer to the physical, psychological and social domains of health, seen as distinct areas that are influenced by a person's experiences, beliefs, expectations, and perceptions. Similarly, Coons et al (2000) states that HR-QOL refers to how health impacts an individual's ability to function and his or her perceived well-being in physical, mental and social domains of life. There are various HR-QOL measurement tools available for use in the health care setting and these tend to be either generic instruments, which are designed to be applicable across a wide range of populations and interventions, or specific HR-QOL measures which are designed to be relevant to particular interventions or in certain subpopulations (e.g. individuals with asthma). Quality of-life assessment measures changes in physical, functional, mental, and social health in order to evaluate the human and financial costs and benefits of new programs and interventions. Various HRQOL measurement scales were identified in the literature, both generic and specific. In deciding which HR-QOL tool to use in this study, an extensive search of the literature was carried out to identify a tool which would be most suitable for the population involved. To decide on a tool's suitability the validity, reliability, sensitivity and responsiveness of each specific tool was investigated. Due to the absence of a specific HR-QOL tool designed for hip fractures patients, a search for a suitable generic tool was conducted. To establish which tool would be most suitable, the most commonly used generic HR-QOL tools were investigated. These include the Nottingham Health Profile (NHP) developed by Hunt and McKenna (1980), Euroqol EQ-5D (EQ-5D) developed by the EuroQol group (1990), Health Utility index (HUI) (Feeney et al 1996), The World Health Organisation Quality of life assessment instrument (WHOQOL-BREF) developed by the WHO Group (1998) and the SF36 Health Survey (Ware and Sherbourne 1992).

The Nottingham Health Profile is a generic quality of life survey used to measure subjective physical, emotional, and social aspects of health. It is divided into two sections. Part I of the survey measures six dimensions of health including: physical mobility, pain, social isolation, emotional reactions, energy, and sleep. Part II of the survey consists of thirty-eight items which assess the six dimensions of energy, pain, emotional reactions, sleep, social isolation, and physical mobility. All items are answered either yes or no. The dimension scores range from 0 to 100, the higher the score, the greater the perceived health problems.

The EQ-5D (The Euroqol Group 1990) was designed by the Euroqol Group as a standardised, non-disease-specific instrument for describing and valuing health-related quality of life. The descriptive system comprises 5 dimensions (mobility, self care, usual activities, pain/discomfort, anxiety/depression). Each dimension has 3 possible levels (no problems, mild to moderated problems and severe problems). Different combinations of responses to these dimensions are weighed to produce a single utility index by converting all 243 possible health status responses. On the basis of their responses, patients are classified into a health status index with a value between 0.111 (worst possible state) and 1 (best possible state) according to a calculation of the health status score of the EQ5D in a Japanese population (Tsuchiya et al 2002). It provides a simple, generic measure of health for clinical and economical appraisal. It has been used in many areas of clinical practice and has been translated into 83 languages.

The Health Utility Index is a generic multidimensional, preference-based measure of health status and health-related quality of life (Feeney et al 1996). HUI is a family of three distinct, stand-alone measurement systems: Mark 1 (HUIl), Mark 2 (HUI2) and Mark 3 (HUI3). HUI is currently defined as including both HUI2 and HUI3 systems. Therefore, current HUI questionnaires cover both systems. It is widely used in describing treatment processes and outcomes in clinical studies; economic evaluations of health care programs; the measurement and monitoring of population health. It consists of eight dimensions of health status: vision, hearing, speech, ambulation, dexterity, emotion, cognition, and pain with 5 or 6 levels per dimension, varying from highly impaired to normal.

WHOQOL-Bref is a shortened version of the WHOQOL-100 quality of life assessment which was developed by the WHOQOL Group with fifteen international field centres, simultaneously, in an attempt to develop a quality of life assessment that would be applicable cross-culturally (WHO 1994). It comprises 26 items, which measure the following broad domains: physical health, psychological health, social relationships, and environment. It was developed for use in situations where time is restricted, where respondent burden must be minimised and where facet-level detail is unnecessary e.g. with large epidemiological surveys and some clinical trials according to Skevington et al (2004)

The SF-36 is a multipurpose short form health survey with only 36 questions. It is an abbreviated form of the SF 76. It was developed as a part of the Medical Outcomes Study (Stewart et al 1989) to assess 8 physical and mental health problems as seen from the patient's perspective. It is a generic measure, as opposed to one that targets specific treatment, disease or age group and has been widely used in surveys of general and specific populations. It has been translated in more than 50 countries as part of the International Quality of Life Assessment (IQOLA) project (Aaronson et al 1992) It takes into account the functional ability as well as the social and psychological aspects of the participants.

For the purpose of this study all QOL questionnaires were studied for suitability using the psychometric measures of each instrument as well as the time taken to complete and ease of completion. These psychometric measures are tabulated below.

In this study it was decided to utilise the SF 36, under licence from a collaborator in the study. The validity and reliability of the SF-36 has been confirmed among patient populations in the USA and shown to detect differences in health status for patients with different types and severity of medical condition (McHorney et al 1993, 1994). Likewise, high levels of validity and reliability was confirmed in the UK in community and patient populations (Brazier et al 1992, Jenkinson et al 1993) and in Ireland (Blake et al 2000, Murphy et al 2007). The SF-36 scales have been shown to achieve approximately 80-90% of their empirical validity in studies involving physical and mental health (Ware 2000). The reliability of the SF 36 scale vary across groups with a range of coefficients from 0.65 to 0.94 (Ware et al 2002) For each scale, item scores are coded, summed and transformed, with the final values (expressed as a percentage) ranging from 0 (worse health) to 100 (best health).

Table 4.1: Psychometric measures of Quality of Life assessment tools.

Instrument	Reliability	Validity	Responsiveness	Internal Consistency
Euroqol EQ-5D	Test–retest reliability of each of the five EQ-5D dimensions as ordinal level data with Spearman's rho, rank correlations ranged from 0.29 (P=0.008) for Mobility to 0.60 (P=0.001) for Anxiety/depression. (Fransen and Edmonds (1999) The reliability coefficients (ICC) and Goodman and Kruskalls gamma of the EQ-5D utility and vas demonstrate greater reliability than condition-specific instruments: EQ-5D Utility ICC 0.73, Gamma 0.69, EQ-5D Vas ICC 0.70, Gamma 0.57. (Hurst et al 1997)	Comparison beteen EQ-5D and SF-12 (Johnson and Coones 1998) All relationships between EQ-5D dimensions and SF-12 component scores were found to be significant at the 1% level, with the exception of MCS-12 and mobility (p= 0.015) The VAS scores were positively correlated with both component scores; r= 0.55 for PCS-12 and r= 0.41 for MCS-12.	EQ-5D recorded improvement in patients self reported improvement, EQ-5D Utility SRM 0.70, 95% CI 0.41-0.96. EQ-5D Vas-SRM 0.71, 95% CI 0,4-0.96.(Hurst et al 1997)	Because the EQ-5D has single item dimensions, internal consistency reliability does not apply to each dimension.(Pichard et al 2007)
WHOQOL-Bref	**Test retest Reliability:** (Carpiniello et al.2006) At the test-retest evaluation, intraclass coefficients and 95% confidence intervals per each of the four domains were respectively: "Physical": 0.92 (0.85-0.96); "Psychological": 0.94 (0.88-0.97); "Social Relationships":0.89 (0.80-0.93); "Environment": 0.80 (0.75-0.85); all correlations were statistically significant (p<0.05).	(WHOQOL Group 1998) **Concurrent Validity:** Domain scores produced by the WHOQOL-BREF correlate highly (0.89 or above) with WHOQOL-100 domain scores (calculated on a four domain structure). **Discriminative validity**,(Skevington et al 2004) t-tests of domain 1 to 4 scores for illness vs. well samples D1 (physical) 39.2, p<0.01 D2 (Psychological) 19.9, p <0.01 D3 (Social) 13.0 , p <0.01 D4 (Environmental) 7.6, p <0.01	**Community Dwelling Older Adults:** (Hwang et al, 2003) **Responsiveness Effects** (Based on Guyatt's method).Large Effect for Physical Capacity (–1.42), for Psychological Well-being (–0.80) Moderate Effect for Social Relationships (–0.46), Environment (–0.71),Overall Quality of Life and General Health (–0.56)	Skevinton et al 2004. Total internal consistency for Domains 1 to 4 respectively 0.82, 0.81, 0.68, 0.80

Health Utility Index	**Test –Retest Relaiblity: (Fisk et al 2005).** Intra-class correlation (ICC) coefficients were 0.87 for the HUI Mark III,	**Concurrent validity:** (Fisk et al 2005). High correlation between HUI Mark III and the (Expanded Disability Status Scale (EDSS). Spearmans correlation 0.77	**Responsiveness.** Based on analysis of variance.(Pressler et al 20011) Poor (ANOVA p= .284	**Internal consistency reliability** (Pressler et al 2011).Poor-cardiac failure patients.Cronbach's alpha = 0.51)
Nottingham Health Profile	**Test retest Reliability:** (McEwan, 1993)Test-retest correlation coefficients at four weeks ranged from 0.75 to 0.88 for the six sections of Part I and from 0.44 to 0.86 (0.55-0.89 in a second group) for the seven items in Part II. Spearman correlations among domain scores ranged from 0.32 (sleep and social isolation) to 0.70 (pain and physical mobility). The intraclass correlation coefficient was found to be 0.95, with an effect size of 0.52 (McDowell & Newell, 1996).	**Concurrent Validity:** (Hunt et al 1980). correlation coefficient = 0.74 when compared with McGill Pain Questionnaire; = 0.65 when compared with a physiotherapist's disability rating). **Discriminant Validity:** (Hunt et al 1980). All six sections of the NHP showed significant differences (p < 0.001) between four groups of elderly people with distinct health statuses	**Workers:** (Beaton et al, 1997; Moderate Responsiveness (ES = 0.52).	**Disabled Population**: (Baro et al, 2006) Excellent, normal cognitive functioning patients (Cronbach's alpha = 0.82) Excellent, moderate Cognitive functioning patients Cronbach's alpha = 0.87)
SF 36	**Test retest Reliability:** (Steffen and Seney 2008). ICC >.80 in all domains except Social Functioning **Inter-Rater Reliability: (**Faria et al 2011) inter-rater reliability SF-36=0.96.	**Concurrent Validity:** (Meyer-Rosberg et al) Patients with neuropathic pain. reported statistically significant and positive correlations for the majority of the common domains of both the NHP and SF36.(r=0.29-0.79) (Prieto et al 1997) COPD Patients. (r=0.25-0.77),	Tidermark et al 2003. (Elderly patients with hip fracture over 4 month period) SF-36 global **SD.** 16.0 (19) (p<0.001) **SES**:0.89 **SRM**:0.82	**In elderly women: (Brazier et al 1996).** (Cronbach's alpha 0.56 for Social Functioning to 0.91 for Physical functioning.

4.3: Patients' Knowledge about Osteoporosis

Osteoporosis is a skeletal condition characterised by low bone mass and microarchitectural deterioration leading to bone fragility and increase risk of fracture (Consensus Development Conference 1993). It is estimated that between 13-18% of women aged fifty years and over have osteoporosis (Wolfe et al 2000) with over 70% of those over the age of 80 years having it (Melton et al 1995). Osteoporosis knowledge is an important contributor to osteoporosis preventive behaviour according to Winzenberg (2003), however this is not a clear-cut relationship. Cross-sectional studies have varied in whether they have found an association between levels of osteoporosis knowledge and osteoporosis preventive behaviours (Wallace et al 2002, Satterfield et al 2000). Kasper et al (2001) and Sedlak et al (2000) state that while education improves knowledge, behaviourial changes do not always follow. According to Ailinger et al (2005) knowledge is considered the first step of behaviour change. Such knowledge provides professionals, patients and the lay public with the information required to make informed decisions about health practices as stated by Cranney et al (2002).

Treatment of osteoporosis has been shown to reduce risk of fracture particularly in those who have had a history of fracture (Petrella and Jones 2006).However studies have shown that adherence with osteoporosis medication can be as low as 30% (Cramer et al 2005) A review of the literature identified numerous tools for the assessment of patient knowledge of osteoporosis, Osteoporosis Knowledge test(OKT), developed by Kim et al (1991), Osteoporosis Questionniare (OPQ) developed by Pande et al (2000), Osteoporosis Knowledge assessment Tool (OKAT) developed by Winzenberg et al (2003) and the Facts on Osteoporosis Questionnaire (FOOQ, Ailinger et al 1998) to name but a few. While almost all these assessment tools include items on awareness about osteoporosis, knowledge about risk factors and knowledge about preventative behaviour, they vary in the amount and type of information collected in each one of these areas. Only a few instruments assess knowledge regarding diagnosis, treatment and consequences of osteoporosis.

The OKT is a twenty four item instrument consisting of two subscales addressing exercise(16 items) and Calcium (17 items).developed by Kim in 1991 to assess the knowledge level of osteoporosis and its related risk factors among allied healthcare professionals. The questionnaire addresses knowledge about specific facts and statistics about osteoporosis. It has been used in various studies assessing knowledge of osteoporosis in different populations. (Sedlak et al 2000, Elliott et al 2008, Edmonds et al 2012).

The Osteoporosis Questionnaire (OPQ) is a validated instrument designed by Pande et al (2000). It is a twenty item multiple choice questionnaire involving questionnaires in the areas of general information (5), risk factors (7), consequences and treatment (four each). There are four possible responses for each question, only one of which is correct. Each correct response scores 1 point while incorrect response scores −1 point, and a "do not know" response scores 0 point. The maximum and minimum score on the OPQ is +20 and -20 respectively. It has been translated into various different languages (Vytrisalova et al 2008, Patil et al 2010).

The Osteoporosis Knowledge Assessment Tool (OKAT) is a 20 item instrument with true, false and don't know responses. The tool had questions on four basic themes: understanding (symptoms and risk of fracture) of osteoporosis, knowledge of risk factors for osteoporosis, knowledge of preventive factors such as physical activity and diet relating to osteoporosis and treatment availability. It was developed Winzenberg et al (2003) to assess Osteoporosis knowledge in an Australian population and has been translated into several languages (Riaz et al 2008, Tadic et al 2012).

The Facts of Osteoporosis Questionnaire (FOOQ) is another instrument designed to assess knowledge about osteoporosis. It was initially developed in 1998 by Ailinger and was theoretically informed by Orem's (1990) Self-Care theory. It measures patient knowledge about osteoporosis risk factors, known facts and preventive behaviors. It is a self-reporting measure consisting of 20 statements which the person answers True, False or Don't know and a score is derived by calculating the percent of questions correctly answered. It was revised following the National Institutes of Health (NIH) consensus conference in 2000 to incorporate updated osteoporosis knowledge. The revised quiz was validated by osteoporosis experts (Ailinger 2003). It has a content validity index of 0.87 and an internal consistency reliability of 0.76. It is the only instrument to measure osteoporosis knowledge that is based on a theoretical framework. According to Werner (2005) the FOOQ assumes that "a person's knowledge of potential health problems is a prerequisite for promoting self care behaviours to prevent disease"

The FOOQ was used as the instrument to assess osteoporosis knowledge in this study, as it has been well validated and regarded to be a questionnaire that would be easy to administer in the study population context as it does not require in-depth knowledge about statistical figures on osteoporosis which some of the other questionnaires require. Also it has been used previously in an Irish setting (Moloney 2007) thus increasing its suitability to this population. Permission to use the research instrument was granted by Professor Ailinger.

Table 4.2: Psychometric measures of Osteoporosis Knowledge Assessment Tools

Instrument	Reliability	Validity	Readability	Internal consistency
Osteoporosis Knowlegde Assessment tool (OKAT)	(Winzenberg et al 2003). Ferguson's sigma of 0.96	**Inter-item correlation**(Winzenberg et al 2003) (r < 0.09, based on a sample size of 467, and p > 0.10).	Winzenberg et al 2003)**The Flesch reading** ease of 45 The index of difficulty- Of the individual items 17 had an index of difficulty less than 0.75.	**<u>Internal reliability</u>** (Winzenberg et al 2003)). a Cronbach's alpha of 0.70
Osteoporosis Knowledge Test.(OKT)	(Ailinger et al 2003) two subscales, (calcium and exercise) with reported reliability coefficients (0.72 and 0.69, respectively).	**Validity** of the OKT was evaluated by factor analysis and discriminant function analysis (Kim et al., 1991). Persian (Baheiraei et al 2005) and Chinese (Lee & Lai, 2006) populations, Male populations (Sedlak et al., 2000). With a possible range of scores from 0 to 24, higher scores = greater knowledge.		**<u>Internal reliability</u>**. (Chen and Liu 2005) (Cronbach alpha = 0.83–0.87
Osteoporosis Questionnaire (OPQ)	Excellent reliability(Kuder-Richardson =0.84), (Pande et al 2000)	**Criterion Validity:** (Pande et al 2000) contrasted groups = 13.6 +/- 4.3 vs 8.5 +/- 5.4; (p=0.003)	Flesch readability index = 74.3(score of 70-100 indicating easy to understand. (Pande et al 2000)	Not ass
Facts of Osteoporosis quiz	**Reliability** (Ailinger et al 1998) reliability of 0.83	**<u>Content Validity: (</u>**Ailinger et al 2003).Content vailidity index of 0.87. **<u>Content validity:</u>** (Ailinger, Emerson (r=0.92) Mean knowledge 13–19 Total possible score=25. Higher score indicates higher knowledge	**<u>Readability.</u>** (Ailinger et al 2003). Grade 6	**<u>Internal consistency:</u>** (Ailinger et al 2003). Cronbach's alpha 0.76

4.4: Nutritional Assessment

Frail elderly adults in the community, in hospital and in long term institutions are at increased risk of malnutrition (Guigoz and Vellas 1997). Prevalence for malnutrition in the elderly range from 5-10% in community dwellers (Guigoz et al 2002) to 30-60% in hospitalised patients (Naber et al 1997). Malnutrition can often go undetected and if left untreated, it can have serious consequences on health, which include: increased risk to infections (Sullivan 1995), delayed wound healing, impaired respiratory function and muscle weakness and social isolation and depression (Hansson et al. 1990, Cederholm et al 1995, Covinsky et al. 1999). Malnutrition in the elderly diminishes quality of life by contributing to serious illness, decreased functional capacity, altered self-perception of health, and precipitated chronic disability (Millen 1999). It can be identified as an ominous sign according to Chen et al (2001), which, if left untreated, presents as a downward trajectory to further health problems. The early detection of dietary risk is important and allows for early intervention which may prevent later complications as stated by Ryu and Kim (2010).

From the literature reviewed there are three measurement methods utilised in identifying malnutrition in the elderly. These include dietary intake, anthropometric measurements and serological measurements. The literature highlights the inadequacy of any single method or tool in assessing a patients nutritional status (Chen et al 2001, Ryu and Kim 2010) hence combinations of these methods have been used to develop a subjective scoring systems designed to increase the sensitivity and specificity of nutritional status determinations as stated by Schneider et al (2004). Some nutritional scores are based on mathematical equations while others are based on clinical and subjective assessment. Assessment tools most frequently used in assessing risk of malnutrition include the Nutritional Risk Index

(NRI), Nutritional Risk Screening (Kondrup 2002), the Malnutrition Screening Tool (MST), the Subjective Global Assessment (SGA) and the Mini Nutritional Assessment (MNA).
The Nutritional Risk Index (NRI), developed by the Veterans Affairs Total Parenteral Nutritional group (1991) is based on mathematical equations. It was developed originally in AIDS and cancer populations. The NRI score is derived from the serum albumin concentration and the ratio of actual to usual weight. Patients were classified into four groups as no, mild, moderate or severe risk by NRI. (Aziz et al 2011).

Nutritional Risk Screening (NRS) was introduced by the European Society of Parenteral and Enteral Nutrition (Kondrup et al 2003). The purpose of the NRS-2002 system is to detect the presence of undernutrition and the risk of developing undernutrition in the hospital setting (Kondrup et al 2003). It consists of 4 pre-screening questions followed nutritional components in addition to grading of severity of disease.

The Malnutrition Screening Tool (MST) was developed for use in acute adult hospital patients to identify malnutrition or risk of malnutrition (Ferguson et al 1999). It has also been validated for use in patients undergoing cancer treatments (radiotherapy, chemotherapy). The MST consists of two questions related to recent unintentional weight loss and eating poorly because of a decreased appetite. It does not require any anthropometric measurement such as weight or calculation (body mass index, percent weight loss). Any health worker can use this screening tool. It has been demonstrated to be simple, quick, valid and reliable (Isenring et al 2009).

The Subjective Global Assessment (SGA) combines self report and clinical assessment to identify the nutritional status of patients.(Detsky et al 1987). It is a tool that uses 5

components of a medical history (weight change, dietary intake, gastrointestinal symptoms, functional capacity, disease and its relation to nutritional requirements) and 3 components of a brief physical examination (signs of fat and muscle wasting, nutrition-associated alternations in fluid balance) to assess nutritional status (Steiber et al 2004).
It has been used as a diagnostic tool and prognostic instrument in hospitalized patients undergoing surgery (Detsky et al 1987), dialysis patients (Enia et al 1993) and liver transplant patients (Hasse et al 1993) and in elderly adults in long term care setting (Gordan et al 2000). It is a simple, non invasive, reproducible and valid tool for determining nutritional status in the elderly according to Duerksen et al (2000).

The Mini Nutritional Assessment (MNA) developed by Guigoz and Vellas (1999) was designed to detect the presence of undernutrition and the risk of developing undernutrition among the elderly in home-care programmes, nursing homes and hospitals. (Kondrup et al 2003). It is a combination of a screening and an assessment tool, as the last part of the form is a more detailed exploration of the items in the first part of the form. It is recommended by the European Society of Parenteral and Enteral Nutrition (ESPEN) for use in elderly adults to assess for the risk or presence of malnutrition (Kondrup et al 2003).
For the purpose of this study it was decided that the Mini Nutritional Assessment was most suitable assessment tool to identify nutritional risk in the study subjects. This decision was based on the fact that the Mini Nutritional Assessment tool was developed specifically to determine malnutrition in an elderly population while most of the other nutritional tests are poorly adapted to the elderly as they tend to overestimate malnutrition in this group according to Schneider and Hebuterne (2004). The MNA is easy to use, composed of simple questions and measurements and takes about 20 minutes to complete requiring no training. It comprises various methods of assessment i.e., anthropometric measurements,

dietetic assessment, subjective assessment and global evaluation. It is a well validated tool with high sensitivity, specificity and reliability and has been used in hundreds of studies and translated into more than 20 languages. (Kaiser et al 2009). Murphy et al (2000) found the MNA to be a useful diagnostic tool in the identification of elderly orthopaedic patients at risk of malnutrition. It has been used previously in an Irish setting with older adults and in particular in the study site with older adults (Romero-Ortuno et al 2011) and was thus deemed most suitable to use with the population involved in this study.

Table 4.3: Psychometric measurements of Nutritional Assessment Tools

Instrument	Reliability	Validity	Responsiveness	Internal Consistency
Nutritional risk Index	**Test Retest:** (Wolinsky et al 1986) ranged between .67 and .71.	**Construct Validity** (Wolinsky et al 1986)was assessed using factor analysis and various outcome measure comparisons for those at risk vs those not at risk on measures of perceived health status, ADL, IADL, morale, physician visits, ER visits, and nights spent in the hospital. All but one were statistically significant at the .05.	Kyle et al 2006 Sensitivity 43% Specificity 89%	(Wolinsky et al 1986) Reliability coefficients (internal consistency) of .603, .544, and .515 were obtained at T-1, T-2, and T-3, respectively
Malnutrition Screening Tool (MST)	**Inter-Rater reliability** Ferguson et al (1999) Agreement by 2 dietitians in 22/23 cases Kappa = 0.88 Agreement by a dietitian and nutrition assistant 31/32 (97%) of cases Kappa = 0.93	**Predictive Validity:** (Ferguson et al 1999) Compared to Subjective Global Assessment (SGA) and objective measures of nutrition assessment. Patients classified at high risk had longer length of stay	Ferguson et al 1999 Sensitivity = 93% Specificity = 93%	

Subjective Global Assessment	**Inter-rater reliability:** (Allan et al 1987) Interobserver agreement (kappa = 0.78%, 95% confidence interval 0.624 to 0.944, p < 0.001).	**Convergent Validity.** (Allan et al 1987) loss of subcutaneous tissue- Kendall's Tau 0.82 (*p*< 0.001) and muscle wasting – Kendall's Tau 0.78 (*p* < 0.05). Highly significant associations between the nutritional condition of patients according to the different tests (SGA, NRS 2002 & MNA) and BMI (Kruskal-Wallis, p<0.01)	Ozkalkanli MY et al (2009) Sensitivity= 50%; Specificity= 797	**Internal consistency** (Ulander et al 1993) Judgements by an expert panel resulted in 65% agreement
Mini Nutritional Assessment (MNA)	**Reliability:** (Bleda et al 2002) Test re test: ICC =0.89. Kappa values of 0.51 were reported for hospitalized elderly patients(Gazzotti et al 2000) and 0.78 for institutionalized elderly(Bleda et al 2002)	**Validity.** screening validity of the MNA^{R}-SF is nearly as good as the MNA^{R} full form, with a sensitivity of 86-96% in 6 different studies	(Rubenstein et al 2001) Sensitivity = 97.9% Specificity =100%	**Internal Consistency.** (Bleda et al 2002). Cronsbach's Alpha = 0.74
Nutrition Risk Screening 2002 (NRS)	**Inter-Rater Reliability.** (Kondrup et al. 2003) Good agreement between a nurse, dietician and physician Kappa = 0.67	**Validity**(Kondrup et al 2003) NRS-2002 showed a significant Kappa concordance agreement with SGA (kappa= 0.853, p < 0.001).	Ozkalkanli MY et al (2009) Sensitivity 69% Specificity 80%	

4.5: Osteoporosis Medication Adherence

Medication adherence is defined by the Who Health Organisation as “the degree to which a person’s behaviour corresponds with the agreed recommendations from a health provider” (WHO 2003 p3), while Delamater (2006) defines it as the “active, voluntary, and collaborative involvement of the patient in a mutually acceptable course of behaviour to produce a therapeutic result”. Medication adherence is of great concern to healthcare practitioners as non adherence in widespread and associated with adverse outcomes and higher healthcare cost according to Osterberg and Blaschke (2005). It is estimated that non adherence with general medical regimens ranges from between 20-80% (Dunbar-Jacob et al 1995) and is associated with treatment failures, increased morbidity and mortality, and enormous burden to society and the economy.

(Reginster and Lecart 2004). Suboptimal osteoporosis medication adherence is a well-documented problem (Hanson et al 2008). Poor adherence to osteoporosis therapy has been attributed to several factors including the disease’s asymptomatic nature, adverse effects of medication, patients’ lack of awareness of treatment benefit, drug costs, and inconvenience according to Tosteson et al (2003), Segal et al (2003) and Unson et al (2003). The consequences of medication non adherence in the elderly are profound according to MacLaughlin et al (2005).These include increased hospitalization, disease progression, poor disease control and increased mortality (McDermott et al 1997, Ho et al 2006). In a study carried out by Chan et al (2001), 26% of hospital admissions were the direct result of non adherence, omission and cessation of medication in an elderly(>75yrs) population, with the most common manifestation of non adherence being that of falls, orthostatic hypotension, heart failure and delirium. Similarly Malhotra et al (2004) identified

8% of medical admissions in an emergency department as being attributable to non-adherence, of which 63% was intentional non adherence.

There are various ways of measuring medication compliance and persistence, the latter being the time of initiation to discontinuation of treatment as defined by Cramer et al (2008). These include patient self report, pharmacy refill records, use of electronic lids and biological assays. Medication adherence scales or surveys are simple and low-cost approaches to identifying medication non adherence in clinical practice. A number of validated medication adherence scales have been identified in the literature, the Medication Adherence Questionnaire (MAQ); the Self Efficacy for Appropriate Medication Use Scale(SEAMS); the Brief Medication Questionnaire (BMQ);Hill-Bone Compliance Scale(HBCS) and the Medication Adherence Report Scale (MARS).

The Medication Adherence Questionnaire (MAQ) otherwise known as the Morisky-Green scale was designed by Morisky et al (1986) to measure adherence in hypertensive population. It has since been used in several different settings such as studies of participants with HIV (Corless et al 2005), Diabetes (Krapek et al 2004), Osteoporosis (Turbi et al 2003) and Asthma (Erickson et al 2001). It is a simple scale involving only 4 items with Yes/No answers that ask the patient how he/she complies with the medication regimen prescribed by the doctor and allows for patients to be classified as compliant or non-compliant. According to Lavsa et al (2011) the MAQ is most adaptable at the point of care and across populations and is the quickest to administer and score and has been validated in the broadest range of diseases.

The Self Efficacy for Appropriate Medication Use Scale (SEAMS) was developed by a multidisciplinary team with expertise in medication adherence and health literacy for use among patients with a variety of chronic diseases and across various levels of patient literacy. (Rizzer et al 2007). It is a 13 question tool consisting of two dimensions; first the assessment of self- efficacy for taking medicines under difficult circumstances, such as when patients are busy, away from home, or have multiple medications to take. The second is assessing the self- efficacy for taking medications under uncertain or changing circumstances, such as when the patient is unsure about how to take the medications or changes are made to the therapeutic regimen. Patients indicate their level of confidence in taking medications correctly, under a number of different circumstances (i.e., 1=not confident, 2=somewhat confident, and 3=very confident). Higher scores indicated higher levels of self-efficacy for safe medication.

The Brief Medication Questionnaire is a self-report tool for screening adherence and barriers to adherence. It includes a five item Regimen Screen that asks patients how they took each medication in the past week, a two item Belief Screen that asks about drug effects and bothersome features, and a two item Recall Screen about potential difficulties remembering (Svarstad et al 1999). It has been used in various settings and found to be sensitive, reliable and valid. (Svarstad et al 1999, Svarstad 2005, Ben et al 2012).

Hill-Bone Compliance Scale assesses patient behaviour for three behavioural domains of hypertension treatment and comprises 14 questions that are summed up to subscales: 'reduced sodium intake' (three items), 'appointment keeping' (two items), and 'medication taking' (nine items). Each item could be answered on a 4-point-scale,

resulting in a score ranging from 9 (perfect adherence) to 36 points. Reliability and validity of the instrument was established by Kim et al (2000).

The Medication Adherence Report Scale 5 (MARS-5) is a scaled questionnaire and has been used to assess medication adherence in a variety of health populations, including asthma, COPD, chronic pain, high cholesterol and diabetes (Horne and Weinman 1999). It comprises five adherence statements, each scored on a 5 point Likert scale with reverse scoring (where 1='always', 2='often', 3='sometimes', 4='rarely', and 5='never). A total medication adherence score is obtained by summing the responses to each of the items. Scores range from 5 to 25 with a score of >20 = high adherence and <20 suboptimal adherence. It has been used in various settings and populations and found to be reliable, valid and easy to use (Horne et al 2001, George et al 2005, Lehane 2007).

As there is no gold standard questionnaire each one was assessed on its ease of administration and length, internal consistency, reliability, sensitivity (i.e., likelihood of detecting non adherence if present), and specificity (i.e., likelihood of not detecting non adherence if not present), as well as the diseases in which it has been validated. Following an intensive literature review it was decided to incorporate the Medication Adherence Report Scale 5 (MARS-5) to identify compliance with osteoporosis medication in this study. Since 1996, the MARS has been used in research studies and has demonstrated good internal reliability (coefficient alpha of 0.70) and test-retest reliability (0.97) (Horne et al 2001) It has been used in different population for example patients with chronic obstructive airways disease (George et al 2007), Asthma (Clatworthy et al 2009) and hypertension (Horne et al 2001, Lehane 2007). Horne et al 2008 states that the MARS attempts to diminish the social pressure on patients to under-report non-adherence by phrasing questions in a non-threatening manner. This questionnaire was previously used in an Irish setting with older adults and hence was deemed suitable for the population involved in this study Murphy et al 2005). Permission was obtained to use this questionnaire.

Table 4.4 Psychometric measurements of Medication Adherence Assessment tools

Instrument	Reliability	Validity	Responsiveness	Internal consistency
Medication Adherence Questionnaire	**Interobserver Agreement** (Suarez et al 2011) 0.821 (Kappa)	**Convergent Validity:** (Suarez et al 2011). Cramer's-V 0.516	(Hernando et al 2002) **Sensititvity:** 72% **Specififcity:** 91%%	Cronbach's Alpha: 0.61. (Stacey et al 2011)
Brief Medication Questionnaire	**Test retest reliability:** (Ben et al 2012). Gamma coefficients of r=0.83; p>0.001	Correlation between BMQ and MGT was r=0.28, p>0.001. (Ben et al 2012	Sensitivity: 0.77 Specificity 58% (Ben et al 2012)	Cronbach's Alpha: 0.66. (Ben et al 2012)
Self-efficiacy for Appropriate Medication Use Scale	**Test retest reliability:** Spearman's=0.62, p>0.001. (Risser et al 2007)	**Criterion related Validity:** (Risser et al 2007) Strong Correlation with the Morisky Scale (Spearman's ?=0.51, p>0.0001)	Specificity and Sensitivity not reported	Cronbach's Alpha: 0.89 (Risser et al 2007)
Hill-Bone Compliant Scale	Item total correlations all >.31.(Lambert et al 2006).	**Construct Validity:** **Inter Item correlation** 0.28. (Kim et al 2000). **Predictive validity:** Non compliance predicted higher diastolic pressures (p=.21,P<0.05) (Lambert et al 2006)	Sensitivity: 37% Specificity: 63%. (Koschack et al 2010)	Cronbach's Alpha 0.64. (Stacey et al 2011) Cronsbach alpha 0.79(Lambert et al 2006)
Medication Adherence Report 5 Scale	**Test retest reliability:** Pearson's r =0.97 (Horne et al 1999)	**Convergent Validity:** Correlation between MAR-D and SIMS-D = Spearman's rho 0.26 (p<0.01) (Mahler et al 2010)		Cronbachs alpha: 0.67-0.90 (Horne and Hankins 2007) Cronbachs alpha 0.60-0.69 (Mahler et al 2010)

4.6: Anxiety and Depression Assessment

Depressive symptoms are common in medically ill older people (Alexopoulos 2005) with prevalence rates identified in various studies of between 15% and 25% (Holmes and House 2000, Pouget et al 2000.) Fenton et al (1994) found that rates of depression at the time of hip fracture to be estimated at 9% to 47%. Mental health status at the time of surgery has been reported to be an important determinant of outcome, with mental disorder associated with poorer functional recovery and higher mortality (Shamash et al 1992, Holmes and House 2000).] Approximately one in five people who are not depressed at the time of their fracture become so after 8 weeks (Mossey et al 1990). As depressed patients are more likely to have difficulties concentrating, are more likely not to exercise or maintain a balanced diet and tend to resort to alcohol and other substances to reduce anxiety and alter sleeping patterns (Von Vort 1990), the effectiveness of the rehabilitation programme can be diminished. Givens et al (2008) state that cognitive and mood disorders were common in elderly hip fracture patients and are associated with greater risk of poor outcomes, both independently and in combination. Recognition and treatment of these conditions may reduce adverse outcomes in this vulnerable population. Hence the inclusion of mental health status was deemed important in this study.

A literature review on anxiety and depression revealed the many scales and scores there are to measure these states in the clinical area. These include the Becks Anxiety Inventory (Beck et al. 1988), Becks Depression Index (Beck 1961) the General Health Questionnaire (Goldberg 1978), The Geriatric Depression Scale (Yesavage 1983) and the Hospital Anxiety and Depression Scale (Zigmond and Snaith 1983).

The Becks Anxiety Inventory (BAI), created by Dr. Beck and other colleagues (1988), is a 21 item self-administered instrument which measures symptoms associated with anxiety. It was developed as a screening measure that discriminates anxiety from depression with a focus on subjective, somatic, or panic related symptoms of anxiety. Since its development, the BAI has been widely used in clinical research in mental health care, mainly as a measure of general anxiety (Piotrowski 1999) and has been translated into 13 different languages. Scores range from 0-63 with a score 0-21 indicating very low anxiety levels, 22-35 indicating moderate anxiety and 36-63 indicating severe anxiety.The measure is reliable and valid across age, gender, and in numerous cultures (Kabacoff et al 1997).

Beck Depression Index (BDI) (Beck 1961) - a widely used scale that measures the severity of depression by evaluating 21 symptoms. It is a self-report rating inventory that measures characteristic attitudes and symptoms of depression (Beck, et al., 1961). It takes 5-10 minutes to administer. The items are scored from 0 to 3 and measure mood, pessimism, sense of failure, lack of satisfaction, guilty feelings, sense of punishment, self hate, self accusations, self-punitive wishes, crying spells, irritability, social withdrawal, indecisiveness, body image, work inhibition, sleep disturbance, fatigability, loss of appetite, weight loss, somatic preoccupation, and loss of libido. A short form of the BDI (BDI-SF) consisting of 13 items was used in a study of terminally ill patients (Chochinov et al. 1997).

General Health Questionnaire (Goldberg 1978) is a self-administered instrument designed to detect depression, anxiety, social impairment, and hypochondriasis. Several versions of different length are available. In its original version, it had 60 items (GHQ-60 Goldberg & Hillier, 1979), which were reduced to 30 (GHQ-30), 28 (GHQ-28;) and 12 items (GHQ-12) (Goldberg & Williams 1988). The 12-Item General Health Questionnaire (GHQ-12) is the most extensively used screening instrument for common mental disorders, in addition to being a more general measure of psychiatric well-being (Del Pilar et al 2008) The GHQ is simple to administer, easy to complete and score and widely used in many studies of (occupational) well-being (Jones et al 2006) The GHQ can be scored in a variety of ways which is useful in providing multiple outcome measures (Jackson 2007).

The Geriatric Depression Scale (GDS)(Yesavage 1983) is a simple scale developed to diagnose depression in older persons. It is a 30 item self report assessment using 'yes', 'no' answers. One point is assigned to each answer and the cumulative score. A score of 0-9 is reported as "normal", 10-19 as "mildly depressed", and 20-30 as "severely depressed". It has been The GDS may be used with healthy, medically ill and mild to moderately cognitively impaired older adults. It has been extensively used in community, acute and long-term care settings and can be used in patients with a MMSE of over 14.

The Hospital Anxiety and Depression Scale (Zigmond and Snaith1983) is a self-assessment scale with depression and anxiety subscales. The HADS scale, developed by Zigmond and Snaith(1983) for use with medically ill, hospitalised patients to screen for depression and anxiety has been validated in the community and primary care settings. It is a self-reporting questionnaire composed of statements relevant to either generalised anxiety or depression. It comprises seven statements reflecting anxiety and seven reflecting depression. Each statement is answered by the respondent on a four point response category (0-3). A total anxiety and depression score is obtained individually by summing the responses to each question relevant to the respective state. Possible scores range from 0 to 21 for anxiety and 0-21 for depression with a score of 0-7 for either subscale regarded as within normal limits, a score of 8-10 = borderline abnormal while a score of 11 or higher = abnormal. The HADS has been used in research studies in a variety of settings and countries, in the elderly and in adolescents. Bjellgood et al (2002) in a review of 747 identified studies found the HADS demonstrated good internal consistency with the total HADS Cronbach's alpha value ranging from 0.68-0.93 (mean0.83) for HADS-A (anxiety) and from 0.67-0.90 (mean 0.82) for HADS-D (depression). They identified the sensitivity and specificity of both HADS-A and HADS-D to be 0.80.They concluded that HADS performs well in assessing severity and caseness of anxiety disorders and depression in both the hospital and primary care setting. Bearing in mind the ease and length of time to administer, sensitivity and specificity it was decided that for the purpose of this study the HADS was most suitable for measuring depression and anxiety in our post hip fracture population. Also the HADS has been previously used in various Irish setting (Collins et al 2009, O'Connor et al 2009) to assess mood variability. Permission to use this questionnaire was received.

Table 4.5: Psychometric measurements of Anxiety and Depression Assessment tools

Instrument	Reliability	Validity	Responsiveness	Internal consistency
Becks Anxiety Inventory	**Test-retest reliability** (Becks et al 1993) 1-week interval (ICC 0.75).	**Concurrent validity**: Becks et al 1993) the correlation with the Hamilton Anxiety Rating Scale—Revised was .51. **Discrimatory Validity:** (Wetherell and Arean 1997) Correlation between BAI and BDI was 0.56 ($p<0.0001$). Correlation between the BAI and the CDS was somewhat higher ($r = .65$, $p < .0001$).		**Elderly Medical Patients:** (Wetherell and Arean 1997). High Internal Consistency (Cronbach's alpha = 0.92)
Becks Depression Index	**Parkinson's Disease:**(Visser et al, 2006) **Excellent** test–retest reliability (ICC = 0.89) Test–retest reliability for individual items ranged from 0.31 to 0.86	**Concurrent Validity:** Increased BDI scores have been associated with higher ratings on the Depth of Depression Scale ($p < 0.01$) (Beck et al, 1961). **Predictive validity**: **Stroke:** (Desrosiers et al, 2002). **Adequate** correlation with stroke survivor handicap situation (LIFE-H) at discharge ($r = -0.48$; $p < 0.001$) Convergent validity: (Snyder et al, 2000).**Excellent** correlation between the BDI and the Geriatric Depression Scale ($r = 0.78$)	**Acute Stroke:** (House et al, 1991) BDI was sensitive to change in stroke patients Somatic symptoms appeared to decline, while no change was reported for cognitive affective symptom	**Non-Psychiatric subjects meta-analysis:** (Beck & Steer, 1988) **Excellent** internal consistency (Cronbach's alpha = 0.81)

General Health Questionnaire	**Chronic Stroke**: (Robinson & Price, 1982)**Excellent** test re test reliability (*r* = 0.90, within two months) **Elderly population:** (Malakouti et al, 2007*)* **Excellent**, Cronbach's alpha = .90	**Chronic Stroke:** (O'Rourke, 1988)….. No difference between the GHQ-30 and the Hospital Anxiety and Depression (HAD) Scale was found for Any DSM-IV diagnosis (*p* = 0.95) Grouped depression (*p* = 0.56) Anxiety (*p* = 0.25)	**Chronic and Acute stroke patients:** (Lincoln et al, 2003)	**Ischaemic heart disease:** (Failde et al, 2000) **Excellent** Internal Consistency (Cronbach's alpha = 0.95)
Geriatric Depression Scale	**Chronic and Acute Stroke**: (Sivrioglu et al, 2009)**Excellent** test-retest reliability (7 days between administrations; *r* = 0.75)	**Meta analytic evidence** of Criterion Related Validity: (Wancata et al, 2006). GDS validity was similar to the Center for Epidemiological Studies Depression scale (CES-D), but significantly better than the "Yale-1-question" scale. **Excellent** correlations between classification criteria “no depression,” “mild depression,” and “severe depression” and the GDS (*r* = 0.82), SDS (*r* = 0.69), and HAMD (*r* = 0.83)	**Meta-analytic Results**: (Mitchell et al, 2009; *n* = 17 studies reported) GDS-30 (after meta-analytic weighting) sensitivity = 77.4% (95% CI=66.3% to 86.8%) and a specificity=65.4% (95% CI=44.2% to 83.8%).	**Chronic and Acute Stroke**: (Sivrioglu et al, 2009).**Excellent** Internal Consistency (Cronbach’s alpha = 0.89) **Institutionalized elderly population** (Lesher, 1986, *n* = 51 nursing home residents). **Excellent** Internal Consistency (Cronbach’s alpha = .99)

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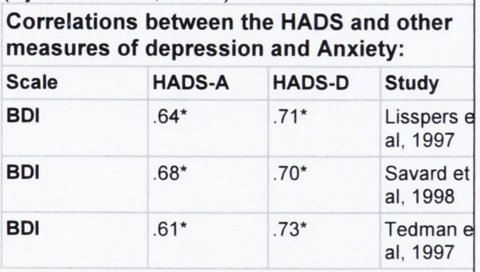
<tr>
<td>Hospital Anxiety and Depression Scale</td>
<td><u>Test Re-test reliability</u>: (Herrmann, 1996; meta-analytic results).Excellent at 0-2 weeks (<i>n</i> = 79; <i>r</i> = 0.84 - 0.85)
Adequate to Excellent at >2-6 weeks (<i>n</i> = 111; <i>r</i> = 0.73- 0.76)
Adequate at >6 weeks (<i>n</i> = 901; <i>r</i> = 0.70)</td>
<td><u>Concurrent Validity</u>:
(Bjelland et al, 2002)

Correlations between the HADS and other measures of depression and Anxiety:
<table>
<tr><th>Scale</th><th>HADS-A</th><th>HADS-D</th><th>Study</th></tr>
<tr><td>BDI</td><td>.64*</td><td>.71*</td><td>Lisspers e
al, 1997</td></tr>
<tr><td>BDI</td><td>.68*</td><td>.70*</td><td>Savard et
al, 1998</td></tr>
<tr><td>BDI</td><td>.61*</td><td>.73*</td><td>Tedman e
al, 1997</td></tr>
</table>
BDI = Beck Depression Inventory
GHQ-28 = General Health Questionnaire</td>
<td><u>Meta-analytic Evidence</u>: (Bjelland et al, 2002)
Scores of 8 on both the HADS-A and HADS-D demonstrated an optimal balance between sensitivity and specificity</td>
<td><u>Acute Stroke</u>: (Aben et al, 2002).Excellent internal consistency (Cronbach's alpha = 0.85)
<u>Meta-analytic Evidence</u>: (Bjelland et al, 2002; literature review of 747 papers).Adequate to Excellent (0.68 to 0.93)
Adequate to Excellent (0.67 to 0.90)</td>
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4.7: Fear of Falling

Several factors have been associated with less favourable outcomes post hip fracture such as age, sex, cognition, co-morbidities, mobility and premorbid activities of Daily living according to Balen et al (2001), Hoffmeyer and Klopfenstein (2000) and Osens et al (2004). Fear of Falling (FoF) has been identified as a psychosocial factor that is associated with reduced participation in the rehabilitation process and functional restrictions which can result in dependency and poorer outcomes in hip fracture patients (Petrella et al 2000, Resnick et al 2007, Wijlhuizen 2008) and may have greater influence on functional recovery than depression and pain as stated by Oude Voshaar et al (2006). Visschedijk et al (2010) in a systematic review carried out on measurement instruments for FoF, identified two groups in which these instruments could be divided into. Group 1 included instruments that measured FoF directly by asking a single question such as "are you afraid of falling?" while group 2 included instruments that measured balance confidence or fall efficacy. The instruments identified in the literature review to measure the latter were the Activities-specific Balance Confidence (ABC) scale, the Survey of Activities and Fear of Falling in the Elderly (SAFE), the Geriatric Fear of Falling Measures (GFFM) and the Falls Efficacy Scale I (FES-I).

The Activities-specific Balance Confidence (ABC) scale is a 16-item questionnaire that assesses a person's confidence in performing various mobility-related tasks which were generated by 15 clinicians and 12 elderly outpatients. Psychometric testing involved 60 community seniors (aged 65-95) self-classified as either high or low in mobility confidence according to their perceived need for a walking aid and personal assistance to ambulate outdoors(Powell and Myers 1995). Items are rated on a rating scale that ranges from 0-

100. Score of zero represents no confidence, a score of 100 represents complete confidence. Significantly lower ABC scores were associated with lower levels of mobility (Powell and Myers 1995) and falls (Lajoie and Gallagher 2004). It has an 84% sensitivity and 87% specificity in correctly classifying fallers and non-fallers in a cross-sectional study of older people living in the community as reported by Lajoie and Gallagher (2004) and can differentiated older people who reported avoiding activity because of fear of falling from those who did not (Myers et al 1996). According to the authors, the ABC Scale might be more appropriate for assessing more active persons (Powell & Myers, 1995), as some of the activities are more difficult. This scale then would not be the most effective tool to measure fear of falling among more high-risk, community-dwelling older adults.

The Survey of Activities and Fear of Falling in the Elderly (SAFE) was developed by Lachman et al (1998) and examines 11 activities of daily living, instrumental activities of daily living, mobility tasks and social activities. For each activity, there are questions asking personal information about the activity. Responses are rated with three or four points Likert scales. Higher scores indicate a greater fear of falling. Based on the assumption that activity avoidance may be an early sign of fear of falling, the SAFE measures information about participation in exercise activities and social activities. Jung (2008) states that the SAFE is too complicated for easy administration to the elderly Also, according to Huang (2006) it is difficult to compute the SAFE score, because it is made up of a skip pattern. The SAFE score measures ‘worried about falling’ which may not necessarily be equivalent to the construct “fear of falling” and, hence, not highly recommended as a measure of fear of falling according to Greenberg (2012).

The Geriatric Fear of Falling Measures (GFFM) published in 2006, is based on a previous qualitative study that developed a model for understanding fear of falling among older adults living in Taiwan (Huang, 2006). It includes three subscales (psychosomatic symptoms, risk prevention, modifying behaviour) with 15 points total that are intended to measure activity restriction. It has good test-retest reliability (r= 0.88) but poor validity (r=0.29) when compared to the FES. However, the authors of GFFM acknowledge That the data is limited to Taiwanese elders and suggest reliability and validity should be investigated further.

The Falls Efficacy Scale was developed by Tinetti et al (1990) to assess the confidence a person has in performing several activities of daily living without falling. This consisted of a 10 item questionnaire which was validated in a sample of community dwelling elderly people. It was shown to be reliable and have construct and predictive validity in subsequent studies (Tinetti et al 1994). Many commentators felt that this scale could be improved upon by including not only more complex activities but also evaluation of the impact of fear of falling in social circumstances. ProFane (The Prevention of Falls Network Europe) developed the Falls Efficacy Scale International (FES-I) in answer to these comments (Yardley et al 2005). This is a 16 item questionnaire which has demonstrated good internal reliability (Cronbach's alpha 0.90) and test –retest reliability is high (interclass correlation coefficient 0.97). In this study a validated, the FES-1 was used for screening purposes. This version consists of sixteen questions assessing the respondents concern of falling while performing certain activities, each scored on a 4 point Likert scale (where 1= not at all concerned, 2=somewhat concerned, 3= fairly concerned, 4=very concerned). A total falls efficacy score is obtained by summing the responses to the sixteen questions to give a total which will range from 16 (no concern about falling) to 84(very concerned about falling).

The FES-I was deemed most appropriate for this study as it has been shown to be more sensitive to change than the ABC scale according to Petrella et al (2000) and Visschedijk (2010). It has been used in particular for frail elderly while the ABC scale has been more often used for relatively healthy community populations (Jorstad et al 2005). The FES has the advantage of indicating which daily activities the subject finds particularly worrying to complete so further training may be given to this area. It has been used in studies involving older adults in Ireland (Delappe et al 2006) hence its suitability to this population.

Table 4.6: Psychometric measurements of Fear of Falling Assessment Tools.

Instrument	Reliabiltiy	Validity	Responsiveness	Internal Consistency
Falls Efficacy Scale	Test-retest Reliability. **Geriatric**: (Tinetti et al, 1990) **Adequate** test-retest reliability, *r* = 0.71 **Chronic Stroke**: (Hellstrom & Lindmark, 1999) **Excellent** test-retest reliability, ICC = 0.97	**Geriatric**: (Huang & Wang, 2008) **Adequate** concurrent validity with the ABC Scale (*r* = -0.55) **Adequate** concurrent validity with the Geriatric Fear of Falling Measurement (*r* = -0.57) **Spinal Cord Injury**: (Wirz et al, 2010)**Excellent** concurrent validity with the Berg Balance Scale and the 16-item FSE-I (*r* = -0.81)	**Geriatric Hip Fracture**: (Petrella et al, 2000). Mean change in score over time: 14–72/365, Moderate effect size (0.78), SRM = 0.75	**Geriatric**: (Tinetti et al, 1990). **Excellent** internal consistency (Cronbach's alpha = 0.91)
Activity Related Balance Confidence	(Miller et al 2003). **Test-retest** reliability (intraclass correlation coefficient) was .91 (95% confidence interval [CI], .84–.95) with individual item test-retest coefficients ranging from .53 to .87	(Talley et al 2008) **Concurrent validity** between the ABC and SAFE measured using a correlation coefficient was −0.65 (*P*<.001).	(Holbein et al 2005). MDC_{95} scores of 18% to 38%	(Miller et al 2003) **Internal consistency,** measured by Cronbach α was .95.

Geriatric Fear of Falling Measures	(Huang 2006) **Test retest reliability:** (Huang et al 2006) Pearson correlation coefficients 0.88 ($p<0:0001$). **Inter-rater Relaibility** The Spearman rank correlations for these scores were 0.91 ($p<0:001$), 0.94 ($p<0:001$), and 0.89 ($p<0:001$) for the RP(risk prevention), PS(Psychomatic symptoms) and MB(Modifying Behaviour) subscales, respectively.	(Huang 2006) **Concurrent Validity b**etween GFFM and FES using Pearson's r correlation was highly significant ($r = 0:29$, $p = 0:002$).	Huang and Wand (2009) GFFM is sensitive to change at 8 weeks. Moderate effect size SRM = 0,54.	Huang (2006). **Internal Consistency:** Cronbach's α, for the GFFM as a whole was 0.86

4.8: Assessing Mobility and Activities of Daily Living

The assessment of functional status is critical when caring for older adults as normal aging, acute illness, worsening chronic illness and hospitalisation can contribute to a decline in the ability to perform tasks necessary to live independently according to Gallo and Plaveza (2006). Stavley et al (1999) define mobility as a person's purposeful movement through the environment from one place to another while Peel et al (2005) describe it as where people move or travel, taking into account the frequency of movement and degree of independence during such movement. Decrease in mobility in elderly hip fracture patients post hip fracture has been identified in the literature (Visser et al 2000, Magaziner et al 2000, Bentler et al 2009). Measuring mobility in the elderly can be carried out in various ways. One approach is to assess how a person carries out personal activities of daily living. The term activities of daily living or ADLs, refers to the basic tasks of everyday life, such as eating, bathing, dressing, toileting, and transferring while instrumental ADLS (IADLs) include managing money, preparing light meals, shopping and using the telephone as defined by Chan-Weiner et al (1990). When people are unable to perform these activities, they need help in order to cope, either from other human beings or mechanical devices or both. Graf (2008) describes the assessment of ADLs as critical in caring for the older persons as it can not only establish a baseline of functionality but can provide objective data to assist with targeting individualized rehabilitation needs or to plan for the provision of specific services such as meal preparation, home carer etc. Another approach to mobility assessment is the assessment of risk factors for falling. This includes the study of gait, postural stability and lower limb strength.

There are many instruments that try to measure all aspects of mobility and ability to self care in the literature either independently or accumulatively. Some of these include the Barthel Index, The Rivermead Mobility Index, The Functional Independent Measure (FIM), the Nottingham Extended Activities of Daily Living Scale and the Frenchay Activities Index to name but a few.

The Barthel Index (BI) was developed in 1965 to measure disability in adults with neurological and musculoskeletal conditions (Mahoney and Barthel 1965) and later modified by Granger et al (1979). It has been recommended by the Royal College of Physicians for routine use in the assessment of older people (RCP 1992). It is an ordinal scale comprising 10 questions about basic activities of daily living, such as continence and ability to bathe independently. It has been used in many community and rehabilitation settings as a measure of disability and is often used for frail elderly patients (Yohannes et al1997). Reliability and validity are well established (Collins et al 1988, Fricke et al 1997). Shah et al (1989) reported an alpha internal consistency coefficient of 0.87 to 0.92. This was reiterated by Hsueh et (2001) who found the BI to have excellent internal reliability with Cronbach's alpha ranging from 0.89-0.92, and an inter-rater reliability (correlation coefficient of 0.94) indicating very high agreement. The 10 subtest items include (1)) bowel and, (2) bladder continence (3) personal grooming, (4) getting on/off the toilet, (5) feeding, (6) walking or propelling a wheelchair, (7) moving from wheelchair to bed and return, (8) dressing and undressing, (9) stair climbing, (10) bathing.

Each subtest item on the original Barthel Index is rated 0, 5 or 10 (or 15 for two of the test items). Maximum total score is 100. The amended or 22 point Barthel has the same subsets with ratings between 0-3 for each with a maximum of 22.

The Rivermead Mobility Index (RMI) consists of 15 questions about mobility ranging from the ability to turn over in bed to the ability to run. It was developed for patients who had suffered a head injury or stroke at the Rivermead Rehabilitation Centre in Oxford England (Collen et al 1991) and is a measure of disability related to bodily mobility. Collen et al (1991) reported an inter-observer reliability to be never more than a difference of 2 points in the total score. This was reiterated by Green et al (2001) who highlighted the test retest reliability of the RMI to be similar with a reliability coefficient of 2.2 with 90% of patients scores differing by 2 points or less.

The Functional Independence Measure (FIM) is a global measure of disability and medical rehabilitation functional outcome. This scale focuses on the burden of care – that is, the level of disability indicating the burden of caring for them. It includes 18 items, 13 physical domains based on the Barthel Index and 5 cognitive items. Each item is scored from 1 to 7 based on level of independence, where 1 represents total dependence and 7 indicates complete independence. A simple summed score of 18 – 126 is obtained where 18 represents complete dependence/total assistance and 126 represents complete independence. The FIM has been well studied for its validity and reliability. It is widely used and has one scoring system increasing the opportunity for comparison. However it is important to remember, when interpreting FIM scores, that it is an ordinal not continuous level scale according to Linacre et al. (1994).

The Nottingham Extended ADL Index (NEADL) was developed and evaluated as a questionnaire for postal use by Nouri and Lincoln, in1987. It assesses the ability to carry out functional tasks, such as using public transport, housework, social life and hobbies. It consists of 22 questions divided into four subsections: mobility, kitchen tasks, domestic activities and leisure. Respondents are asked whether they do the activity rather than if they can do it, in order to assess level of activity rather than capability. It has been shown to be valid and reliable in numerous settings (Green et al 2001, Hardwood et al 2002, Nicholl et al 2002). Hardwood et al (2002) demonstrated good internal reliability (Cronbach's alpha) of 0.90 with a test retest reliability of 0.96. Gompertz et al., (1994) found that the NEADL to be sensitive to change while. Jacob-Lloyd et al., (2005) suggest that the Nottingham Extended ADL Scale was more sensitive to change that the Barthel Index in their study of 55 patients from discharge to first follow-up appointment.

The Frenchay Activities Index (FAI) was designed for interview administration, and is a measure of social activities and lifestyle following stroke. Piercy et al (2000) found inter-rater reliability to be moderate to high. Wade et al (1985) found a high correlation between the FAI and the Barthel Index. Available evidence suggests the instrument has good validity, and is amongst the easier measures for stroke patients to complete.

In this study subject's mobility and activities of daily living were assessed using the amended Barthel Score and the Nottingham Extended Activities of Daily Living Index. These instruments were decided upon based on their ease of use, time to complete, their validity and reliability and their use in similar populations internationally and in Ireland (Hartigan 2007a, Hartigan 2007b, Crawford 2009).

Table 4.7: Psychometric measurements of Mobility and Activities of Daily Living Assessment Tools.

Instrument	Reliability	Validity	Sensitivity	Internal Consistency
Barthel Index	Inter-rater: (Hsueh et al, 2001) **Adequate to Excellent** item level agreement among raters (kappa value range, 0.53-0.94) **Excellent** total score agreement (ICC = 0.94) Test-retest:(Green et al 2001) Mean difference 0.4, relativilty coefficient 2.0 (Bland and Altman test)	Acute Stroke: (Hsueh et al, 2002) **Excellent** correlation between the FIM motor and 10 item BI at both admission and discharge (*r* ≥ 0.92) **Excellent** agreement between the FIM motor and 10 item BI at both admission and discharge (ICC ≥ 0.83)	(Hsueh et al, 2002): Responsiveness (Standardised Response Mean) BI = 1.2 (Salbach et al, 2001)	(Hsueh et al, 2001) **Excellent** internal consistency alpha = 0.89 to 0.90
Rivermead Mobility Index	Hsueh et al,(2003) **Excellent** inter-rater reliability: (ICC = 0.92, total score) (Chen et al, 2007; Green, Foster & Young, 2001) **Excellent** test-retest reliability (ICC = 0.96)	(Hsueh et al, 2003) **Excellent** concurrent validity with: Modified Rivermead Mobility Index and STREAM (Hsueh et al, 2000; Hsueh et al, 2003) **Excellent** predictive validity with: Barthel Index (rho = 0.77, 24 days post stroke)	(Hsueh et al, 2003) (Standardised Response Mean) RMI 14-180 days post stroke 1.9	Franchignoni et al,(2003) **Excellent** internal consistency (Cronbach's alpha = 0.92)

Frenchay Activities Index	(Post & de Witte, 2003; *n* = 45 stroke survivors; 3 to 9 days between assessments) **Excellent** inter-rater reliability (ICC= 0.90; FAI total) **Adequate-Excellent** inter-rater reliability (Kappa range = 0.41 - 0.90; at item level) General Population (Turnbull et al, 2000):**Excellent** test-retest reliability (*r* = 0.96) Lower Limb Amputation (Miller et al, 2004; **Excellent** test-retest reliability (ICC = 0.79)	(Schuling et al, 1993; Cup et al, 2003 **Excellent** concurrent validity with the Barthel (*r* = 0.79) **Adequate** concurrent validity with the Euroqol (*r* = 0.65) **Excellent** concurrent validity with the Rankin (*r* = -0.80) **Adequate** concurrent validity with the Stoke Adapted Sickness Impact Profile-30 (*r* = -0.43)	(Schepers et al, 2006; Wade et al, 1985): FAI (coupled with Stroke Adapted Sickness Impact Profile) detected the most patient change and had moderate effect sizes (*d* = .59) for chronic stroke patients between 6 and 12 months post stroke). FAI was also noted to chang from pre-stroke, 6 months an	(Schuling et al, 1993; **Excellent** internal consistency (Cronbach's alpha = 0.83- controls/normal) (Cronbach's alpha = 0.87- post-stroke) **Adequate** internal consistency (Cronbach's alpha = 0.78- pre-stroke-retrospective reports)
Functional Independence Measure	Test-retest reliability (Pollock 1996). **Excellent** Motor-FIM (ICC = 0.90) **Excellent** Cognitive-FIM (ICC = 0.80) Meta analytic findings: (Ottenbacher et al, 1996; *n* = 11 studies published between 1993 and 1995; **Excellent** overall consistency (median reliability = .95) between raters across patients with different diagnosis and levels of impairment	(Hsueh et al, 2002) Concurrent validity evidence: **Excellent** correlation between the FIM and the 10-item version of the Barthel Index (BI): Admission *r* = 92 Discharge *r* = 94	(Hsueh et al, 2002, pg 189) Motor subscale Standardised response mean = 1.3 Change scores relation 0.75 (Moderate)*	General Rehab: (Dodds et al, 1993) **Excellent** internal consistency: Cronbach's alpha = 0.93 admission; 0.95 discharge.

Nottingham Extended Activities of Daily Living	Test retest Reliability: (Harwood and Ebrahim 2002) Reliability coefficient 0.79-0.96	Construct Validity: (Harwood and Ebrahim 2002) Correlated strongly with the Handicap scale, SF-36 physical and social function scales. Spearmans rho 0.72	Responsiveness (Harwood and Ebrahim 2002). Total mean change at 6 months 1.0(original scoring - 5.3(likert type scoring)	Cronbach's Alpha: 0.90 (Harwood and Ebrahim 2002)

4.9: Cognitive Status

Cognitive impairment is common in hospitalise elderly patients with a prevalence rate of between 10 and 50% depending on condition and population studied (Levkoff 1994, Lipowski et al 1994). This rate is higher in hip fracture patients with a prevalence rate of 35%-61% as stated by Murray et al (1993). Dementia and cognitive impairment are known to be risk factors for hip fractures and are associated with increased postoperative morbidity and mortality (Gruber-Baldini et al 2003, Seitz et al 2011). Seitz et al (2011) identified the estimated prevalence of dementia among older adults with hip fractures to be 19.2% with the prevalence of cognitive impairment to be 41.8%. Gruber-Baldini et al (2003) concurred with this and found that post hip fracture cognitive problems persisted 12 months following surgery and that this persistence predicted later functional and social impairment. While there are many tools identified in the literature to assess cognitive status the most commonly used measurements would appear to be the Mini Mental State Examination (MMSE) as developed by (Folstein et al, 1975), Clock Drawing Test (CDT) as developed by Freedman (1994), Mini Cog (Borson et al 2000), The General Practitioner Assessment of Cognition (GPCOG Brodaty et al 2002) and Six Item Cognitive Impairment Test (6CIT Katzman et al 1983) and the Abbreviated Mental test (Hodgkinson et al 1972).

The CDT is used to quickly assess visuo-spatial and praxis abilities, and may determine the presence of both attention and executive dysfunctions. Although it may detect cognitive impairment it is poor at distinguishing various subtypes of dementia as stated by Woodford and George (2007) and is weak in the diagnosing or monitoring of delirium (Adamis et al 2005). Due to this the CDT is usually used in addition to other quick screening tests such as the Mini-Mental State Examination (MMSE).

The Mini-Cog is the CDT with an additional three word recall test thus memory testing. The result obtained is either the presence or absence of cognitive impairment. This, according to Woodford and George (2007) while adding to its simplicity, results in no value for monitoring disease progression or severity.

The GPCOG is similar to the mini-cog in that a recall test is added to the CDT in addition to a short informant questionnaire. It is recommended as one of the tools most suitable for use by General Practitioners in the assessment of cognitive impairment by Brodaty et al (2006).

The 6 CIT also known as the Short Orientation Memory Concentration Test. It was developed in 1983, by regression analysis of the Blessed Information Memory Concentration Scale (BIMC). It takes about 3-4 minutes to complete and has an inverse scoring system with questions weighted to produce a score of 0-28 with higher numbers representing more significant cognitive impairment. The scoring can be complicated which makes it less suitable for use in busy clinical settings as stated by Woodford and George (2007).

The Abbreviated Mental Test (AMT) was introduced by Hodgkinson et al (1972) is a quick to use 10 item scale originally developed by geriatricians. The maximum score is 10 and a score below 7 suggests cognitive impairment. It is widely used in clinical and research settings for detecting and monitoring cognitive impairment and is easily administered and well tolerated by raters and subjects (Holmes and Gilbody 1996). It takes about 3 minutes to complete however it lacks validation in primary care, with most validity data referring to correlation to the MMSE (Jitapunkul et al 1991, MacKenzie et al 1996).

The MMSE is by far the most commonly used screening tool to provide a brief, objective measurement of cognitive functioning. It was originally created by Fostein, Folstein and McHugh (1975) to differentiate organic from functional psychiatric patients. MMSE results are frequently used to classify the severity of cognitive impairment or to document serial change in dementia patients as recommended by Tombaugh and McIntyre(1992). It is a fully structured scale that consists of 30 items grouped into seven categories: orientation to place (state, county, town, hospital, and floor), time (year, season, month, day, and date), registration (immediately repeating three words), attention and concentration (serially subtracting 7, beginning with 100, or, alternatively, spelling the word world backward), recall (recalling the previously repeated three words), language (naming two items, repeating a phrase, reading aloud and understanding a sentence, writing a sentence, and following a three-step command), and visual construction (copying a design). It takes between 5 to 10 minutes to administer, and scores range from 0 to 30. A score of 1 is given for each correct answer, with lower scores indicating greater cognitive impairment. The most common cut off for the MMSE is that recommended by Tombaugh and McIntyre (1992) with scores of less than 17 indicative of severe cognitive impairment, scores between 18 and 23 indicative of mild impairment, and scores of 24 or better indicative of normal cognitive functioning. However O'Byrant et al (2008) highlighted the need for a higher cut off point for highly educated people suggesting that a cut off of 27 or higher was needed to achieve diagnostic accuracy. NICE (National Institute for Health and Clinical Excellence) classify 21-24 as mild, 10-20 as moderate and <10 as severe impairment. The MMSE has shown to have moderate to high levels of reliability according to Tombaugh with the highest alpha level of .96 obtained by Foreman(1987) in a mixed sample of hospital patients with more modest results of .68 and .77 obtained by Kay et al (1985) and Holzer et al respectively (1984). Lopez et al (2005), using a criterion-referenced tests showed the reliability of MMSE using the >24 cut off score to be .803 and .795 for Serial 7s and WORLD respectively. The tool has demonstrated test-retest reliability when administered over both 24-hour and 28-day intervals using single and multiple examiners according to Folstein et al (1975). Further test retest reliability assessments fell between .70 and .90 (Folstein et al 1975, O Connor et al 1989, Jorm et al 1991).

In this study the decision to use the Mini Mental State Examination (MMSE) to assess cognition was based on its ease of use, ability to monitor cognitive changes over time and its reasonable psychometric measures. It has also been used and validated extensively in the Irish setting to assess cognitive function and hence suitable for use in this study (Cullen et al 2005, OKeefe et al 2005).

Table 4.8: Psychometric Measurements of Cognitive Status Assessment Tools

Instrument	Reliability	Validity	Responsiveness	Internal Consistency
Mini Mental State Examination	**<u>Meta-analytic Evidence</u>:** (Tombaugh & McIntyre, 1992). **Poor to Excellent** test-retest reliability in MMSE's administered < 2 months (*r* = 0.38 – 0.99) **<u>Mixed diagnoses</u>:** (Folstein et al, 1975; *n* = 206 normal elderly and elderly with cognitive or emotional disorders). **Excellent** 24 hour test-retest (same examiner) reliability (*r* = 0.88). **Excellent** 24 hour test-retest reliability (with different examiner; *r* = 0.827). **Excellent** 28 day (mean time between assessments) test-retest reliability (*r* = 0.098)	**<u>Acute Stroke</u>:** (Agrell & Dehlin, 2000).MMSE scores were found to significantly correlate with the BI, MADRS and Zung Depression Scale ($p > 0.05$) **<u>Mixed diagnosis</u>:** (Folstein et al, 1975; *n* = 206 normal elderly and elderly with cognitive or emotional disorders). **Excellent** convergent validity with: WAIS (Wechsler Adult Intelligence Scale) Verbal IQ (*r* = 0.78) WAIS (Wechsler Adult Intelligence Scale) Performance IQ (*r* = 0.66)	The MMSE was not useful to assess memory problems or overall cognitive impairment after stroke. (Blake et al, 2002)	**<u>Meta-analytic Evidence</u>:** (Tombaugh & McIntyre, 1992) **Poor to Excellent** internal consistency (Cronbach's alpha = 0.54 to 0.96)

Instrument	Reliability	Validity	Responsiveness	Internal Consistency
Clock Drawing	**Inter=Rater Relaibility:** **Alzheimer Disease:**(Tuokko et al, 1992; Mendez et al, 1992; Rouleau et al, 1992). **Excellent** inter-rater reliability (r = 0.94 - 0.97 across three annual assessments) **Surgical and Medical Patients:** (Manos & Wu, 1994). Excellent inter-rater reliability (r = 0.88 - 0.96) **Test retest Reliability:** **Medical Patients:** (Manos & Wu, 1994). **Excellent** test-retest reliability (r = 0.87)	**Acute Stroke:** (Adunsky et al, 2002) **Adequate** concurrent validity with: FIM- Cog Domain (r = 0.51) MMSE (r = 0.59)		Not established
Mini cog	**Test-retest reliability:** (Brodaty et al 2006, Lorentz et al 2002) "reasonable" test-retest reliability over four weeks ($r = 0.85$, $P < 0.01$).		Borson et al (2003) Sensitivity: 76% Specificity: 89%	

Instrument	Reliability	Validity	Responsiveness	Internal Consistency
6 Item Cognitive Impairment Test	**Alzheimer's**: (Fuld, 1978; n = 18 patients) Retesting 3 weeks after the initial assessment resulted in a score within 4 points of the original score.	**Nursing home patients:** (Katzman 1983). **Excellent** correlations with the full Blessed test (*r* = 0.941) **Alzheimer's Disease**: (Davous et al, 1987). OMCT appeared equivalent to the Mini Mental State Examination in identifying dementia	Not Established	Not Established
Amended Mental Test	**Inter-rater reliability:** (Burleigh et al 2002) Kappa = 0.56(95% CI) indicating moderate agreement between the sets of observations.	(Antonelli Incalzi et al., 2003). Negative Predictive Validity 99%, Positivity Predictive Validity 25%	Jitapunkul et al., 1991). sensitivity of 91% specificity of 75%	Jitapunkul et al., 1991). Cronbach's alpha, based on the internal consistency of the AMT, 0.89.

4.10: Conclusion

Hip fractures most commonly affect older adults, many with multiple comorbidities, and treatment and recovery is varied and involves extensive support from multiple disciplines. As seen from the literature review, hip fractures can have a negative outcome on various aspects of a person's recovery including post fracture mobility, ability to self-care, mood, quality of life, nutritional status and fear of falling. Assessment of these outcomes is essential to evaluate care given and to highlight areas that require improvement in the rehabilitation process and service requirement of these patients. As hip fracture can be indicative of osteoporosis, screening for this condition is important as is the assessment of the patient's knowledge of osteoporosis and medication adherence to identify fracture risk and improve fracture prevention. The use of standard assessment scales recommended by the joint report of the Royal College of Physicians and the British Geriatrics Society (1992) can increase clinicians' awareness of problems, improve communication within the multidisciplinary team and improve patient care. Various questionnaires have been highlighted in this study to assess each of these outcomes. The questionnaires that were used in this study were decided upon on the basis that they were the most suitable for the population involved in the study. Each one has been validated and deemed reliable and responsive and have been used extensively in different countries and with different populations. They all have been used in studies on older people in Ireland hence to need to retest their reliability in an Irish setting did not arise.

Questionnaires are a quick, easy method of information collection and as such were deemed appropriate for this study to assess various psychological and physical statuses of the participants. The method of administration of these questionnaires will be discussed in the methodology chapter.

Chapter 5

Methodology

5.1: Introduction

The purpose of this chapter is to outline the methodology, the design, sampling methods to be employed, the research setting, data collection methods, data collection process and ethical considerations. Polit and Beck (2008) define research methodology as the steps, procedures and strategies for gathering and analysing data in a study. There are two main approaches that underpin research methodologies, the qualitative and the quantitative paradigms (Cormack 2000). This chapter is divided into the following sections:

- Qualitative Research.
- Quantitative Research.
- Hypothesis.
- Study design.
- Sampling.
- Data collection.
- Ethical considerations.
- Data analysis.

5.2: Qualitative Research

Qualitative research is a broad term that incorporates many different approaches which seek to understand human experience, perceptions, motivation and actions. It is has been described as being systematic, subjective research in which the data is in the form of words, the analysis of which tries to establish underlying concepts and themes

(Couchman and Dawson 1999, Burns and Grove 2005). It is conducted to describe and promote understanding of human experiences such as pain, caring, powerlessness and comfort. The main features of qualitative research are inductive, interactive and holistic explorations carried out by flexible and reflexive methods of data collection and analysis (Parahoo 2006). Qualitative research includes many methods: ethnography (the study of human behaviour as it is influenced by the culture in which it takes place (Parahoo 2006), phenomenology (an inductive approach that aims to describe experience as it is lived through (Lobiondo-Wood and Harber 2006), grounded theory (an inductive approach whereby hypotheses and theories arise out of data which is collected and analysed simultaneously (Parahoo 2006) and historical (a narrative description or analysis of events that occurred in the remote or recent past (Burns and Grove 2005). Qualitative research stresses the uniqueness of individuals, collecting data from subjects usually in their environment, taking into account how culture, society and other factors influence people's experiences. Qualitative research is often associated with the search for reasons in contrast to quantitative research which looks for causes. It is subjective, and focuses on descriptions in the form of speech or writing unlike quantitative research which is objective and focuses on endpoints in the form of numbers. Qualitative research has become more popular in nursing research in recent years. This is due to the change in nursing philosophy away from task-centred approach to a more patient-centred approach, which brings with it a more holistic perspective incorporating the emotions, reactions and needs of patients with regard to their illness. Qualitative research, because of its in-depth nature of studies and the analysis of the data required usually relates to a small, select sample (Cormack 1991). A limitation of this can be the notion that the researcher could have an influence by a particular disposition, affecting the generalisation of the small scale study (Carr 1994).

5.3: Quantitative Research

Quantitative research has been used by nurses in research since Florence Nightingale collected statistical data on the causes of mortality during the Crimean War. It is a broad term used to describe designs and methods of research that yield numerical data which is usually analysed using statistical methods (Gerrish and Lacey 2006). Quantitative research consists of stating, in advance the research question or hypothesis, operating the concepts and selecting the methods of data collection and analysis. It is concerned primarily with the measurement of facts about people, events or things and establishing the strength of a relationship between variables (Couchman and Dawson 1999). Quantitative research can be grouped into three overlapping categories, descriptive, correlational and casual. Descriptive study designs aim to collect more information about characteristics within a particular field. Their purpose is to provide a picture of situations as they naturally happen (Parahoo 2006). Correlational studies seek to examine relationships between variables. The purpose of such studies is to develop hypotheses and in turn contribute to theory development (Gerrish and Lacey 2006). Quasi-experimental and experimental designs can be grouped into the casual category as the purpose of both designs is to examine causality. They set out to confirm or reject the effect of one variable on another. Quasi-experimental research is a design for an intervention study in which complete control is not possible. Treacy and Hyde (1999) describe it as any variation on the theme of the experiment where the design is relaxed.

Experimental study designs are the most powerful method of examining causality as they contain strict control of variance (Burns and Grove 2005). The researcher controls the variables and randomly assigns subjects to different conditions (Polit and Becks 2008). Experimental studies exert the greatest amount of control possible to examine causality more closely. There are three essential elements of experimental research according to Burns and Grove (2005) and they are:

1. Researcher-controlled manipulation of the independent variable. This involves the researcher doing something such as introducing a treatment or intervention to some subjects of the study and withholding it from others.

2. Researcher control of the experimental situation. This usually involves the introduction of a control group that does not receive the intervention, hence controlling the experimental situation.

3. Randomisation. This is a method of assigning subjects to groups in a manner determined by chance alone. Random allocation means that each subject has an equal chance of receiving either treatment, but this treatment cannot be predicted. Types of randomisation include simple randomisation, block randomisation (used to keep numbers in the various study groups as close as possible) and stratified randomisation. The latter is used to achieve an approximate balance of important characteristics within the study. The purpose of randomisation is to balance the participants at the start of the study and reduce systematic bias. By maintaining this balance of participants the investigators can identify the effect of the intervention being studied, while minimising effects from compounding factors. Randomisation can be attained by various methods such as flipping a coin or pulling names out of a hat. However, most researchers use a table of random numbers to generate a sequence, or computers to produce randomisation (Polit and Becks 2006). Randomised control trials are quantitative comparable controlled experiments in which investigators study two or more interventions in a series of individuals who are randomly allocated to receive them (Jadad and Enkin 1998). In a RCT, participants are randomly assigned to receive either the intervention or control treatment (often usual care services).This allows the effect of the intervention to be studied in groups of people who are the same at the outset and treated the same way except for the intervention being studied. Any difference between the groups at the end of the study can be attributed to the intervention and not to

chance. RCTs are popular in healthcare research because of their potential ability to reduce selection bias. Bias can be described as any influence that produces a distortion in the results of a study (Polit and Becks 2006) and can affect RCTs at all stages. There are many potential sources of bias including the process of selecting the groups (selection bias), the process of allocation to treatment, and the achievement of proposed treatment and assessment of results. In RCTs, researchers try to anticipate, detect, quantify and control bias to increase the generalisability of the study. Selection bias can occur in the way participants are selected or rejected for the study. Schultz and Agrimes (1995) identified an exaggeration in the effect size of intervention by as much as 40% in trials where randomisation was not concealed from the investigator at the time of obtaining consent. If properly implemented randomisation can reduce selection bias. Another methodological strategy to reduce bias is that of blinding. Blinding occurs when the investigators attempt to keep one or more of the participants in the study unaware of the intervention being given or evaluated (Jadad and Enkin 2007). A double blind study is one where neither subjects nor the people responsible for carrying out the assessment know the treatment being received.

RCTs are the simplest, most powerful and revolutionary tool of research according to Jadad 1998, and provide an unbiased, balanced and reliable method for determining whether interventions are effective (Green and Raley 2000).

The conduct of quantitative research requires rigor, discipline, adherence to detail, strict accuracy and control. Control involves the application of rules to limit the possibility of error, to reduce extraneous variables, which could influence the results and increase the probability that the results accurately reflect reality.

Qualitative and quantitative research has different characteristics and arises from different traditions. Qualitative stems from the constructivism movement while quantitative stems from positivism. These two traditions are the extremes between which research approaches fall along a continuum. Until recently, the argument as to which approach was the best in nursing research has been dichotomous with proponents of each approach aligned to a particular camp. However more recently it has been recognised that the different research methods can accomplish different goals and can enhance practice. Quantitative and qualitative research can complement each other as they obtain different kinds of knowledge that are equally important for a holistic approach in nursing practice. Nowadays, similarities of the two approaches have been highlighted and the combination of the two approaches encouraged. The combination of the different methods in research is known as triangulation. Triangulation provides a more complete understanding of the issue being studied by giving different insights to the topic. In the complex world of nursing research such a research approach can add depth and breadth to the results. It would seem that there is no 'right' methodology, just the appropriate one and the appropriate methodology is one that serves the research needs and allows for the research questions to be answered fully.

In selecting a research approach for this study qualitative and quantitative methodologies were evaluated for appropriateness to measure the predisposing risk factors for falling in elderly post hip fracture patients and the extent to which the CNS can make a contribution to maximizing post hip fracture outcomes in these people. Due to the wide scope of assessments incorporated in this study it was decided that a quantitative approach would be most suitable.

5.4: Hypothesis

It has been noted in the literature review that falls may have serious consequence for the older person. One of the most serious consequences is that of hip fracture due to the increased risk of morbidity and mortality. Hip fracture in the elderly can involve significant health problems that influence daily life (Wolinsky et al 1997). The risk of hip fractures is determined not only by bone mineral density (BMD), but also by factors associated with physical frailty and an increased risk of falls (Cummings et al 1995, Dargent-Molina et al 1996). Attempts to reduce hip fractures have focused mainly on reducing the causes and risk factors such as gait and balance problems, muscle weakness, visual impairment, depression, osteoporosis and drug side effects (Kannus et al 2000).Intervention studies in the UK, America and New Zealand have shown that a combined multidisciplinary assessment and treatment programme can reduce falls by 30-46% (Tinetti et al 1993, Robertson et al 2001). Likewise a Cochrane review has shown that combined multidisciplinary assessment and treatment post hip fracture can result in a reduction in death, institutional care and functional deterioration in these patients. Follow up studies of hip fracture patients are scarce in Ireland. We do not know if multidisciplinary follow up of these patients will deliver similar benefits to those studies outlined above. Nor do we know if this follow up, coordinate by a Clinical Nurse Specialist (CNS) can improve outcomes such as quality of life, fear of falling or medication adherence in these patients.

5.5: Main Research Hypothesis

The main hypothesis to be tested is that a multidisciplinary bone health and falls assessment and intervention co-ordinated by a Clinical Nurse Specialist at three months following fracture can improve post hip fracture outcomes, in elderly persons, over the course of one year.

Secondary Research Questions.

1. Can the above intervention reduce disability and improve quality of life.
2. Can the above intervention increase Osteoporosis knowledge, osteoporosis medication prescribing and adherence to this medication?
3. Can the intervention reduce fear of falling?
4. Can the intervention reduced re-admission rate to acute hospital and placement in long term care facilities.

5.6: Study Design

5.6.1: Introduction

Study design is a process in which methodology and statistical analysis are organised to ensure the null hypothesis can be rejected or accepted and that the conclusion reached reflects the truth (Lerman 1996). Ho et al (2008) states that the study design must fit the type of question asked to provide appropriate and effective measures. In this study we hypothesise that a multidisciplinary falls and bone health assessment and intervention co-ordinated by a Clinical Nurse Specialist can improve post hip fracture outcomes, in elderly persons, over the course of one year.

An experimental study design was implemented in this study as the design most suited to answer the research question. This was a randomised control trial. This study design was decided upon in an effort to provide an unbiased, reliable method to determine if the interventions were effective.

5.5.2: Randomisation

Randomisation is necessary to ensure that any potential bias is reduced as much as possible. In this study randomisation will be achieved by using a computer generated minimisation programme. Minimisation is an alternative method of obtaining treatment groups that are comparable in prognostic variables. It achieves balance on a set of prognostic factors. Even in small trials it will provide groups that are very similar on several prognostic factors (Roberts and Torgerson 1998). A running total is kept of how many patients have been assigned to each group. At the start of the trial treatment is randomly allocated to the first patient. Subsequent patients are assigned using a randomisation weighted towards the group to which assignment would minimise the imbalance. After each patient is entered the relevant totals for each factor are updated.

In this study the participant's age, gender and MMSE and Nottingham Extended Activities of Daily Living (NEADL) score were the prognostic factors used. The minimisation spread sheet provides you with a sentence such as 'allocate to control' or 'allocate to study group', based on the characteristics of the patients. The allocation is done by an automated process on the basis of the variables, which are independent of the expected individual impact of treatment. The initial allocations are random and therefore the overall study can be said to be randomised. The reduction of bias is important and as such the use of this randomisation method tries to minimise this on the basis that the researcher has no role in allocation, it is done in an automated and randomised fashion. Computer technology allows for several variables to be followed at the same time so that a minimum of differences will be obtained between the groups (Escosteguy 1999). The variables used in this study was those of age, gender and mental function as assessed using Folstein's Mini Mental test score (MMSE) and NEADL as previously stated, as these variables have a significant influence on the outcomes of hip fracture patients, as discussed in the literature review. Patients were randomised on a one to one basis to either the study or control group.

5.7: Participants and recruitment

All patients attending the study site for repair of a fractured hip over the period of two years were invited to participate in the study. Each patient was seen within a week of admission, during the orthogeriatric ward round, by the investigator and a care of the elderly registrar, at which point a mini mental test (MMSE) and NEADL was carried out. An appointed gatekeeper visited these patients in the acute ward setting and gave them an information leaflet informing them of the aims and objectives of the study, the assessments involved in the study and their rights of participation i.e. ability to leave at will. A letter of invitation to participate and verbal and written information on the study was also given to them at this stage. The gate keeper returned prior to the patient's discharge (no less than 1 week later) to ascertain the patient's wishes to participate or not. If the patient wished to participate the gatekeeper obtained written consent.

The result of the MMSE, as well as their age and gender was imputed into a computer generated minimisation programme for randomisation into the different groups by the gatekeeper. This computer programme was developed by a medical statistician who has no connection with the study.

5.8: Sample Setting

This study was carried out by the researcher in a large teaching hospital in inner city area of Dublin, Ireland. It caters for a population of 234,983 of which 28,284 (12.04%) are older people aged sixty five years or over while 11,222 (4.78%) are seventy five or over. In the year 2007 196 hip fracture patients were admitted and treated to the hospital.

5.9: Sample Size

Sample size is of the utmost importance in randomised control trials (RCT). A trial should recruit a number of participants large enough to obtain a reasonably precise estimation of response to each treatment involved. It must be sufficient to have adequate statistical power, so that if the treatment being studied is effective, the efficacy will not be mistakenly missed in the trial. The sample size will depend on the amount of type one (alpha) error allowed for. Type one error or alpha, measures the probability of a false positive result where the investigators conclude that the two treatments differ when they do not. The probability (p) of type one error is usually stipulated at 0.05, at which there is a 1 in 20 risk that the difference detected is entirely owing to chance (Greenhalgh 1997). Type two errors is the probability of not detecting a difference when it really exists- i.e. a false negative (Greenhalgh 1997). The power of the study, i.e. the degree of certainty that the difference between the treatments will be detected, is 1-beta and is generally set at between 0.80 and 0.90 (Whitely and Ball 2002). Power, is the probability that a study will yield a 'statistically significant' result, conditional on a given effect size, sample size and other parameters such as the variability of the measures involved. In putting together a proposal, this concept is used in order to determine whether or not it is sensible to proceed with work. If the power of the study with a given sample size is too low then it is unlikely that a difference will be detected even if it is present, and so it is hard to justify doing the study in the first place. Common guidance suggests that a minimum value of 0.80 is used (Nakagawa 2004).

In this study the value of 0.80 was used in determining what the sensible minimum value for the sample size should be. If the actual effect size of the intervention is larger, or the numbers recruited turns out to be larger, then the actual power is of course, larger than the 0.80 used at the planning stage. However, power post hoc is of little relevance. In this study a sensible size for the study was determined at the planning stage. Some might suggest that higher values of power should be used when carrying out sample size calculations. It is certainly possible to do this. However, there are strong ethical reasons for not overpowering a study. This is especially the case for studies involving human or animal subjects. If a statistically significant and beneficial treatment effect of the intervention can be detect using 100 subjects, then the trial should stop at that stage and all new cases should be allocate to the more beneficial intervention. On a practical level as well, overpowering a study can be a waste of valuable resources and researcher time. Power calculations give a mechanism for determining sample size at the planning stage. Other considerations that have to be explored are the feasibility of the study within the hospital context and whether or not these numbers are achievable over a reasonable period. In this study, one of the primary quantitative measures of interest is FES-I, fear of falling. In order to detect a reduction of 15% in this measure for the intervention group, with 80% power, allowing 10% loss to follow up, 112 participants was required in each group. The values for the mean FES-I, standard deviation and effect size were obtained from table two and three of Kempen et al (2008).

5.10: Intervention

The intervention group received a comprehensive assessment and referrals to appropriate services for risk factors management. This group received a 2-stage evaluation as described:

1) A 3 month post discharge consultation with the CNS in a pre-assessment clinic followed by a fast tracked appointment in the bone health clinic.

2) A further consultation at 15 months during which the assessment protocol was repeated by the CNS to assess if the identification of fracture risk and referral to the relevant specialties improved patients outcomes.

Assessment carried out by Clinical Nurse Specialist.

This included a detailed history including medications, Folstein Mini Mental Test, Nottingham extended activities of daily living scale (NEADL) and Amended Barthel Score to assess ability to self-care, Laboratory tests inclusive of FBC and ESR, Thyroid Function Tests, Liver, Renal and Bone Profile, Myeloma Screen, a nutritional assessment using the Mini Nutritional Assessment, a multi-component bone health assessment (quantitative ultrasound of heel, DXA scan, biochemical bone markers i.e. CTX, Osteocalcin, P1NP, Parathyroid Hormone, and vitamin D levels were taken, an assessment of patients knowledge of osteoporosis using the Facts on Osteoporosis Quiz, their medications and their adherence to their medications using the Medication Adherence Score. A quality of life questionnaire was also administered (SF-36). Each patient was then fast tracked by the CNS to a consultant led bone health clinic with risk factors identified been highlighted. Educational strategies including visual and written information were offered to this group on falls prevention, osteoporosis and its treatment and reinforced by follow up telephone calls at four monthly periods which also captured the participants falls history.

These patients were compared to the control group at 15 months. The control group were given standard practise which involved follow up in a nurse-led pre-assessment clinic usually within 6 to 12 months post fracture followed by a next available appointment in the bone health clinic. This follow up focused on their bone health and did not incorporate a falls risk assessment, psychological assessment or quality of life assessment. They were contacted by the CNS four monthly to complete a falls dairy, place of residence and completion of the NEADL and Barthel questionnaires. They were then assessed at 15 months for falls risks and completion of the various questionnaires and a comparison between the two groups was made.

Falls Risk assessments	Bone Health Assessments
1. Cognitive assessment (MMSE). **2.** Nottingham Activities of Daily Living. 3. Amended Barthel Score **4.** Nutritional Assessment.-Mini Nutritional Assessment(MNA) **5.** A quality of life questionnaire (SF-36) **6.**Fear of falling assessed using the Falls Efficacy Scale International (FES-I)	**1.** Quantitative ultrasound of heel. **2.** DXA scan (if not already done), **3.** Biochemical bone markers. **4.** Assessment of patients knowledge of osteoporosis, (The Facts on Osteoporosis Quiz) **5.** Adherence to their medications and (Medication adherence Scale)

5.1: The Assessments carried out by the Clinical Nurse Specialist.

5.11: Inclusion Criteria

Inclusion criteria are a set of conditions that must be met in order to participate in a clinical trial. In this study, the criteria for inclusion are as follows:

1. Patients have attended the study hospital for the treatment of a fractured hip.
2. Patients are sixty years of age or over.
3. Patients are capable of completing questionnaires.

5.12: Exclusion Criteria

Patients will be excluded from the study if

1. They are younger than 60 years of age.
2. If the fracture is due to malignancy.
3. The investigator is unable to obtain consent by proxy for patients who have cognitive impairment as determined by their MMSE score.
4. If the patient has severe cognitive impairment as identified by a MMSE score of 18 or lower.

5.13: Reliability

Reliability is defined by Parahoo (2006) as the consistency of a particular method in measuring or observing the same phenomena. It is concerned with consistency, accuracy, precision, stability and homogeneity. A reliable measure is one that will produce the same result if the measurement is repeated using the same method. Assessing the stability of a measuring tool is derived through procedures that evaluate test re-test reliability (Lobionda-Wood and Haber 2006).

In this study a pilot study using the relevant questionnaires i.e. The SF36, the Facts on Osteoporosis Quiz, the Medication Adherence Scale, The Falls Efficacy Scale, the Nottingham Extended Activities of Daily Living score and Folsteins Mini Mental Test Score was carried out. All questionnaires used in this study were structured questionnaires, the reliability of which has been established.

5.14: Validity

Lobiondo-Wood and Haber (1998) and Streubert and Carpenter (1995) define validity as being concerned with whether a measurement instrument accurately measures what it is supposed to measure. There are three types of validity to questionnaires that vary according to the types of information provided and the purpose of the investigator, i.e. face validity, content validity and construct validity (Tarling and Crofts 1998).

Face validity refers to whether the tool looks as though it is measuring the appropriate construct. It is a type of content validity that uses an expert's opinion to judge the accuracy of the instrument (Lobionda-Wood and Haber 2006). Content validity refers to the degree to which the questions or items in the questionnaire adequately represent the phenomenon being studied (Daykin and Stephenson 2002, Pilot and Beck 2006). Content validity is based on expert judgment.

All questionnaire used in this study have been validated.

Validity of a randomised control trial depends on the process of randomisation as this insures that the measurable and non-measurable factors will balance out in the study. Randomisation ensures that factors, other than the treatment itself, which could influence the study, are equally spread between the two groups. As stated randomisation in this study will be obtained by a computer generated minimisation programme developed by a medical statistician.

5.15: Ethical Considerations

As in all areas of medicine and nursing, ethical consideration of our actions is important to protect the rights of the individual. In research, as well as legal responsibilities, the medical research must adhere to ethical responsibilities. The Nuremberg Code was developed in 1949 following the revelations of Nazi atrocities during World War 2 and gave rise to the Declaration of Helsinki in 1964 which was further revised in 1975 (Burns and Grove 1999). These codes require the researcher to protect the rights of the individual at all times and comply with their ethical responsibilities.

The main ethical principles identified involved in medical research are the principles of autonomy for the person, beneficence, justice and confidentiality.

The principal of autonomy for the person deals with the right of people to self-determination and to treatment as autonomous agents and that they may partake in a study without coercion or without the fear of withdrawing (Lobiondo-Wood and Haber 2006). Hence they have the freedom to agree or disagree to participation in research. Self-determination is based on the ability to make 'informed decisions' or give 'informed consent'. Therefore the provision of clear, honest and accurate information about the research study should be given and it is the responsibility of the researcher. In this study an information leaflet was delivered to each potential participant by the gatekeeper. This allowed the participants to make an autonomous decision, without perceived pressure from the researcher, to partake in this study

The principle of beneficence also plays an important role in research. This deals with not harming or distressing the individual and encompasses all forms of distress, i.e. physical, psychological and emotional. In the event that a participant is upset of affected by any issues raised in this study, a participant advocate in the form of a clinical nurse manager in orthopaedics agreed to make herself available to answer any queries participants may have during the study and her contact details was given on the information sheet.

The principle of justice, which deals with the right of people to be treated fairly, is also very important. The selection of the subjects and their treatment should be fair. The right if the subjects to privacy, anonymity and confidentiality should also be protected and assured. Based on the principles of respect and privacy, confidentiality and anonymity must be assured to the subject. Confidentiality is defined by Purtilo (1999) as "the practice of keeping harmful, shameful or embarrassing patient information within proper bounds." The promise of confidentiality according to Lobiondo-Wood and Haber (1998) means 'that individual identities of subjects will not be linked to the information they provide and will not be publicly divulged.'

In this study confidentiality and anonymity was assured and maintained. All data was maintained in keeping with the Data Protection Act (1988) and the Data protection (Amendment) Act (2003). Data computed was given numerical coding for analysis use only. Participants were assured that all questionnaires would be destroyed following completion of the study. The data was imputed into the researcher's personal computer safeguarded by a password known only to the researcher. Participants were reassured that their participation or not in this study, would have no bearing on future visits to the Bone Health Clinic. A guarantee of anonymity and confidentiality was included in the information leaflet.

In this study all the principles were honoured. Permission for the study was obtained from the Ethics Committee of the hospital. Having received clearance, consent from the Nurse Manager of the area involved and verbal consent from the consultants, whose patients were involved, was obtained. Each patient invited to participate was first explained the nature of and reason for the study. They were given an information leaflet on the study and allowed sufficient time to read through this. The researcher then invited and answered questions on the study. At all times the potential participants were made aware that they were under no obligation to participate in the study and that if they did so, it was of their own free will and volition. According to Polit and Hungler (1999), informed consent means that participants are provided with adequate information, are capable of understanding the information and have the power to consent to participation in the study.

Participants in this study were asked to sign a consent form having had time to read and reflect on the information leaflet. They were issued with a copy of the consent form and the information leaflet.

5.16: Data Collection and Protection

Data collection is the process of selecting subjects and gathering data from these subjects (Burns and grove, 2007). An ideal data collection procedure is one that measures or captures the constructs in a way that is relevant, credible, accurate, unbiased and sensitive (Polit and Hungler 2008).In this study data was gathered using a data collection form or study proforma developed by the researcher. This proforma included demographical information on the participant, their medical, fracture and fall history, results of all the tests carried out on the participant as well as values obtained from the various questionnaires that were completed by the participants. This form was being based on a Filemaker Pro database which was also developed by the researcher. This aided easy entry into the database and convenient transfer to a computer statistical package (SPSS).The researcher developed a codebook document which consisted of variable name, abbreviated variable name and possible values of every variable for entry on the SPSS computer file as advised by Pallant (2006). All patients were assessed in the morning between the hours of 09:00 and 12:00 to accommodate the taking of blood samples, in particular bone markers which are influenced by a circadian rhythm.

5.17: Data Analysis

Data analysis is conducted to reduce, organise and give meaning the data (Burns and Grove 2007). Data was entered in full into the Statistical Package for Social Science version 19 (SPSS) and statistical analysis was undertaken. As a quantitative research approach was used in this study, analysis techniques were conducted and included descriptive and inferential analysis. Descriptive analysis includes the demographic representation of the sample as well as frequency distribution, central tendencies and dispersion of variables. Inferential analysis allows the researcher to make generalisation concerning the larger target population from which the specific sample was drawn (Banerjee 2010). Inferential statistical tests infer the possibilities that result from the sample are typical of the population as a whole (Couchman and Dawson 1999).

There are two main types of inferential statistical methods, parametric and non-parametric. Parametric methods refer to the estimation of parameters of the population such as, 'mean' based on the sample when distribution assumptions have been made about the population. Non parametric methods are applicable to estimations without the population distribution being strictly specified. Confidence intervals estimate the precision of a parameter estimate. A confidence level of 95% was used in this study. Statistical tests such as chi-square analysis were used to test for differences between groups and identify the independence or relationship between variables. Paired t-tests were also carried out. This test compares two population means or paired values (such as in a 'before' and 'after' situation) where both observations are taken from the same or matched subjects. Parameters were statistically analysed in an analysis of Variance (ANOVA) with factors representing each time frame. A repeated measures design was used and the Greenhouse-Geisser (Winer 1971) 3-step approach to significant testing was employed. Corrected degrees of freedom and p value and the epsilon value of the correction factor are reported.

Data analysis was carried out using the SPSS package.

5.18: Storage of Data

The chosen questionnaires were once completed by the participants were handed to the investigator for further process. All the completed questionnaires and assessments derived from this study were secured in a locked cabinet in the researcher's office. This data was transferred to computer and stored on discs in the locked cabinet. The use of a coded password prevented unauthorised access to the data on the computer. Names of participants did not appear as part of the computerised data as all participants were assigned a code. All data pertaining to the study will retained securely and confidentially for a period of 5 years, as per good practice, University of Dublin, Trinity College. The distribution and collection of each questionnaire is discussed below in a summary of the methodological process employed in this study.

5.19: Summary of Methodology used in this Study

Recruitment of participants for this RCT occurred between June 2008 and 2010. All patients admitted to the study site were assessed by the Clinical Nurse Specialist and Care of the Elderly registrar at a weekly ortho-geriatric ward round. All patients admitted from the community, long term care facilities and inpatients that fell and sustained a hip fracture were included. Sources of information included the Hospital's Electronic Patient Record, computerised theatre list and the Orthopaedic Consultants' inpatient lists and inpatient falls data. An ortho-geriatric assessment form was completed on every patient by the Clinical Nurse Specialist to record clinical information on hip fracture and to aid clinical record keeping and audit. Hip fractures were defined as any fracture of the femur between the articular joint of the hip and 5 cm below the distal point of the Lesser Trochanter. All hip fracture patients are routinely admitted under the care of the orthopaedic team and are reviewed by the orthogeriatric liaison team on a weekly ward round. This review includes risk factors for osteoporosis, falls history and present treatments. It also included an assessment of cognitive status, prior mobility and ability to self-care, carried out by the clinical nurse specialist using the Mini Mental Score Examination (MMSE), the Nottingham Extended Activities of Daily Living Index (NEADL) and the Amended Barthel Score (ABS). Each participant was asked their place of residence prior to admission. One hundred and fourteen participants were recruited to the intervention group and one hundred and twelve to the control group. This was deemed the number needed to detect a 15% reduction in the fear of falling in the intervention group with 80% power. The previously discussed questionnaires were administered by the investigator to all participants. The administration and collection of each questionnaire is discussed below.

Cognitive function of participants was assessed using the Mini Mental State on all hip fracture patients on admission to hospital by the clinical nurse specialist. Further examination was carried out on the intervention group at 3 and 15 months and on the control group at 15 months. The NICE (National Institute for Health and Clinical Excellence) classification of 21-24 as mild, 10-20 as moderate and <10 as severe impairment was used in analyses of results in this study.

Anxiety and depression levels were assessed in the intervention group at three and fifteen months and the control group at 15 months using the Hospital Anxiety and Depression Score (HADS). Those who did not attend the bone health clinic were request by telephone call to complete the questionnaire which was sent to them by post with a stamped addressed envelope in which to return the completed questionnaire.

Fear of Falling (FoF) was assessed using the Fall Efficacy International Scale (FES-I). The participants were asked to complete this scale when they attended the bone health clinic. For those who did not attended the clinic a request that they complete the questionnaire was made by the clinical nurse specialist during the four monthly telephone calls made to the study participants and it was then sent to them by post. FoF was assessed at 3 months on the intervention group and at 15 months on both groups (the intervention and Control group).

On admission all participants were was asked if they required assistance of a person or mechanical devise for mobility prior to admission to hospital and the NEADL and ABS were completed by the clinical nurse specialist. These questionnaires were repeated at three months and fifteen months post hip fracture for the intervention group in the bone health clinic for those who attended and by telephone calls for those who could not attend. All participants received a telephone call from the clinical nurse specialist to complete these questionnaires at 3, 7, 11.and 15 months. Pain experienced by participants was measured by Numerical Rating Scale (NRS) (0-10). This is a scale on which patients rate their pain from 0 (no pain) to 10 (worse possible pain). Based on previous studies and clinical practice, pain was categorized screening NRS scores as 0 corresponding to "None", 1-4 to "Mild pain", 5-6 to "Moderate pain", and 7-10 to severe pain (Jensen et al 2001, Fejer et al 2005, Paul et al 2005). Each participant was asked if they experienced pain and to identify it's severity at 4 monthly intervals. It was decided to use the NRS as participants were contacted by telephone by the clinical nurse specialist at 4 monthly intervals, hence making the Visual Analogue Scale (VAS) unsuitable for use. Also, research shows that the use of VAS in elderly patients is associated with higher failure of completion rates than the use of NRS, and that the elderly prefer to use NRS in respect to VAS.

A 'Bone Health Assessment for patients with Fractures' form was completed on all hip fracture patients admitted to the study site by the clinical nurse specialist on the weekly orthogeriatric ward round. This included the history of event leading to admission, past medical history and fracture history. Information was obtained from the hospital's Electronic Patients Record, patient's chart and history taken from the patient.

The bone health of each participant was assessed in a Clinical Nurse Specialist led Pre assessment clinic (PAC) followed by a bone health clinic appointment where they were seen by a geriatrician with special interest in bone health and their team. At the PAC appointment all participants received a detailed bone assessment including DXA scan, quantitative ultrasound of heel, biochemical bone markers i.e CTX, Osteocalcin, P1NP Parathyroid Hormone, and vitamin D and Calcium levels, and a detailed history of previous fractures, medications and comorbidities. Serum biochemical and urinary studies were also carried out. The intervention group were allotted specific appointments at 3 months post fracture while the control group were given the next available appointment. The intervention group was then given a fast tracked appointment to the bone health clinic where they were reviewed by a geratrician and their medical team while the control group were given the next available appointment.

Nutritional status of participants was assessed using the the Mini Nutritional Assessment. The intervention group's nutritional status was assessed at 3 months and fifteen months and the control group at 15 months. This assessment involved firstly a screening for the risk of malnutrition. If found to be at risk of malnutrition a more detailed assessment was carried out, noting daily dietary consumption, Mid arm and calf circumference and self view of nutritional status.

The Medical Outcomes Study Short Form 36 (SF-36) was used to measure patient Quality of Life (QoL) at three months for the intervention group and at fifteen months for both the intervention and control group. The SF-36 is a generic measure of QoL that has been widely validated for use across a range of health care professions, settings and patients. It measures QoL across eight emotional and physical domains: physical functioning (PF); role limitations due to physical health (RP); role limitations due to emotional problems (RE); Vitality - energy/fatigue (VT); general mental health (MH); social functioning (SF); bodily pain (BP); general health (GH).

Information was also obtained from the hospital's Electronic Patient's Records system. The clinical nurse specialist also sourced information about deaths from the computerised death notice site 'RIP.ie' and the General Register Office to clarify those participants state of health whom she was unable to reach by telephone.

Chapter 6

In this chapter the demographics of all patients admitted to the study site will be described. This is the group of patients from which the study participants were recruited. This will be followed by the presentation of the results and findings of the study. For ease of reading they will be organised into sections with a brief introduction, methodology and discussion included.

All Hip Fracture Patient Demographics Presenting to Study Site

6.1: Introduction

Hip fractures are a major cause of burden in terms of mortality, disability and cost. With ageing of the population, a marked increase in the number of fractures is anticipated. Furthermore, many studies reveal an increase in the age-adjusted hip fracture incidence (Cooper 1992, Kanis 1993, Cummings 2002, Dhanwal et al 2010, Kanis et al 2012). The incidence of hip fracture is highest in Northern Europe and North America. The incidence rates vary from North to South Europe, the highest being in Sweden and Norway and the lowest in France and Switzerland (Dhanwal et al 2010). When highlighting geographical age and sex standardised rates as well as fracture risk in both men and women, Kanis et al (2012) identified a swathe of high-risk countries extending from North Western Europe (Iceland, UK, Ireland, Denmark, Sweden and Norway), both east to The Russian Federation and south through to central Europe (Belgium, Germany, Austria and Switzerland) and thereafter to the South East (Greece, Hungary, Czech Republic and Slovakia). The incidence of hip fractures is expected to increase over the next few decades as the elderly population increases (Hagino et al 2005). In Ireland, the rates of hip fracture for the total population aged 50 years and over are 407 and 140 per 100,000 for females and males, respectively, as stated by Dodds et al (2009) who predicts this rate to increase by 100% by the year 2026. Despite this, care of hip fracture can vary from site to site. With this increase in numbers will come an increase in cost? It is estimated that in Ireland hip fractures can cost €14,500 per admission as reported by Cotter and colleagues (2006). The care of hip fractures presents a significant challenge to healthcare services and society in general due to increased mortality and morbidity associated with such fractures. A previous study carried out in Ireland showed an 11% early mortality rate rising to 27% at three months following hip fracture. While at two years post hip fracture they reported a mortality rate of 24% compared to 11% for controls (Moore and Quinlan 1989). In order for health service providers to allocate sufficient funds for the management of hip fractures, accurate figures of hip fracture rates and outcomes should be measured. More women than men suffer hip fractures. Previous studies have shown that white women have a calculated 16% lifetime risk of suffering a hip fracture, while white men have a 5% lifetime risk (Sambrook, and Cooper 2006).

6.2: Results

Three hundred and ninety six hip fracture patients were admitted to the study site between these dates. Of this overall group, 69% (n=272) were females and 31% (n=124) male. The mean age was 77.2 years with a range of 40 and 96 years. Nine percent (n=37) of this group was admitted from a long term care institute while 91% (n =359) was admitted from home. The mortality rate for this group was 5% (n=20) at 1 month, 11% (n=45) at 6 months, 14% (n=56) at 12 months and 22% (n=86) at 2 years. Men had a higher mortality rate than females. Results are tabulated below.

	1 month	6 months	12 months	24 months
Female (n=272)	7 (3%)	19 (7%)	30 (11%)	52 (19%)
Male (n=124)	14 (11%)	24 (19%)	28 (22%)	34 (27%)

Table 6.1: Mortality rate and gender of all patients attending the study site for hip fracture repair.

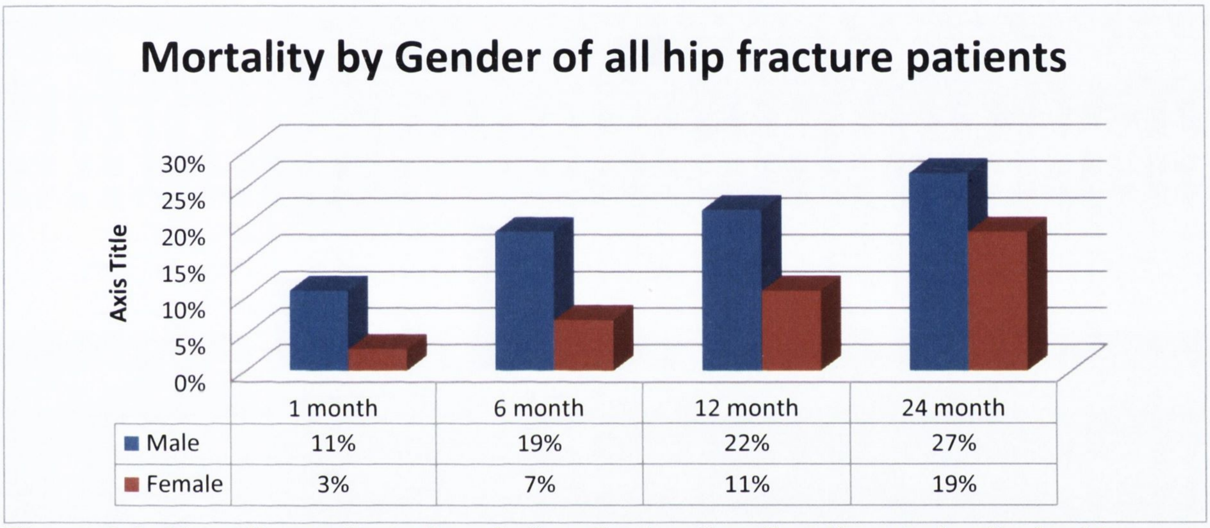


Figure 6.1: Mortality and gender of all patients attending the study site for hip fracture repair.

Those admitted from long term care facilities had a higher mortality rate with 22% (n=8) dying within one month of fracture compared to 3% (n=12) of those admitted from home. Thirty two percent (n=127) were discharge home, 42% (n=166) were discharge to rehabilitation units on and off site, 18% (n=71) were discharged to long term care facilities while 1% (n=5) were discharged to another hospital. Seven percent (n=27) died prior to discharge.

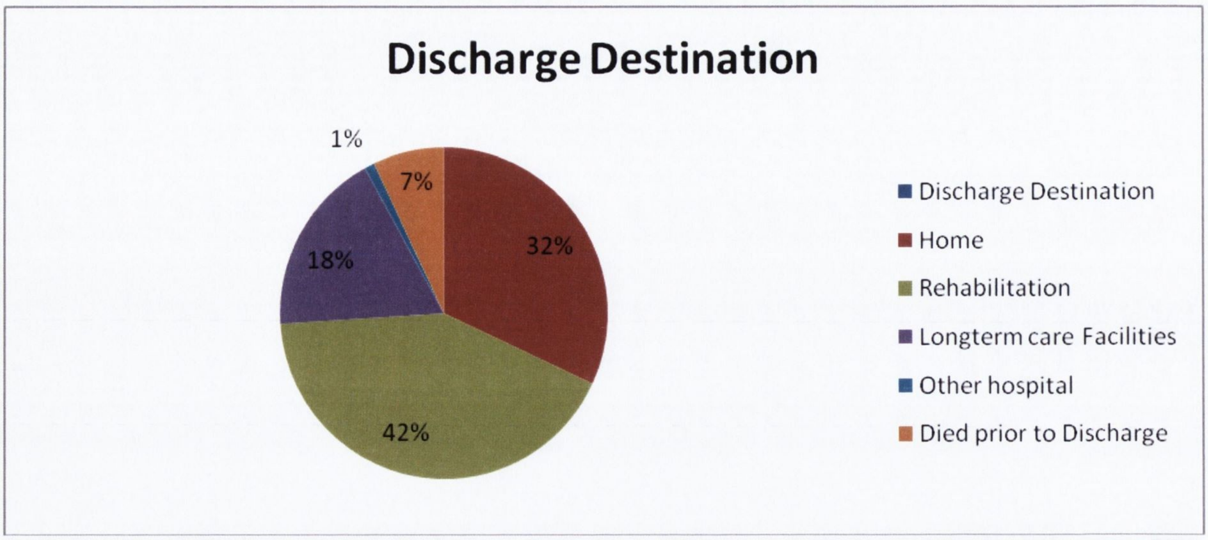


Figure 6.2: Discharge destination for all patients attending study site for hip fracture repair

6.3:Study Participants

This section will deal with the results and findings of the study. The study participants were recruited from all the patients admitted to the study site for hip fracture repair.

Participants were recruited into the study if they fulfilled the inclusion criteria. Two hundred and twenty six participants were recruited for the study while 170 were omitted. The reasons for omission are tabulated below.

Low MMSE	67 (39%)
Cancer/Metastases	9 (5%)
Refused to participate	57 (33%)
< 60 years of age	19 (11%)
RIP	10 (6%)
Resident of another country	4 (2%)
Other	4 (2%)

Table 6.2: Reasons for omission from study

Of the 226 participants, 114 were randomised to the intervention group and 112 to the control group using a computerised minimisation programme using age, gender, MMSE and Nottingham Extended Activities of Daily Living (NEADL) scores as prognostic factors.

6.4: Age and Gender of Study Population

Of the 226 participants, females were predominant with 71% (n=161) of the overall cohort being female and the other 29% (n=65) being male. Of these 17% (n=38) of those participating in the study were in the 60-70 age group, with 32% (n=73) in the 71-80 age group, 43% (n=98) in the 81-90 age group and 7% (n=17) in the 91-97 age group. The mean age of the overall cohort was 79.4 years (± 8.3 years, range 60 to 97). Women were older with a mean age of 80.8 years (± 8.1 years, Range 60-97) while men had a mean age of 75.9 years (± 8 years, range 60 to 94).

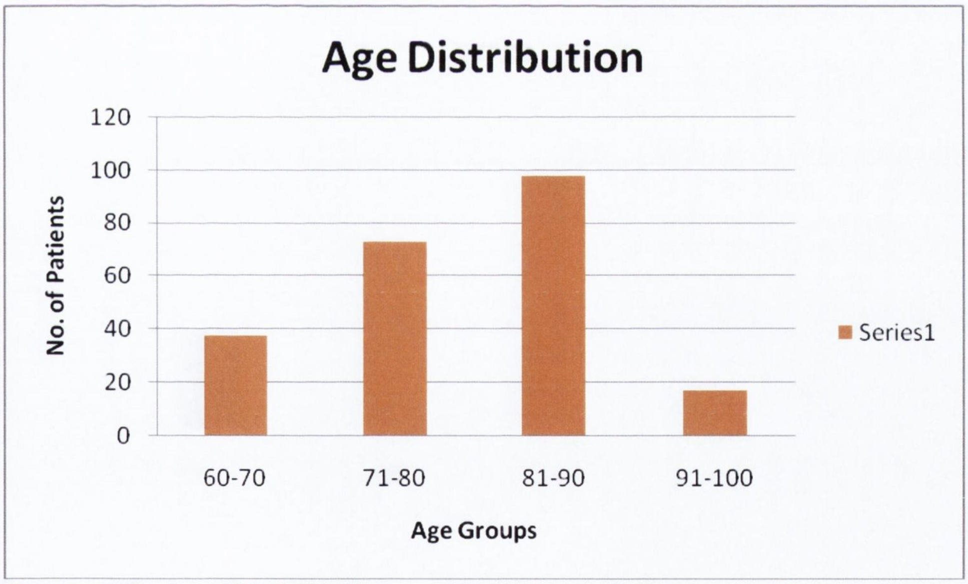
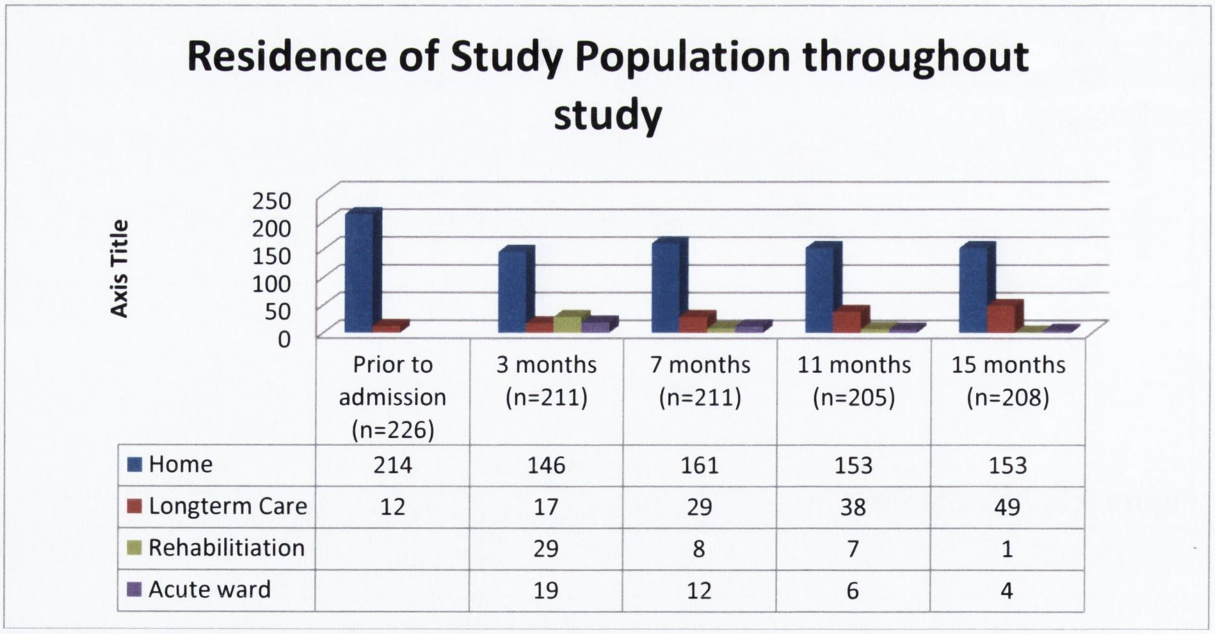


Figure 6.3: Age Distribution of study population

6.5: Residence of Study Population

Of the 226 participants, 95% (n=214) were admitted from home with the remaining 5% (n=12) admitted from Long Term Care facilities. Of those who were admitted from home. 49% (n=104) lived alone while the remaining 51% (n=110) lived with someone else. Women were more likely to live alone with 51% (n=82) of them on their own compared to 34% (n=22) of males living on their own. Each participant was asked where they were living at four monthly intervals. The vast majority of participants were living at home at 15 months, 71% (n=148) of participants who were still alive a 15 months were living at home with 24% (n=49) in long term care facilities. Of participants who were admitted from home 20% were discharged to long term care. The data was analysed using a Chi Square test. There was no significant difference between the intervention and control group and their 15 month residence.



	Prior to admission (n=226)	3 months (n=211)	7 months (n=211)	11 months (n=205)	15 months (n=208)
🟦 Home	214	146	161	153	153
🟥 Longterm Care	12	17	29	38	49
🟩 Rehabilitiation		29	8	7	1
🟪 Acute ward		19	12	6	4

Figure 6.4: Residence of Study Population (Intervention and Control groups) throughout study

There was a difference between place of residence at 15 months and age, with older adults more likely to reside in long term care although this was not statistically significant, χ^2 (2) =19.7, p = 0.073.

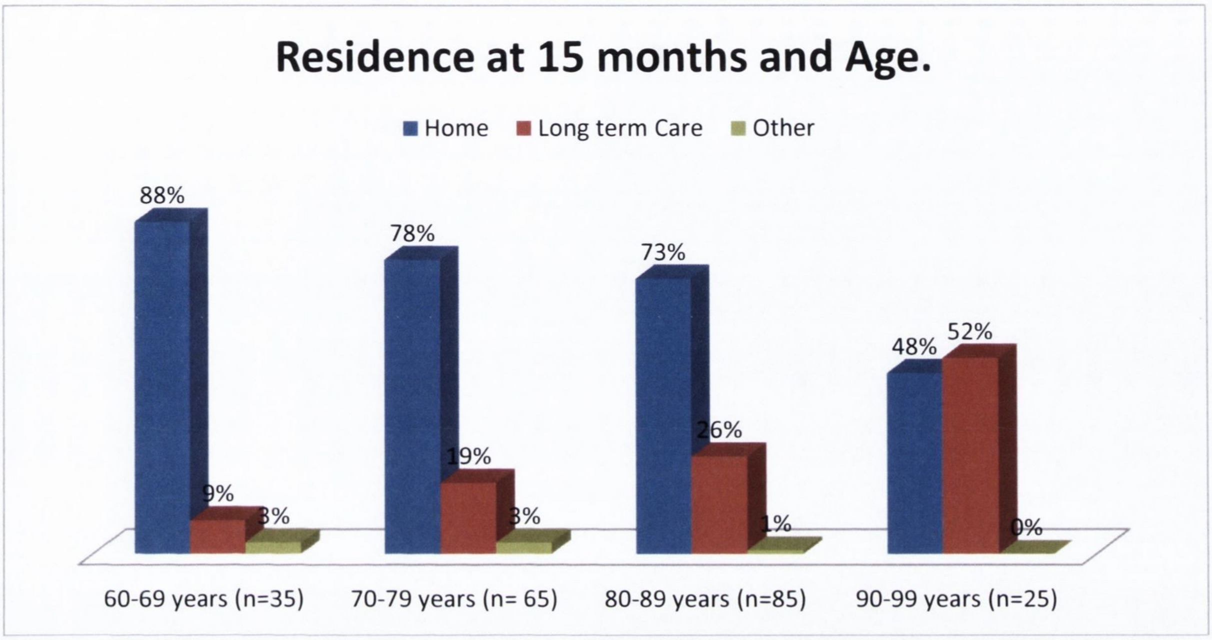


Figure 6.5: Residence and age of study population at 15 months post hip fracture.

Similarly, lower pre-fracture mobility, NEADL and ABS was associated with admission to a long term care facility by 15 months. χ^2 (20) = 37.9, p = 0.009 (mobility), χ^2 (220) = 264, p = 0.02 (NEADL), χ^2 (84) = 195, p = 0.001 (ABS).

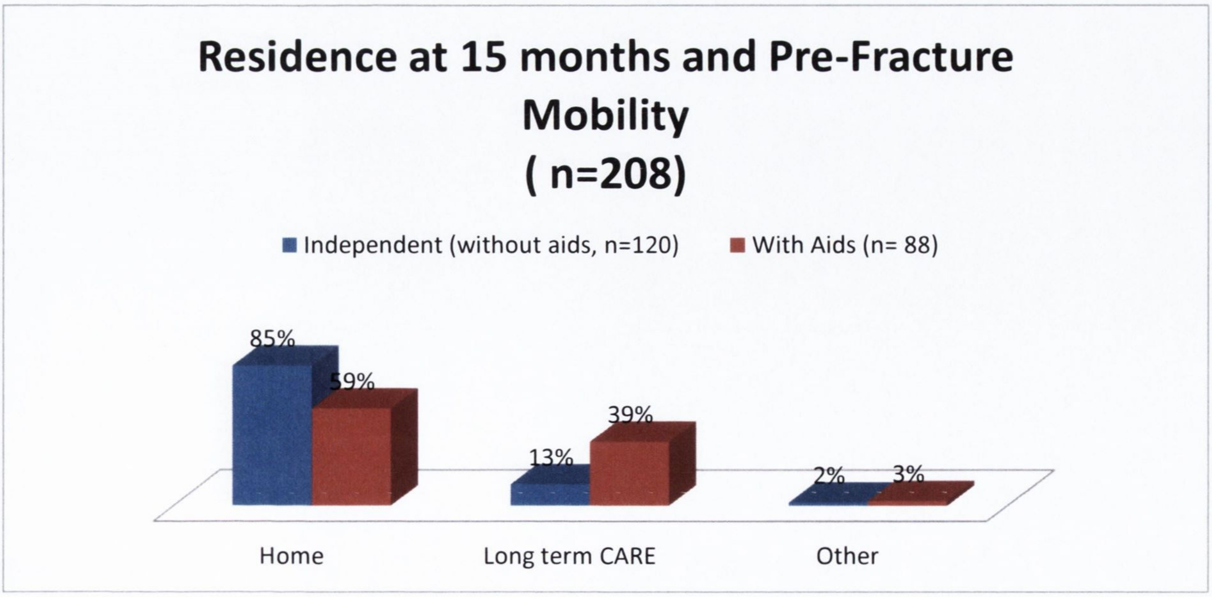


Figure 6.6: Place of residence at 15 months and prefracture mobility of study population

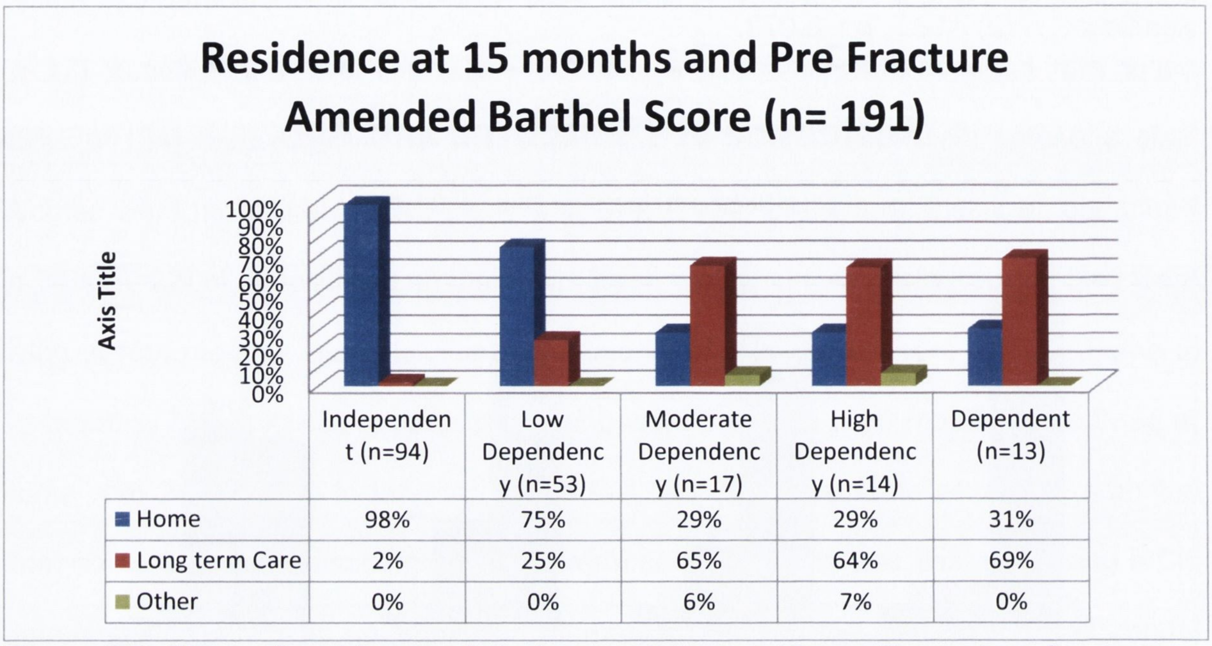


Figure 6.7: Place of residence of study population at 15 months and prefracture Amended Barthel Score.

Reduced cognition on admission to hospital was also associated with placement in long term care at 15 months χ^2 (60) = 135.8, p = 0.001.

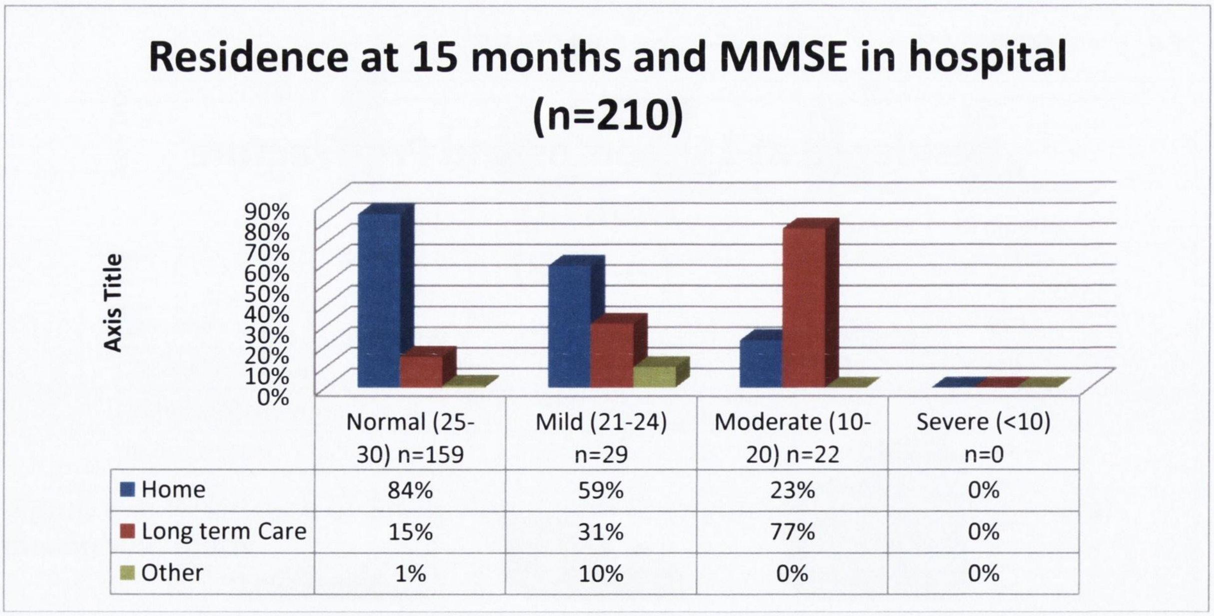


Figure 6.8: Place of residence at 15 months and MMSE results during first week in hospital following fracture.

6.6: Length of Stay in hospital

The median length of stay was 16 days, with the mean length of stay being 38.3 (±58.6) days. 21% (n=47) of patients were discharged home directly from trauma ward, 60% (n=33) were discharged to a rehabilitation units on and off site, 13% (n=28) to residential care, while 5% (n=12) were discharged to other facilities.

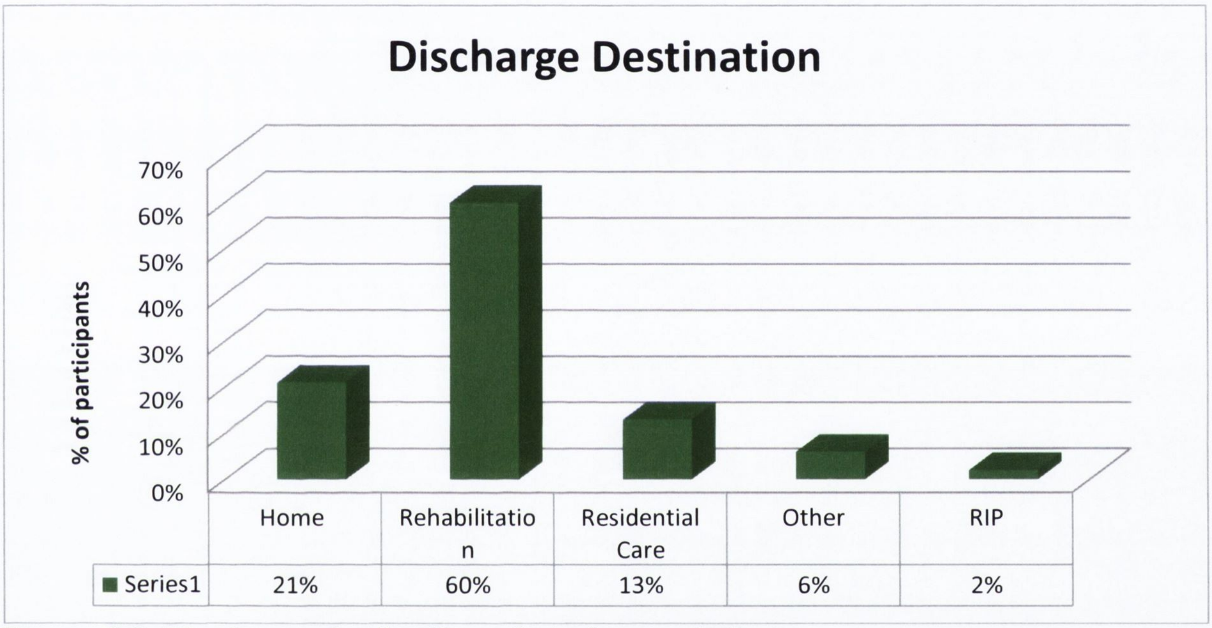


Figure 6.9: Discharge destination of study population

Chapter 7

Cognitive and Psychological outcomes following hip fracture in the Study Population

In this chapter the results of cognitive assessment as measured by the Mini Mental Examination Score (MMSE), the Hospital Anxiety and Depression Scale (HADS) and Fear of falling will be documented.

7.1: Cognition

7.1.1: Introduction

Many people admitted with hip fracture have cognitive impairment and this is associated with falls, recurrent multiple fractures and death (Prieto-Alhambra et al 2014). The incidence of cognitive impairment in the hip fracture population is approximately 40% as reported by Roche et al (2005).It has been identified in the literature as a risk factor for hip fractures but also a risk factor for poorer outcomes following hip fracture (Gruber-Baldini et al 2003, Horgan and Cunningham 2003, Soderquist et al 2006, Stenvall et al 2012). An increased understanding of the complex relationship between cognition, ambulation and rehabilitation outcome is required and poses a significant challenge to health-care professionals.

7.1.2: Results

The mean MMSE score for both groups (Intervention and Control) were similar on admission and at 15 months, 27 and 26 respectively for the intervention group and 26 and 25 respectively for the control group. A significant reduction in cognitive function was identified in the overall group (Intervention and controls) using paired t test to compare MMSE results on admission 27±, 4(M±SD) and 15 months MMSE results 25 ±, 6 (M±SD); t (185) = 5.0, p= 0.001.

An independent t-test was conducted to compare cognitive status in both the intervention group (n=96) and the control group (n=90) at 15 months. There was no significant difference in the scores 26 ± 5, (M±SD) (Intervention group) and 25 ± 7 (M±SD), (Control group).

Even in this select group cognitive function decreased with age. A significant difference was shown using Chi Square test between age and cognitive function χ^2 (6) = 13,

p = 0.043

Cognitive impairment increased the risk of admission to long term care facilities. Chi Square test showed a significant association between cognitive function and place of residence at 15 months post fracture with 57% (n=40) of participants residing in long term facilities at fifteen months post operation diagnosed with cognitive impairment compared to 37%(n=26) of those at home; χ^2 (12) = 105, p = 0.001.

MMSE	**On admission to hospital(n=226)**	**Three months post hip fracture(n=113)**	**Fifteen months post hip fracture(n=186)**
No impairment. (25-30)	159 (71%)	75 (66%)	131 (68%)
Mild impairment. (21-24)	50 (22%)	26 (23%)	27 (15%)
Moderate impairment. (11-20) MMSE ≥ 18 eligible for study	16 (7%)	10 (9%)	24 (13%)
Severe impairment. (<10)	Not recruited	2 (2%)	4 (2%)

Table 7.1: Cognitive function of study population throughout the study.

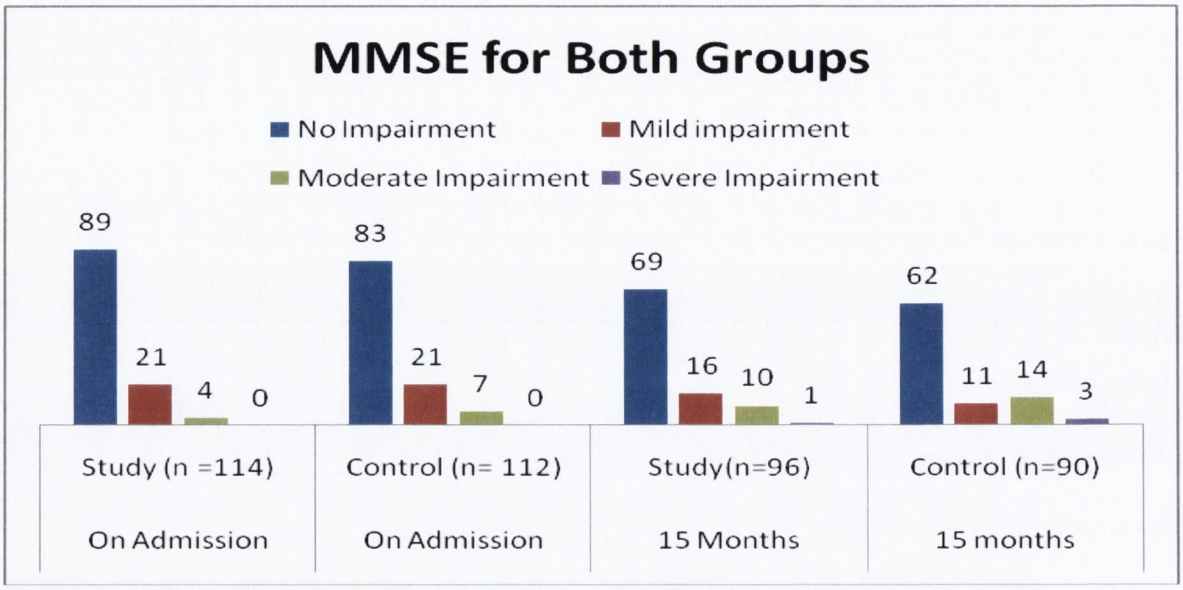


Figure 7.1: Cognitive function of study population throughout the study.

There was a significant difference between the cognitive function of those admitted from long term care facilities and those admitted from home with those admitted from long term care were more likely to suffer from cognitive impairment 58% (n=7) versus 24%(n=51) of those admitted from home. χ^2 (15) = 38.2, p = 0.001.

Furthermore, there was a significant difference in the ability to self-care in those with cognitive impairment compared to those with normal cognition. χ^2 (399) = 660, p = 0.001.

7.2: Section Two:-Hospital Anxiety and Depression Score (HADS)

7.2.1: Introduction

Depression is the most common of mood disorders in elderly people (Iolascon et al 2011). The DSM-IV defines major depression as the occurrence of 5 or more of the following features: depressed mood, diminished interest or pleasure, weight loss or gain, insomnia or hypersomnia, psychomotor agitation or retardation, fatigue or loss of energy, feelings of worthlessness or guilt, diminished energy to concentrate, and suicidal ideation. Depression is a highly disabling condition in itself and when associated with hip fracture significantly reduces functional outcome level (Iolascon et al 2011). Phillips et al 2013 reported that depression following hip fracture is associated with greater physical frailty and poorer long term recovery post-injury. Prevalence of depression in older people after hip fracture ranged from 9% to 47% and largely exceeds the 2% and 10% respectively reported for major and minor depressive disorder in the aged-matched not affected people as stated by Oude Voshaar (2007). This was reiterated by Lenze et al (2007) who reported that there is a higher incidence of major depressive disorder in hip fracture patients compared with the general population, thus suggesting that hip fracture is a risk factor for depression. According to Mossey et al (1990) approximately one in five people who are not depressed at the time of their fracture become so after 8 weeks. Anxiety and depression affect quality of life and increase pain severity as reported by Gambatesa et al (2013). Hip fracture can lead to a serious deterioration in a person's quality of life. This was reiterated by Murphy et al (2007) who also stated that as well as rendering an individual less mobile, the effect of sustaining a hip fracture can also cause psychological problems for patients such as anxiety, altered body image and withdrawal from social networks. Therefore the assessment of anxiety and depression levels in hip fracture patients is important to improve patient outcomes.

7.2: Results

Twenty nine percent (n=27) of the intervention group suffered borderline and above normal levels of anxiety at three months while 34% (n=33) suffered borderline and above normal levels of depression. Depression and anxiety levels of the control group were not measured at this time. At the fifteen months assessment 27% (n=36) and 28% (n=40) of the overall group (both intervention and control groups) suffered above normal levels of anxiety and depression respectively.

HADS	Three months Anxiety (Intervention group n=94)	Three months Depression (Intervention group n=94)	Fifteen months Anxiety (Study population n=145)	Fifteen months Depression(Study population n=145)
Normal	67 (71%)	62 (66%)	107 (74%)	105 (72%)
Borderline Abnormal	14 (15%)	17 (18%)	25 (17%)	31 (21%)
Abnormal	13 (14%)	15 (16%)	13 (9%)	9 (6%)

Table 7.2: Anxiety and Depression levels experienced by Study population as measured by HADS.

Intervention Group analysis of HADS at three and fifteen months

Twenty nine percent (n=27) of the intervention group suffered above normal levels of anxiety and while 34% (n=32) reported above normal levels of depression at three months post hip fracture. At the fifteen month assessment 22% (n=18) and 24% (n=20) suffered above normal levels of anxiety and depression respectively. Statistical analysis using analysis of variance was carried out. A repeated measures design using the Greenhouse- Geisser approach showed there to be a significant difference between the measures taken at the two time frames, F(2.23) = 2.83, p = 0.054.

HADS (Intervention Group)	Anxiety at 3 months.(n=90)	Depression at 3 months.(n=90)	Anxiety at 15 months (n=84)	Depression at 15 months (n=84)
Normal	64 (71%)	60 (66%)	66 (78%)	64 (76%)
Borderline Abnormal	14 (15%)	17 (18%)	14 (17%)	16 (19%)
Abnormal	13 (14%)	15 (16%)	4 (5%)	4 (5%)

Table 7.3: Anxiety and Depression levels experienced by intervention group at 3 and 15 months post fracture.

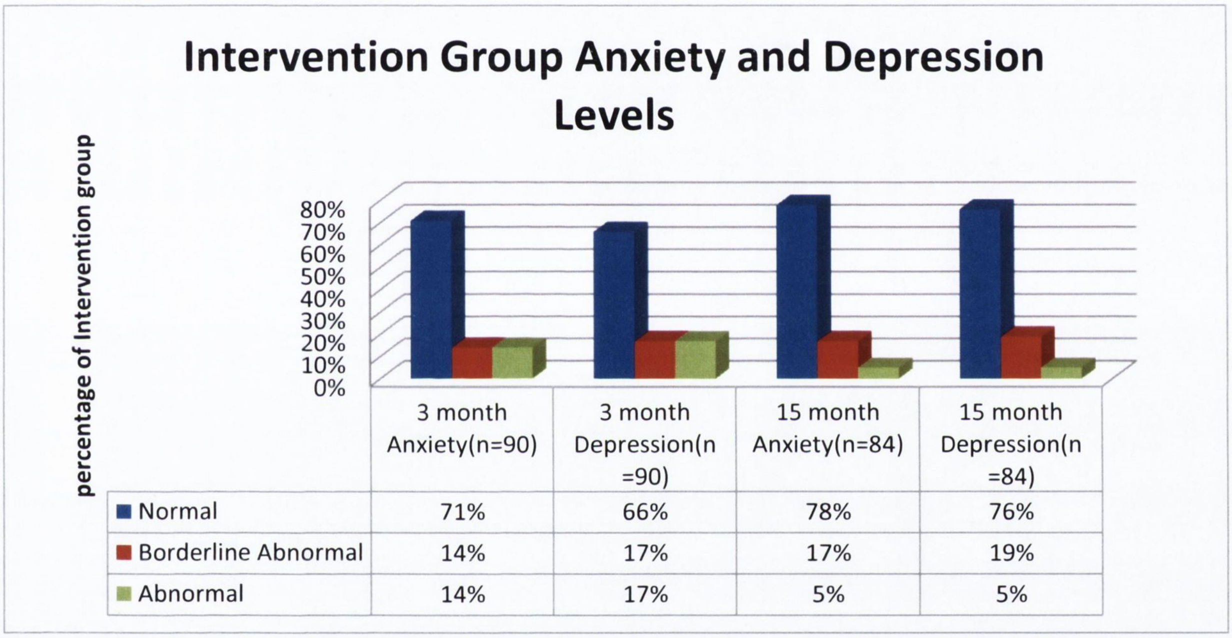


Figure 7.2: Anxiety and Depression levels experienced by Intervention Group at 3 and 15 months.

HADS at 15 months for Both Groups (Intervention and Control)

26% (n=38) of all participants expressed above normal levels of anxiety at fifteen months while 27% (n=40) expressed above normal levels of depression. At fifteen months 30%n=19) of control suffered above normal levels of anxiety compared to 24% (n=19) of the intervention group while 30% (n=24) of intervention group had above normal depression levels compared to 25% (n=16) of controls. This was not statistically significant using Pearson Chi Square test, χ^2 (2) = 3.682, p = 0.05 (anxiety), χ^2 (2) = 0.477, p = 0.05 (depression).

HADS at 15 months	Normal		Borderline Abnormal		Abnormal	
	Anxiety	Depression	Anxiety	Depression	Anxiety	Depression
Intervention group (n = 81)	62 (76%)	57 (70%)	15 (18%)	19 (23%)	4 (5%)	5(6%)
Control group (n= 64)	45 (70%)	48 (75%)	10 (16%)	12 (19%)	9 (14%)	4 (6%)

Table 7.4: Anxiety and Depression levels experienced by Intervention and Control groups at 15 months post fracture.

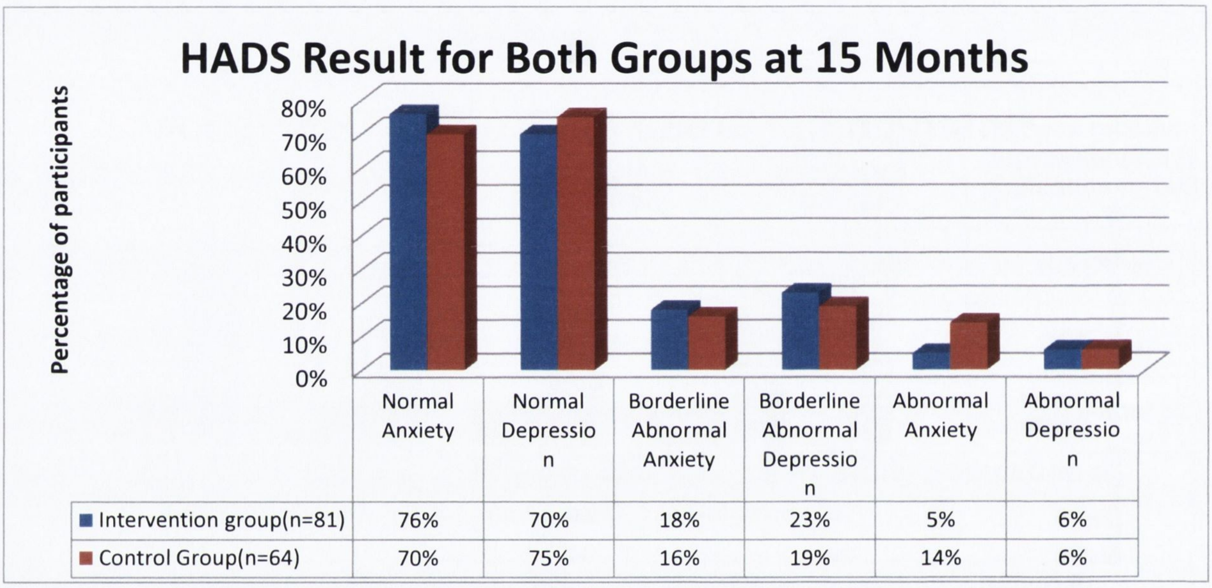


Figure 7.3: Anxiety and Depression levels experienced by Intervention and Control groups at 15 months post fracture.

There was an association between increased anxiety and depresson levels and reduced mobility with 30% of those requiring assistance with mobility expressing above normal levels of anxiety and depression compared to 16% of those independent, however this was not statisitically significant using Pearson's Chi Square test in analysis of data. χ^2 (2)2.07, p = 0.154.

There was an association between above normal anxiety and depression levels and reduced ability to carry out activities of daily living. Above normal anxiety and depression level was associated with lower scores in each domain of the Nottingham Activities of Daily Living. however this was not statistically significant except in Kitchen tasks and depression.

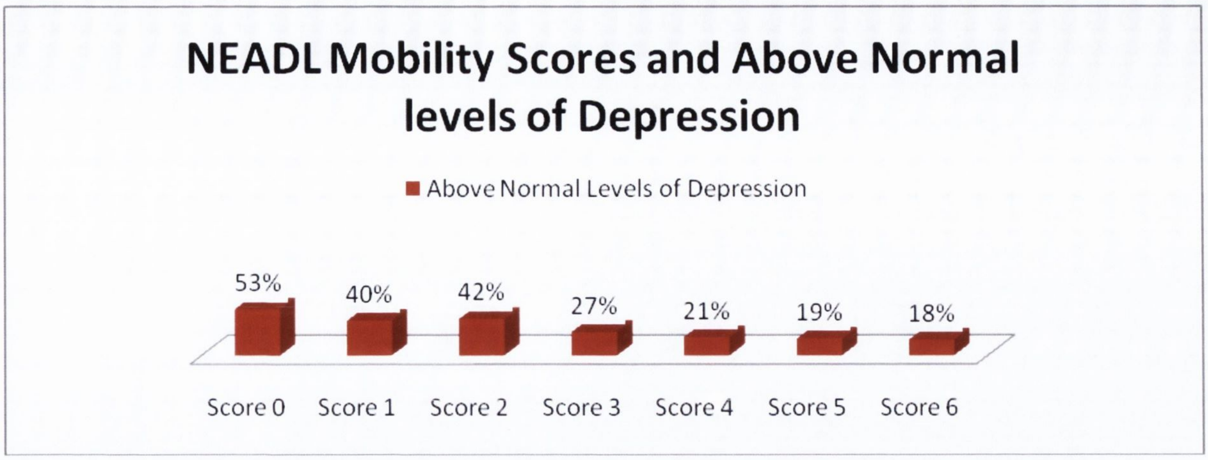


Figure 7.4:Nottingham Extended Activities of Daily Living (NEADL) mobility scores and above normal depression levels in study population at 15 months post fracture.

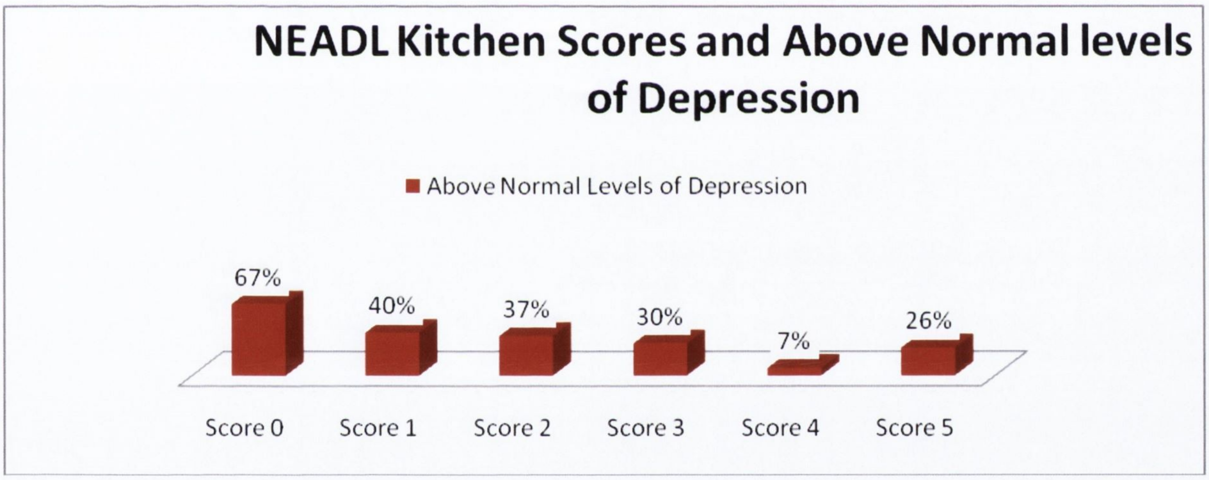


Figure 7.5: Nottingham Extended Activities of Daily Living (NEADL) kitchen scores and above normal depression levels in study population at 15 months post fracture.

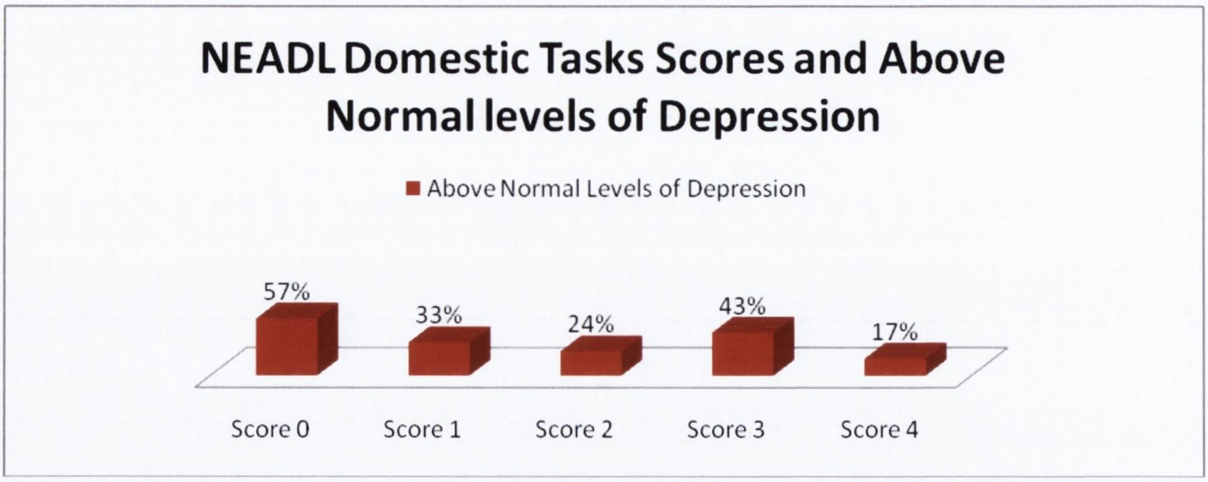


Figure 7.6:Nottingham Extended Activities of Daily Living (NEADL) Domestic Tasks scores and above normal depression levels in study population at 15 months post fracture.

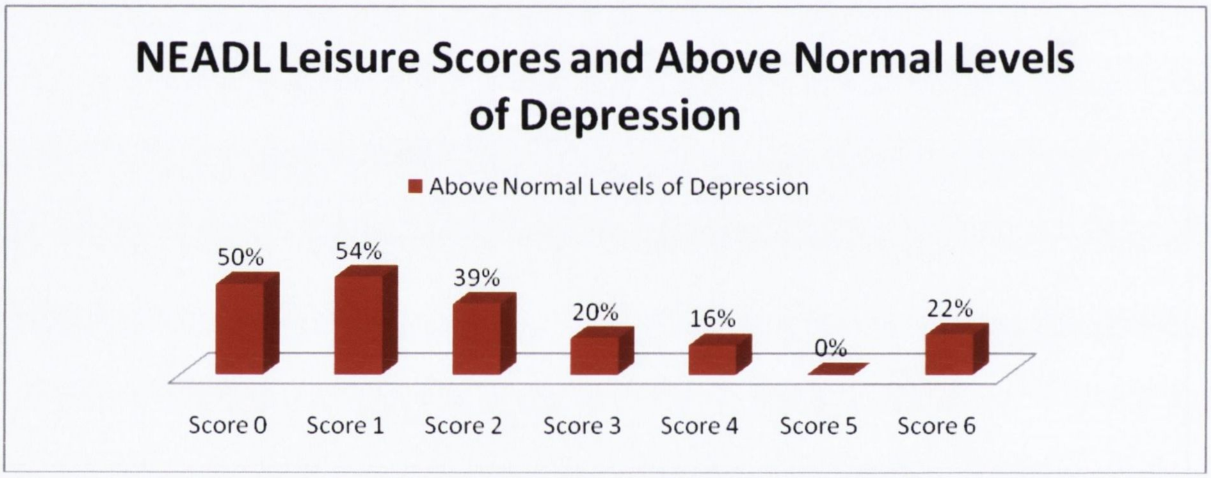


Figure 7.7:Nottingham Extended Activities of Daily Living (NEADL) Leisure scores and above normal depression levels in study population at 15 months post fracture.

NEADL Domain	HADS anxiety	HADS Depression
Mobility	χ^2 (12) =15.7, p = 0.201	χ^2 (12) = 12.9, p = 0.376
Kitchen	χ^2 (12) =17.7, p = 0.122	χ^2 (12)= 34.8, p = 0.001
Domestic Tasks	χ^2 (10) = 14.2, p = 0.164	χ^2 (10) = 9.94, p = 0.445
Leisure Activities	χ^2 (12)= 15.3, p = 0.223	χ^2 (12) = 17.4, p = 0.134

Table 7.5: Nottingham Extended Activities of Daily Living (NEADL) scores and levels of anxiety and depression experienced by the study population at 15 months post fracture Chi Square results.

There was a statistically significant increase in depression in participants with reduced ability to self care as mesured by the Amended Barthel Score. χ^2 (32) = 45.5, p = 0.057. More woman (31%) than men (18%) reported higher than normal levels of depression and higher than normal levels of anxiety, 27% and 24% respectively.

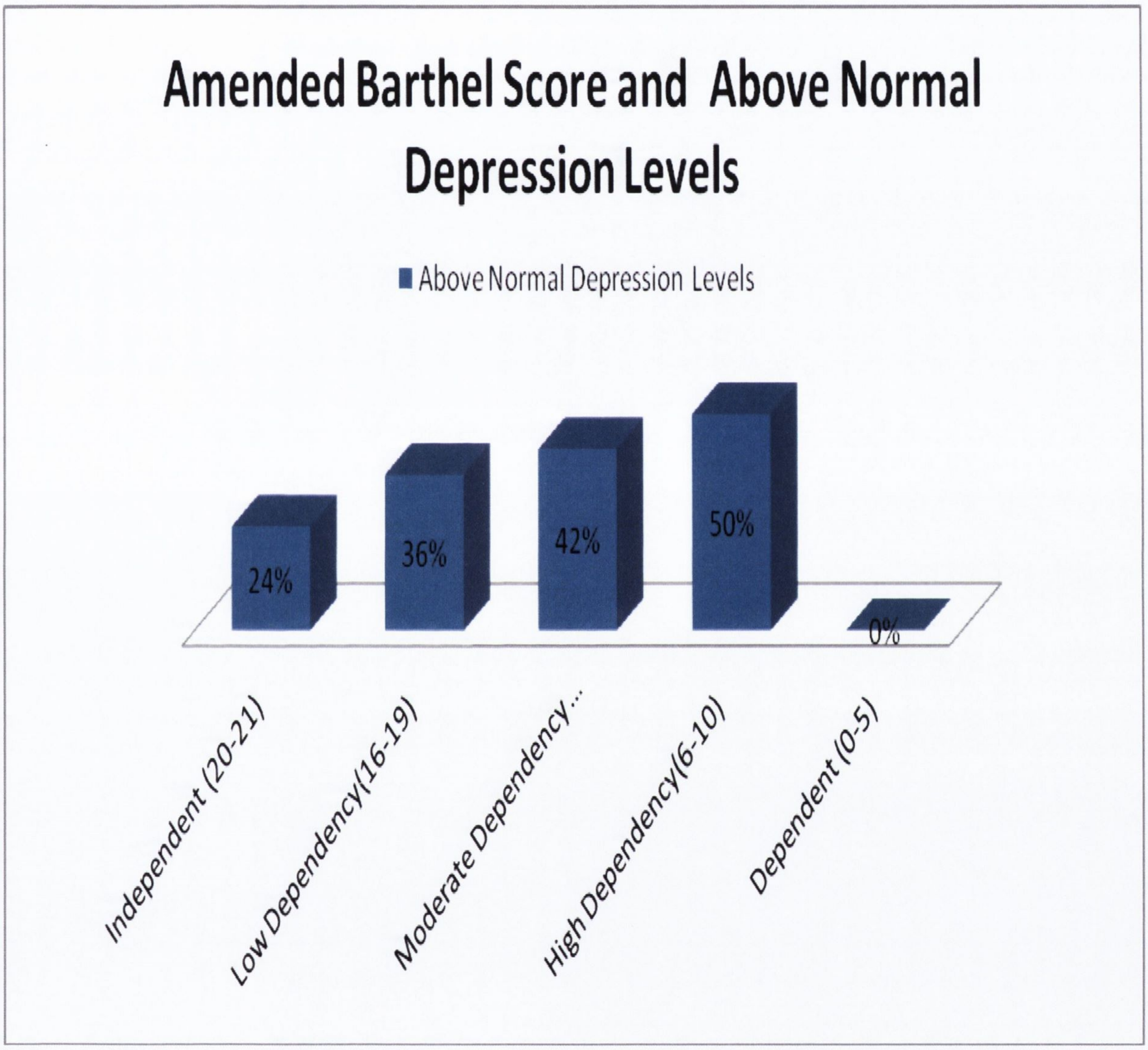


Figure 7.8: Amended Barthel scores and above normal levels of depression experienced by the study population at 15 months post fracture.

There was a high percentage of participants who suffered above normal levels of anxiety (25%-33%) who had reduced ability to self care as measured by the Amended Barthel Score but this was not statistically significant, χ^2 (32) = 29.6, p = 0.586.

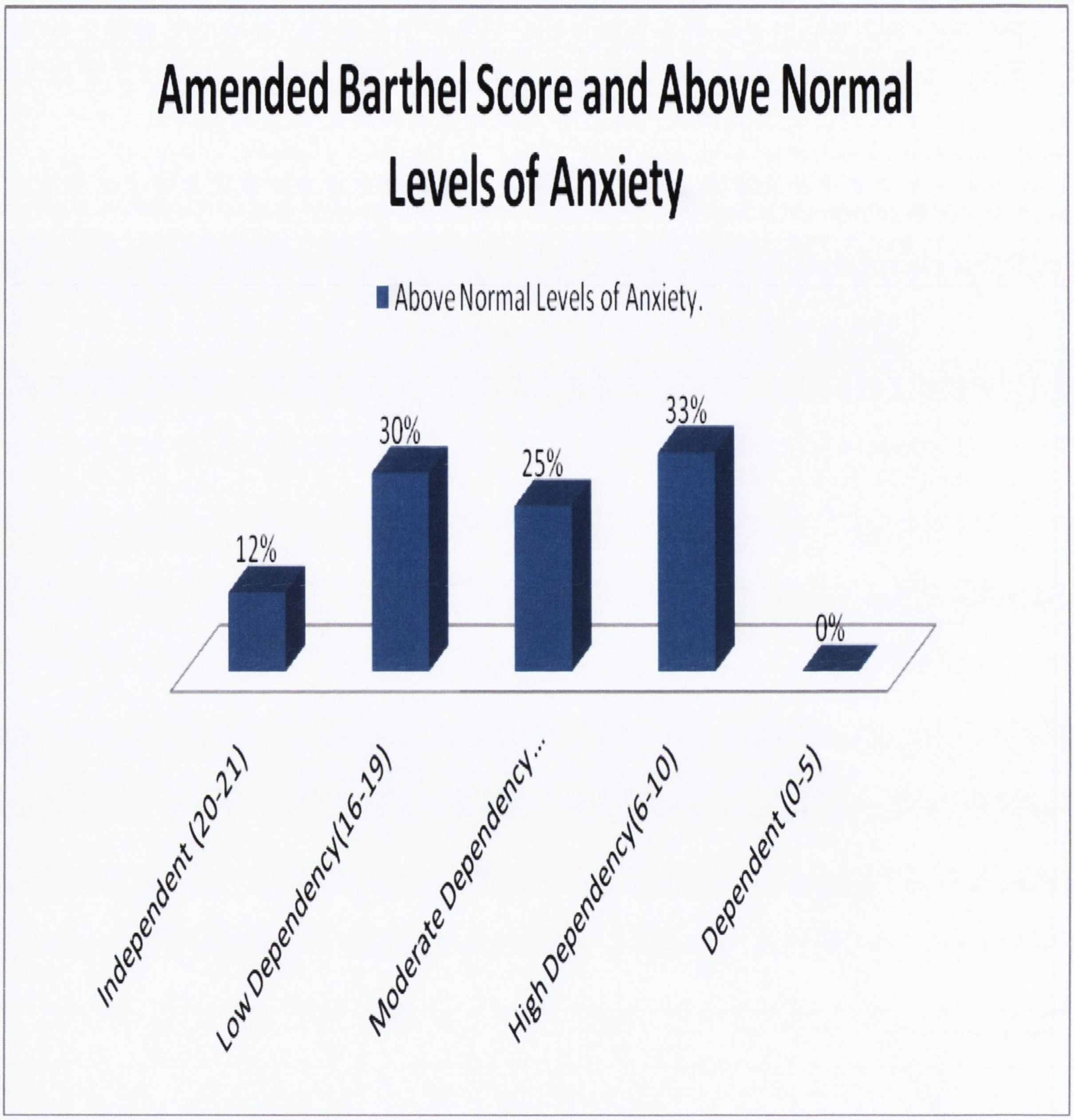


Figure 7.9: Amended Barthel Scores (ABS) and above normal anxiety levels experienced by the study population 15 months post fracture.

7.3: Section Three-Fear of Falling

7.3.1: Introduction

Falls are the leading cause of injury-related death, and the third leading cause of poor health among persons aged 65 years and older as cited by Evitt and Quigley (2004). Many older persons experience psychological difficulties directly related to the fall such as loss of self-efficacy, activity avoidance and loss of self-confidence (Legter 2002). Initially, Fear of Falling (FoF) was merely believed to be a result of the psychological trauma of a fall, also called 'post-fall syndrome' described by Murphy and Isaac in 1982 but has since been identified as a specific health problem in older adults. It is a major health problem among the older people living in the community, in older people who have fallen but also in older people who have never experienced a fall as cited by Jorstad et (2005). Fear of falling (FoF) is common in patients following hip fracture and can have a detrimental effect on outcomes following hip fracture. Visschedijk et al (2010) reported that FoF was associated with several negative rehabilitation outcomes, such as loss of mobility, institutionalization, and mortality. According to McKee et al (2002) assessing for FoF may help identify older people with hip fracture at risk of poor health outcomes. Assessment of FoF is important as a better understanding of FoF can contribute to the early identification of FoF and to more efficient interventions for primary (and secondary) prevention of falls in order to reduce some of the serious adverse health consequences of FoF as recommended by Scheffer et al (2008).

7.3.2: Results

Fear of falling was greatest at three months with 50% (n=47) of the intervention group experiencing severe fear of falling while 27% (n=25) and 22% (n=20) experienced moderate and mild fear of falling respectively. This compares to 17% (n=14) of the same group who experienced severe fear of falling at 15 months, and 27% (n=22) and 49%

(n=39) who experienced moderate and mild fear of falling respectively at this time. Statistical analysis using analysis of variance was carried out. A repeated measures design using the Greenhouse- Geisser approach showed there to be a significant difference between the measures taken at the two time frames, F(1) = 5.23, p = 0.025.

Overall there was a 32% reduction in moderate to severe fear of falling in the intervention group in the study time period of 15 months. Fear of falling in the control group was not measured at 3 months.

At fifteen months 56% (n=35) of control group experienced severe fear of falling while 24% (n=15) and 15% (n=9) experienced moderate and mild fear respectively. Data analysis using Levene's test for equality of variances showed there to be a statistical significance between the two groups with the control group experiencing greater fear of falling than the intervention group at fifteen months. t(163) = -2.19, p = 0.029,

Falls Efficacy Score - International	**Intervention Group at 3 months (n=93)**	**Intervention Group at 15months(n=80)**	**Control Group at 15 months.(n=62)**
No Concern (0-16)	1 (1%)	5(6%)	3 (5%)
Mild Concern (17-32)	20 (22%)	39 (49%)	9 (15%)
Moderate Concern (33-48)	25 (27%)	22 (27%)	15 (24%)
Severe Concern (49-64)	47(50%)	14 (18%)	35 (56%)

Table 7.6: Fear of Falling experienced by Intervention group at 3 and 15 months and the Control group at 15 months.

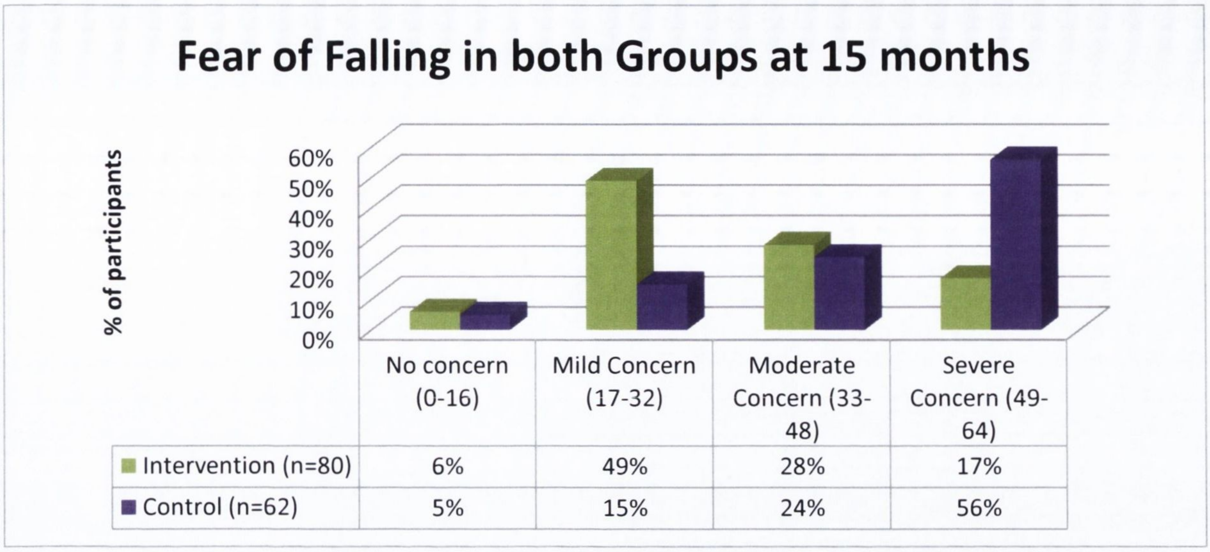


Figure 7.10: Fear of Falling experienced by study population at 15 months

Fear of Falling increased with age at 3 months post hip fracture. Data analyse using Pearson's Chi Square showed a significant increase in fear of falling with increasing age. χ^2 (15) =39.8, p = 0.001.

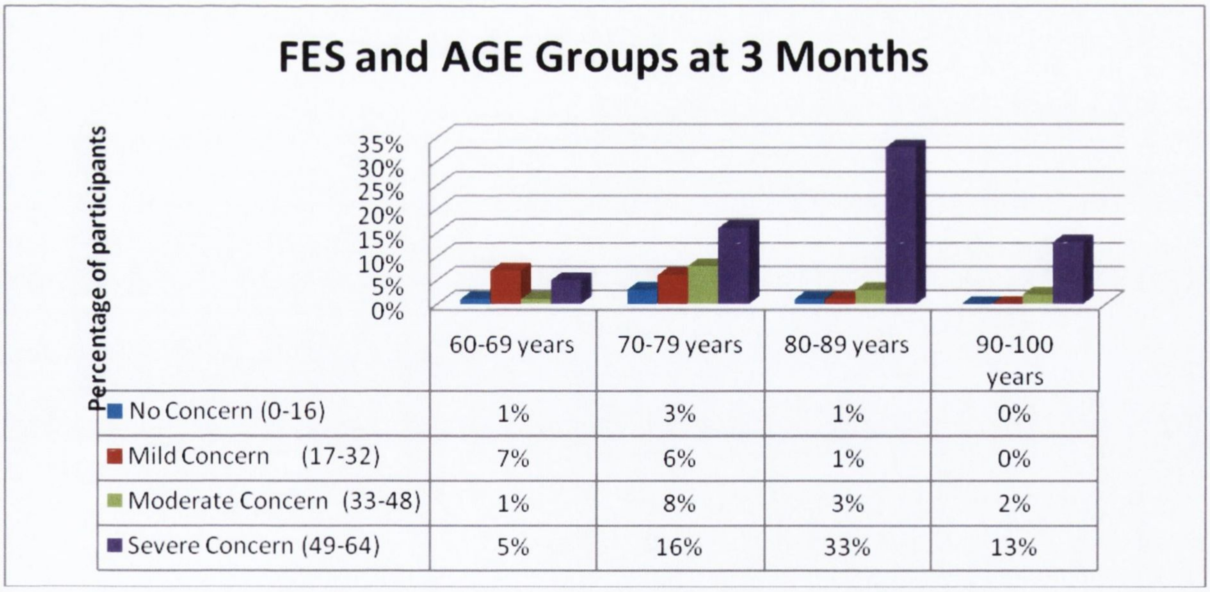


Figure 7.11: Fear of falling and age groups at 3 months post fracture.

While older participants continued to be more fearful of falling at 15 months, this difference was not significant. χ^2 (9) =10.7, p = 0.295.

Women were more likely to be fearful of falling than men. Data analysis using Pearson's Chi Square identified a statistical difference in gender and fear of falling at 3 months following hip fracture. χ^2 (5) = 11.2, p = 0.047. At 15 months this difference was not significant; χ^2 (3) = 2.83, p = 0.418.

Fear of falling was more prevalent in participants who were using assistive devices to mobilise at 3 months. A statistical significance between participants who were independent without aids and those with mobility aids was identified using Pearson's Chi Square for data analysis χ^2 (35) = 60, p = 0.005. Fear of falling increased with reduced mobility. A statistically significant difference between participants who were independently mobile and those who had reduced mobility as measured by the NEADL at three months was identified using Pearson's chi square, χ^2 (35) = 53.6, p = 0.023. In each domain of the NEADL, fear of falling increased with reduced ability to perform specific activities in the kitchen χ^2 (25) = 40.6, p = 0.025, in domestic tasks; χ^2 (25) = 40.1, p = 0.028, in leisure activities; χ^2 (25) = 42.5, p = 0.016. Similarly, a significant difference was identified between those had reduced self-care ability as measured by ABS having increased FOF than those who scored higher. χ^2 (756) = 981, p = 0.001

A significant difference, using Pearson's chi square to analyse data, was identified in fear of falling between participants who were anxious and depressed at 3 months and those who were not; χ^2 (15) = 103, p = 0.001 (anxiety), χ^2 (15) = 109, p = 0.001 (depression). At fifteen months, the difference between anxious and non-anxious participants was not significant however those depressed were more fearful of falling. Data analysed using Pearson's chi square showed near significance, χ^2 (6) = 11.5, p = 0.074.

Chapter 8

Participant's Mobility and Ability to Self-Care

In this chapter we will document and discuss the study participant's mobility and ability to self care prior to fracture and during the study time period. Pain experienced by the participants throughout the study will also be discussed.

8.1.1: Introduction

Hip fracture has severe consequences for older people resulting reduced mobility (Magaziner et al 2000), persistent pain. (Portegijs et al 2009), fear of falling and balance impairments (Oude Voshaar et al 2006, Sihvonen et al 2009) which can all lead to an increased risk further fracture, persistent mobility limitation and disability as well as loss of independence in older people. To cope at their homes safely sufficient mobility and functional ability is needed by the older person. Loss of mobility and the consequent loss of independence is one of the key indicators of clinical outcomes for people with hip fracture. Maximum restoration of mobility is therefore a major goal of rehabilitation (NICE Guidelines 2012). Several studies have highlighted the negative impact hip fracture can have on an older person's ability to mobilise and self care independently (Shyu et al 2004, Portegijs et al 2005, Alarcon et al 2011)

Vochteloo (2013) reported that less than half of all patients regained their prefracture level of mobility after 1 year and that the most important independent risk factors for failure to return to the prefracture level of mobility were a limited prefracture level of activities of daily living and a delirium during admission.

Reduction in ability to carry out activities of daily living has also been highlighted in the literature (Magaziner et al 2000, Magaziner et al 2003) which can lead to increased difficulty in the older person living independently in the community.

8.1.2: Results – Mobility

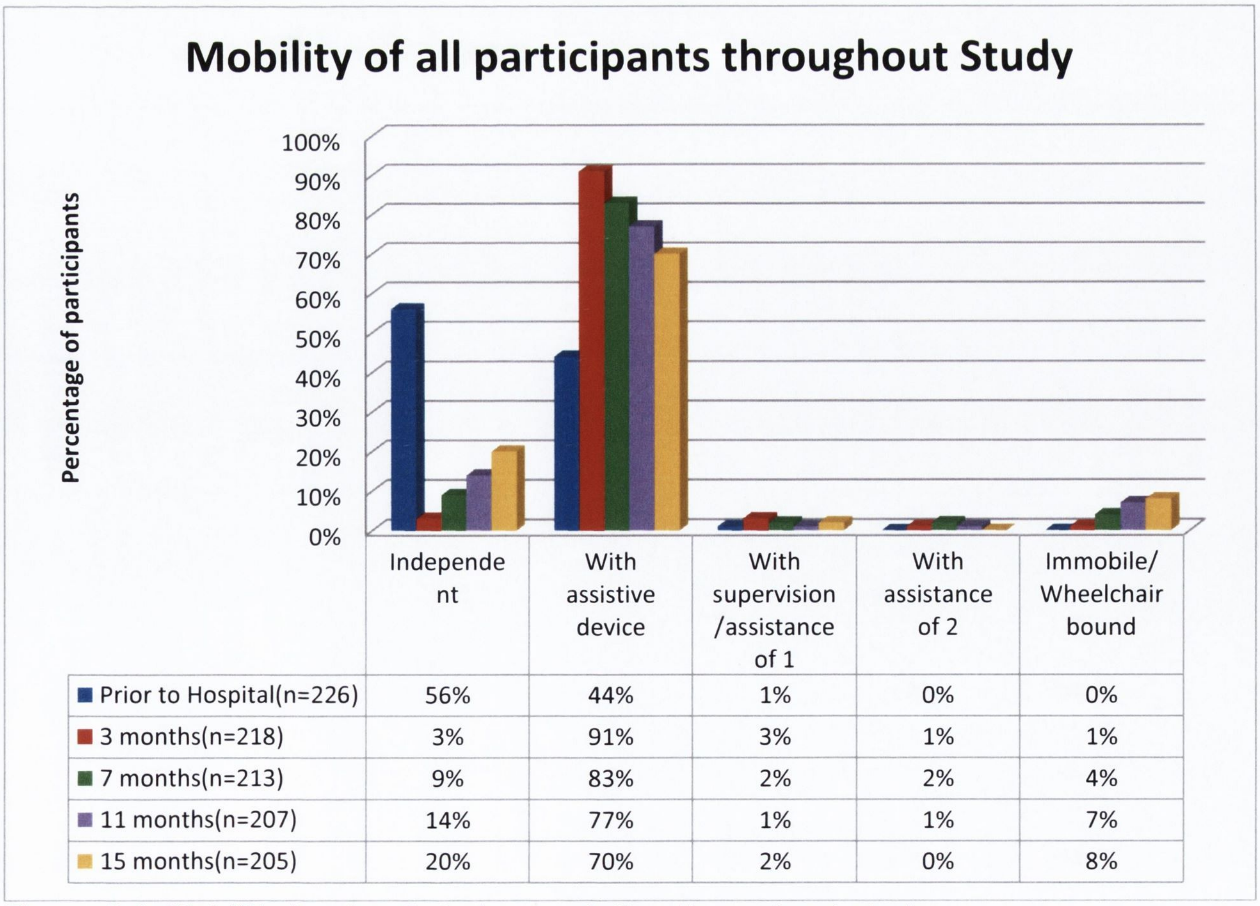
Statistical analysis demonstrated a significant difference between mobility prior to hospital admission and 15 months post fracture in the intervention group. Data analysed using paired t test, t (106) = -6.359, p = 0,001. A similar significant difference was shown in the control group's mobility prior to hospital admission and 15 months post fracture, t (97)= -8.490, p = 0.001.

Using the Chi Square test to analyse the results a significance difference between the two group's mobility at 7 months, χ^2 (9) = 22.79, p = 0.002, 11 months; χ^2 (8) = 19.803, p = 0.005 and 15 months; χ^2 =13.9, p = 0.038 was identified with more of the intervention group independent in mobility at 15 months.

Fifty six percent (n=126) participants were independent without mobility aids prior to hospital admission while 44% (n=100) required some form of assistance. This level of mobility was reduced to 20% (n=41) independently mobile at 15 months. The mobility of participants at each time frame is tabulated below.

	Prior to admission (n=226)	3 months (n=218)	7 months (n= 213)	11 months (n= 207)	15 months (n=205)
Independent	126 (56%)	7 (3%)	20 (9%)	29 (14%)	41 (20%)
Mobile withstick	77 (34%)	64 (29%)	89 (42%)	95 (46%)	83 (40%)
Mobile with Zimmerframe	17 (7%)	92 (42%)	56 (26%)	37 (18%)	42 (20%)
Mobile with Rollator	3 (1%)	13 (6%)	18 (8%)	16 (8%)	14 (7%)
Mobile with Crutches	2 (1%)	30 (14%)%	14 (7%)	11 (5%)	5 (2%)
Mobile with supervision	0	3 (1%)	1 (1%)	0	0
Mobile with assistance of 1	1 (1%)	4 (2%)	3 (1%)	3 (1%)	5(2%)
Mobile with assistance of 2	0	2 (1%)	4 (2%)	2 (1%)	0
Independent with wheelchair	0	1 (1%)	1 (1%)	2 (1%)	2 ((1%
Immobile	0	2 (1%)	7 (3%)	12 (6%)	14 (7%)

Table 8.1: Mobility of study population throughout study.



	Independent	With assistive device	With supervision /assistance of 1	With assistance of 2	Immobile/ Wheelchair bound
🟦 Prior to Hospital(n=226)	56%	44%	1%	0%	0%
🟥 3 months(n=218)	3%	91%	3%	1%	1%
🟩 7 months(n=213)	9%	83%	2%	2%	4%
🟪 11 months(n=207)	14%	77%	1%	1%	7%
🟨 15 months(n=205)	20%	70%	2%	0%	8%

Figure 8.1: Mobility levels of study population throughout study.

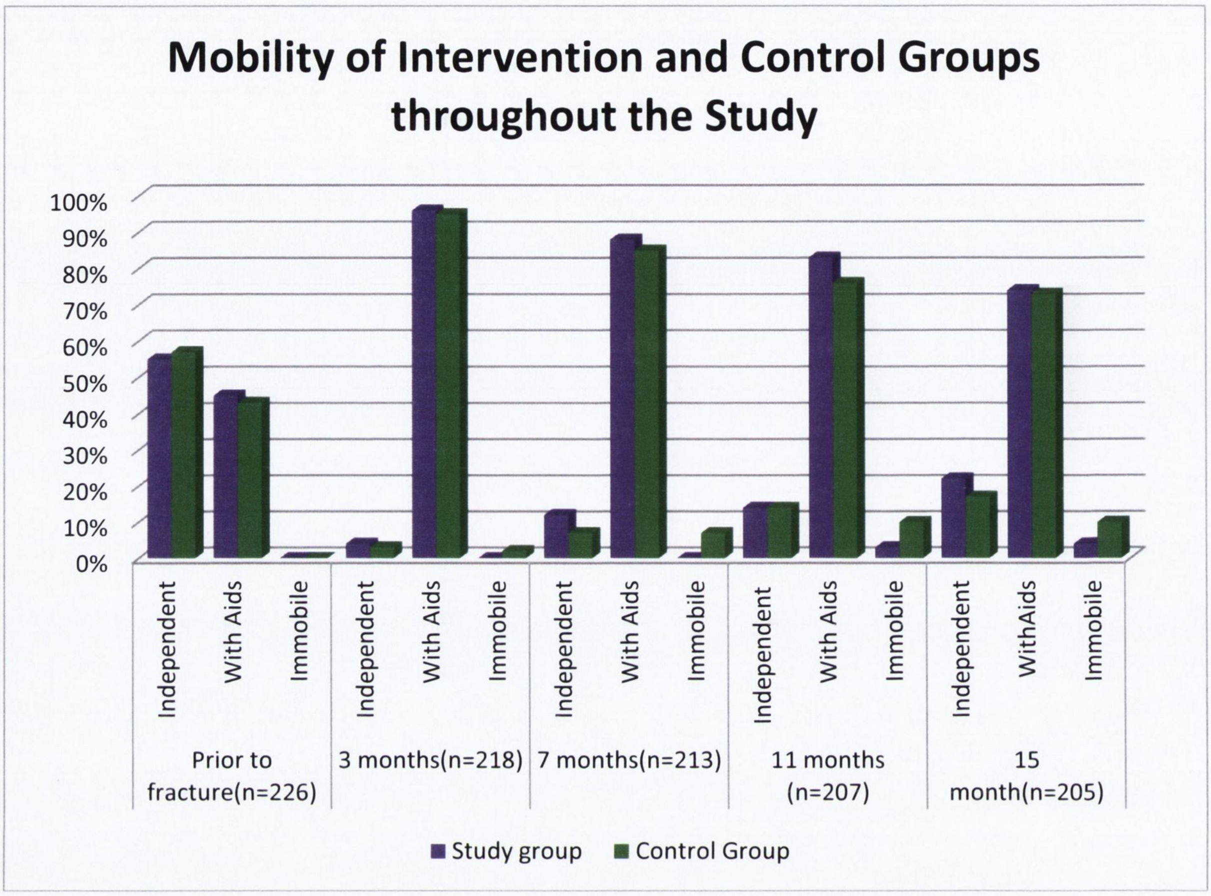
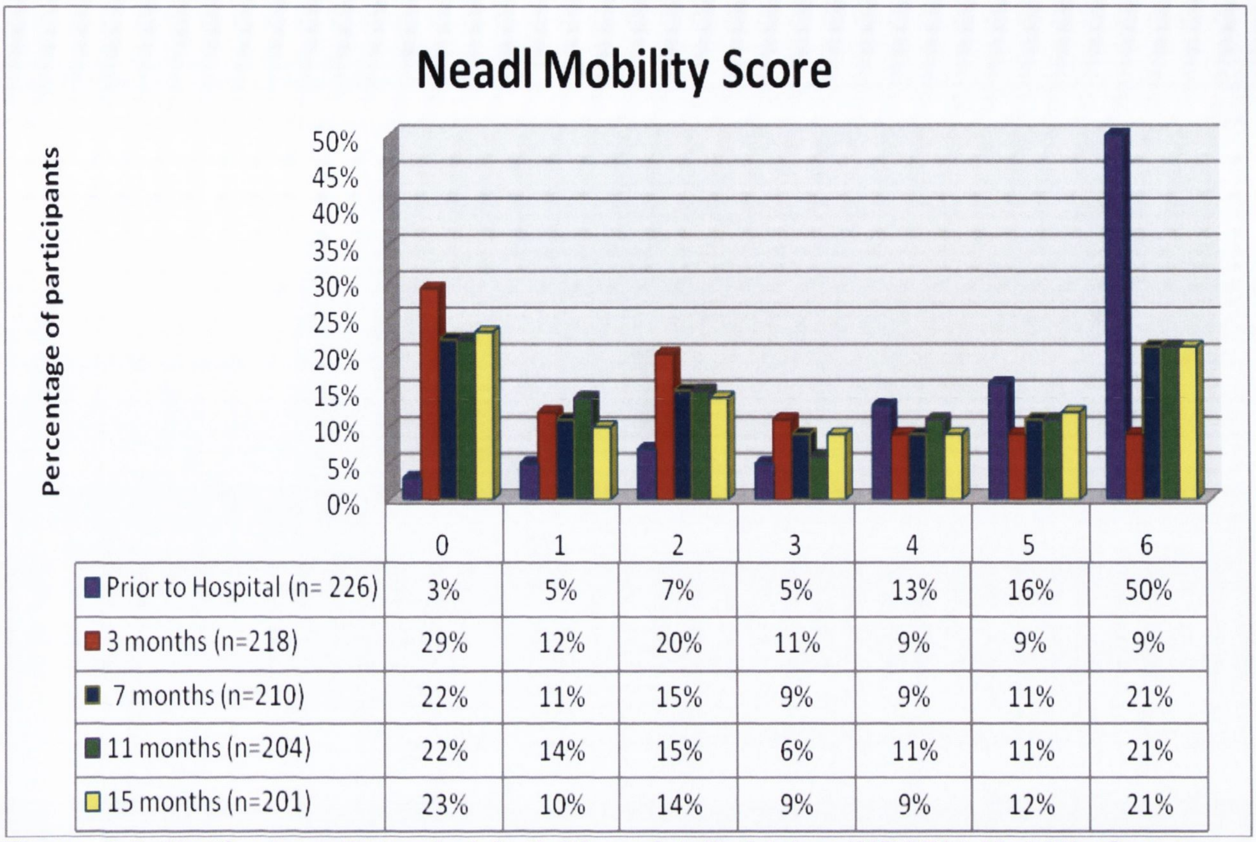


Figure 8.2: Mobility levels of Intervention and Control group throughout study.

Further evaluation of mobility using the NEADL scale showed a significant and sustained reduction in the particiants ability to mobilise in and outside their homes throughout the study period as captured by completion of the NEADL scale at 4 monthly interval for 15 months. A repeated measures analysis using Greenhouse Geisser 3 step approach to significant testing was employed, F (4) = 25.3, p = 0 .001



	0	1	2	3	4	5	6
🟪 Prior to Hospital (n= 226)	3%	5%	7%	5%	13%	16%	50%
🟥 3 months (n=218)	29%	12%	20%	11%	9%	9%	9%
■ 7 months (n=210)	22%	11%	15%	9%	9%	11%	21%
🟩 11 months (n=204)	22%	14%	15%	6%	11%	11%	21%
🟨 15 months (n=201)	23%	10%	14%	9%	9%	12%	21%

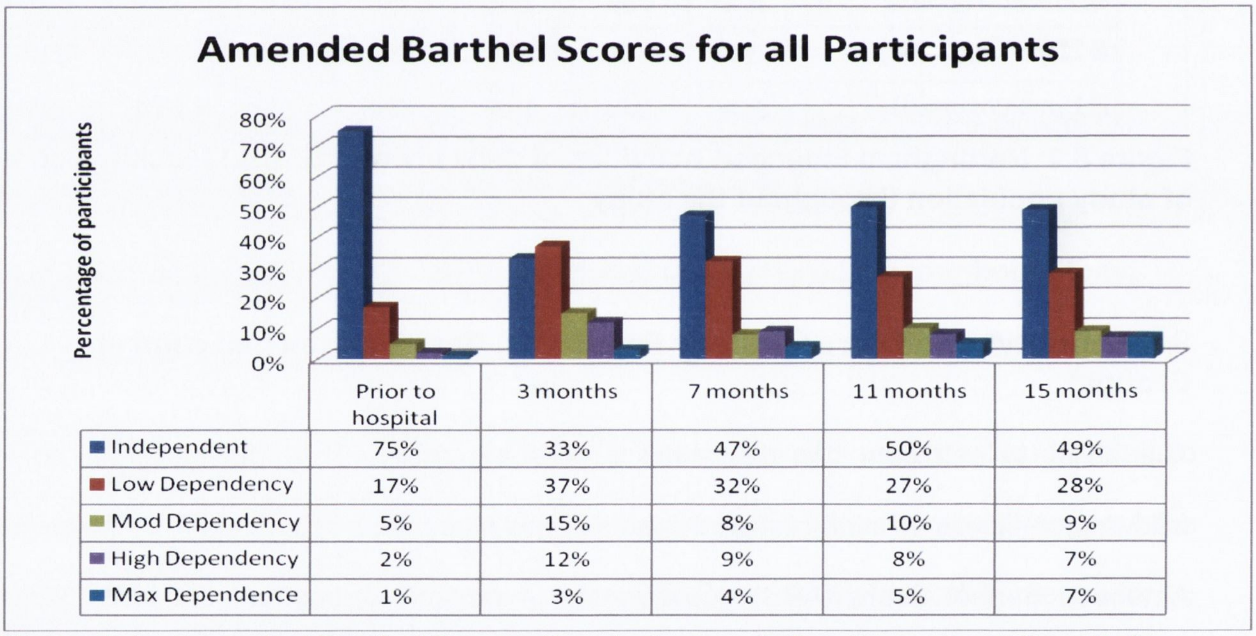
Figure 8.3: Nottingham Extended Activities of daily Living (NEADL) Mobility Score of study population throughout the study

8.1.3: Ability to Self Care for Study Population (Intervention and control Groups)

The ability to self care can determine a person's ability to remain or return home following an illness or injury. All participants in this study were requested to complete an Amended Barthel Score (ABS) questionnaire 4 monthly throughout the study which assesses ability to carry out Activities of Daily Living and the Nottingham Activities of Daily Living which measures instrumental activities of daily living. Results of the ABS were categorised into independent, low, moderate, high and maximum dependency. 75% (n=166) were independent in self care prior to admission to hospital. This was reduced to 49% (n=94) of participants who were independent in self care at 15 months. Table below shows the ability of all participants to self-care throughout the study using the ABS.

Level of Dependency	Prior to hospital	3 months	7 months	11 months	15 months
Independent (20-21)	166 (75%)	71 (33%)	97 (47%)	101 (50%)	94 (49%)
Low Dependency (16-19)	38 (17%)	79 (33%)	65 (32%)	53 (27%)	53 (28%)
Moderate dependency (11-15)	12 (5%)	33 (15%)	17 (8%)	20 (10%)	17 (9%)
High dependency (6-10)	4 (2%)	26 (12%)	18 (9%)	15 (7%)	14 (7%)
Maximum Dependency (0-5)	1 (1%)	7 (3%)	8 (4%)	11 (5%)	13 (7%)

Table 8.2: Ability of the study population to self-care throughout the study as measure by the Amended Barthel Score.



	Prior to hospital	3 months	7 months	11 months	15 months
■ Independent	75%	33%	47%	50%	49%
■ Low Dependency	17%	37%	32%	27%	28%
■ Mod Dependency	5%	15%	8%	10%	9%
■ High Dependency	2%	12%	9%	8%	7%
■ Max Dependence	1%	3%	4%	5%	7%

Figure 8.4: Amended Barthel Scores for study population throughout the study.

A repeated measure analysis using Greenhouse-Geisser approach identified a statistically significant reduction in the ability to self care experienced by participants at 15 months compared to that prior to hospitalisation; F (2) = 18.3, p = 0.001. However a significant improvement from three to fifteen months post hip fracture has been noted; F (2.1) = 18.3, p= 0.001.

There is no significant difference in the ability to self care between the two groups at 15 months.

Data analysis of each of the 10 domains i.e. Bowels, Bladder, Grooming, Toilet use, Feeding, Transfer, Mobility, Dressing, Stairs and Bathing was carried out using paired T-test. There was a significant difference in the scores for bowel continence at 3 months 1.14 ±, 0.5 (M ± SD) and 15 months 1.3 ±, 0.61 (M ± SD); t (201)= 2.6, p <0.008, and for ability to climb stairs at 3 months 2.1 ± 0.96 (M ± SD); and 15 months 1.8 ± 0.95 (M ± SD); t (201) = 4.3, p <0.001 and for ability to bathe independently at 3 months 1.8 ±0.44 (M ± SD) and 15 months 1.5 ± 0.51 (M ± SD); t (201) = 6.4, p = 0.001.

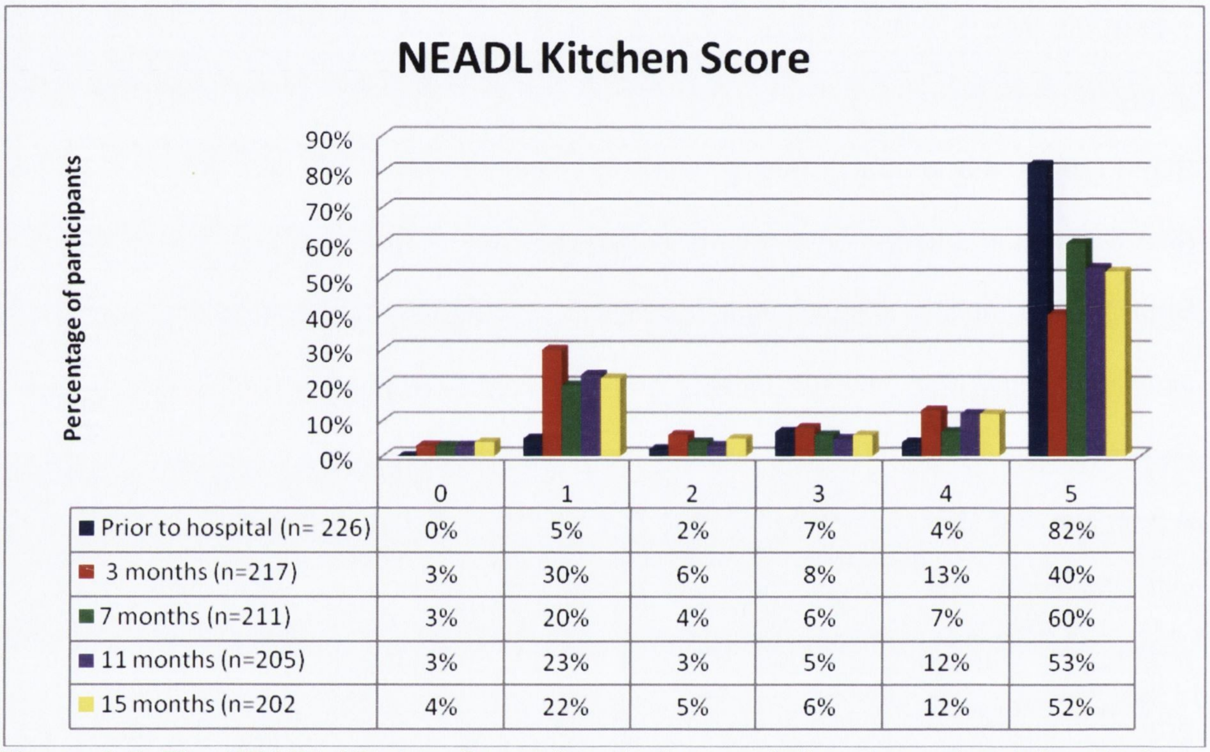
Both groups ability to climb the stairs and bathe independently were statistically significantly reduced as was bowel continence. Participant's ability to use the toilet independently showed a near significant reduction in the 15 months.

Age influenced ability to self care in some of the domains of the Amended Barthel Score, with the older age group experiencing increased activities of living disability at 15 months. Chi Square test showed there to be a significant difference between the age groups in grooming, mobility, dressing, stairs and bathing. Results are tabulated below.

ABS Domain	**Chi Square Test**
Bowels	χ^2 (9) = 13.6, p <0.135
Bladder	χ^2 (9) = 13.4, p<0.144
Grooming	χ^2 (6) = 16.7, p < 0.010
Toilet Use	χ^2 (9)13.1, p< 0.156
Feeding	χ^2 (9) = 14.1, p <0.118
Transfer	χ^2 (12) = 14.8, p <0.249
Mobility	χ^2 (12) = 21.1, p < 0.048
Dressing	χ^2 (90 = 23.3, p< 0.005
Stairs	χ^2 (90 = 19.4, p <0.002
Bathing	χ^2 (6) = 36.4, p < 0.001

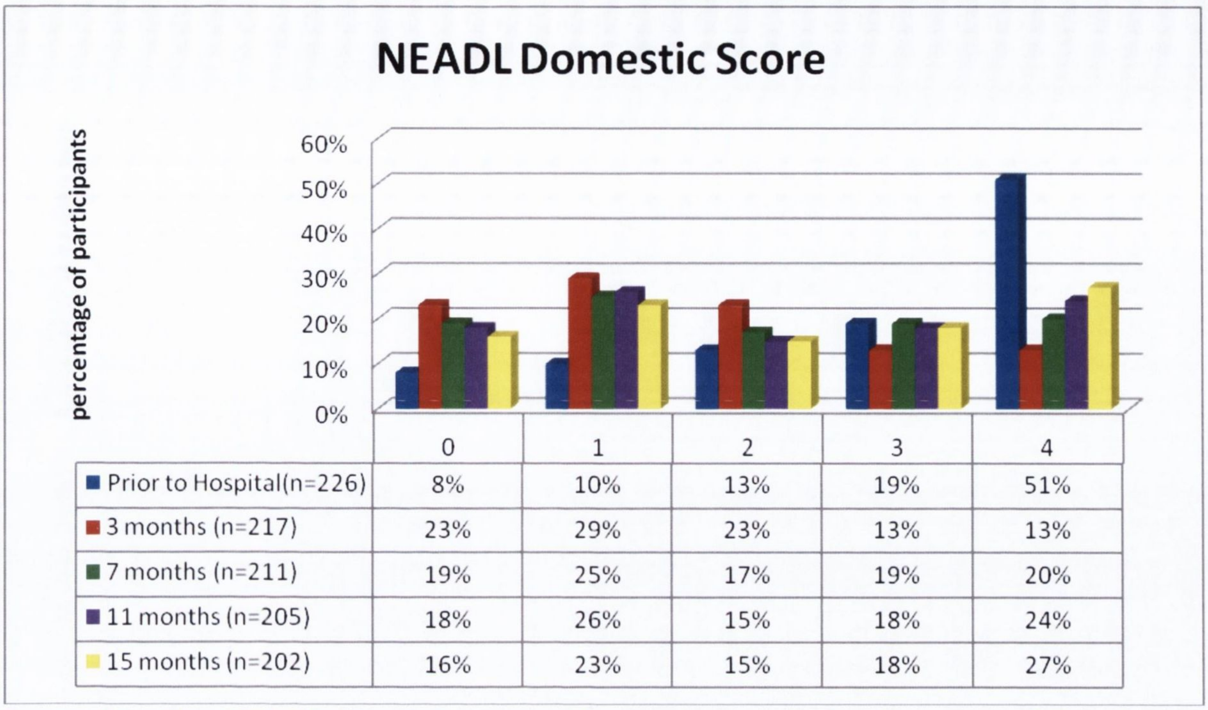
Table 8.3: Chi Square test results of Amended Barthel Score domains and Age comparison.

Further evaluation of the participant's ability to carry out activities of daily living was measured with the completion of the NEADL at 4 monthly intervals. Data analysed using Greenhouse-Geisser repeated measures design identified a statistically significant reduction in each domain, i.e. Kitchen tasks, Domestic tasks, and Leisure activities. F(2) = 7.6, p = 0.001, F(3) = 62.2, p = 0.001, F(3) = 76.8, p = 0.001 respectively.



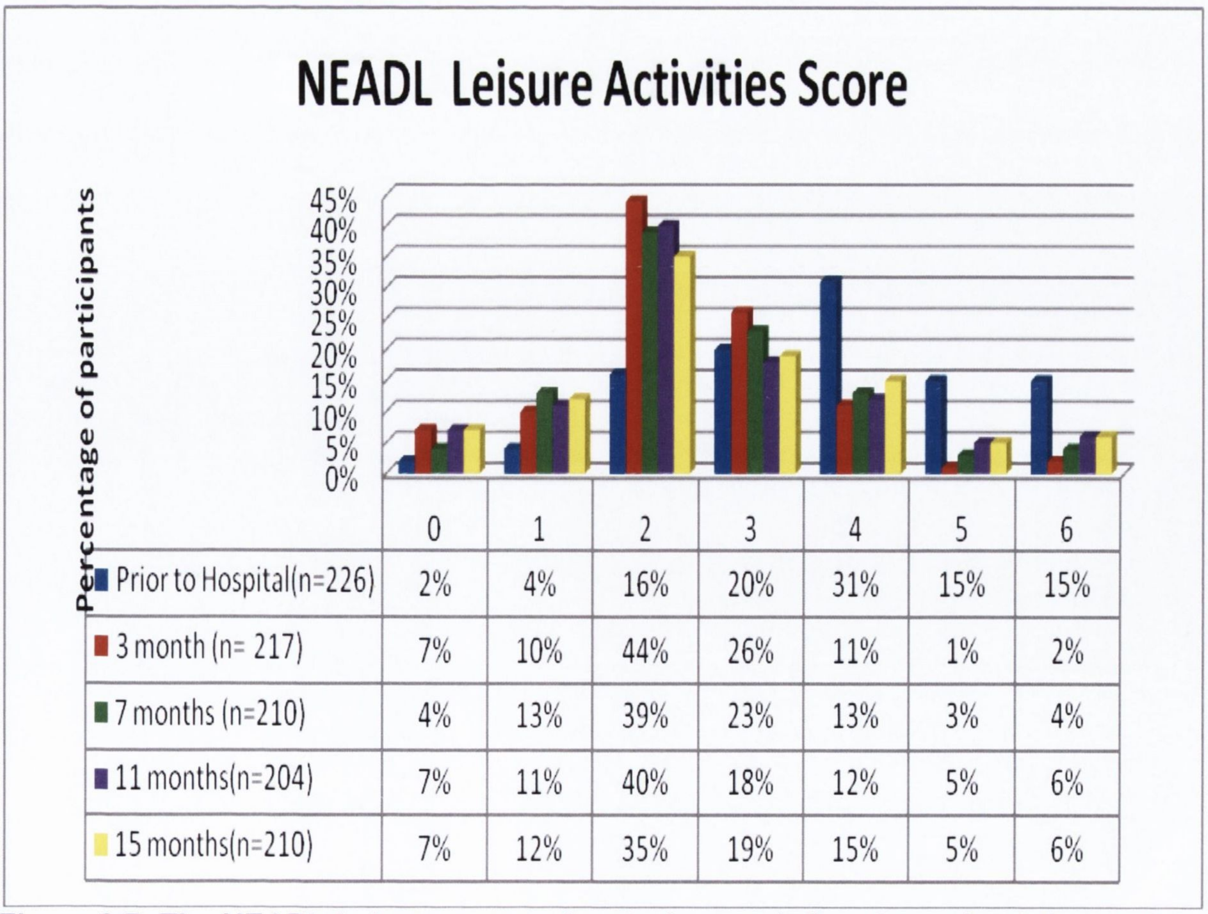
	0	1	2	3	4	5
■ Prior to hospital (n= 226)	0%	5%	2%	7%	4%	82%
🟥 3 months (n=217)	3%	30%	6%	8%	13%	40%
🟩 7 months (n=211)	3%	20%	4%	6%	7%	60%
🟪 11 months (n=205)	3%	23%	3%	5%	12%	53%
🟨 15 months (n=202	4%	22%	5%	6%	12%	52%

Figure 8.5: The NEADL Kitchen Score for study population throughout the study period.



	0	1	2	3	4
■ Prior to Hospital(n=226)	8%	10%	13%	19%	51%
■ 3 months (n=217)	23%	29%	23%	13%	13%
■ 7 months (n=211)	19%	25%	17%	19%	20%
■ 11 months (n=205)	18%	26%	15%	18%	24%
■ 15 months (n=202)	16%	23%	15%	18%	27%

Figure 8.6: The NEADL Domestic score for study population throughout the study period.



	0	1	2	3	4	5	6
■ Prior to Hospital(n=226)	2%	4%	16%	20%	31%	15%	15%
■ 3 month (n= 217)	7%	10%	44%	26%	11%	1%	2%
■ 7 months (n=210)	4%	13%	39%	23%	13%	3%	4%
■ 11 months(n=204)	7%	11%	40%	18%	12%	5%	6%
■ 15 months(n=210)	7%	12%	35%	19%	15%	5%	6%

Figure 8.7: The NEADL Leisure scores for study population throughout the study period.

8.2: Pain post hip fracture

8.2.1: Introduction

Untreated pain is a major health care issue and very little is known about the treatment of pain, and the effect of pain on post-operative outcomes in older adults according to Morrison et al (2003). Patients with hip fracture can incur pain pre-operatively, intra-operatively and post operatively. Post-operative pain is associated with increased hospital length of stay, delayed ambulation, and long-term functional impairment. Therefore, it is important to manage pain adequately throughout the care pathway for hip fracture patients. According to Closs et al, (2002), Bruckenthal and D'Arcy, (2007) the reporting of pain by older adults can be problematic. Reasons for this may include: belief that pain is a normal part of the ageing process; they do not want to be seen as a nuisance; and pain may delay their discharge from hospital. Older people are at a higher risk of complications owing to unrelieved or under-treated pain as reported by Layzell (2009). Herrick et al (2004) reports that persistent pain is common in the frail community dwelling elderly post hip fracture while Sipilä et al (2011) highlights that persistent pain reduces a person's ability to participate in safe mobility and functional ability.

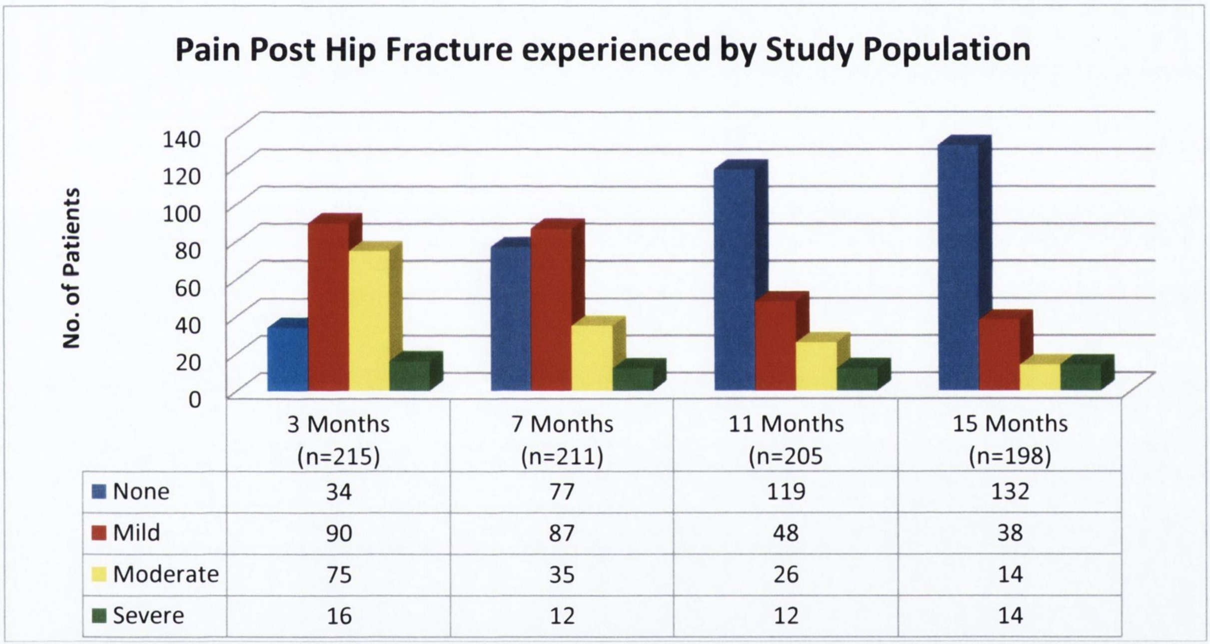
Pain is an important associated factor of physical inactivity in older people with a hip fracture. Therefore pain management may be important in restoring and sustaining the level of physical activity after hip fracture.

8.2.2: Results

Data was analysed using Pearson Chi Square test and showed there to be no significant difference in pain experienced by intervention or control group at each time frame. χ^2 (3) = 2.057, P >0.05.

	3 months (n=215)	7months (n=211)	11 months (n=205)	15 months (n=198)
None	34 (16%)	77 (36%)	119 (58%)	132 (67%)
Mild	90 (42%)	87 (41%)	48 (23%)	38 (19%)
Moderate	75 (35%)	35 (17%)	26 (13%)	14 (7%)
Severe	16 (7%)	12 (6%)	12 (6%)	14 (7%)

Table 8.4: Pain experienced by the study population throughout the study period.

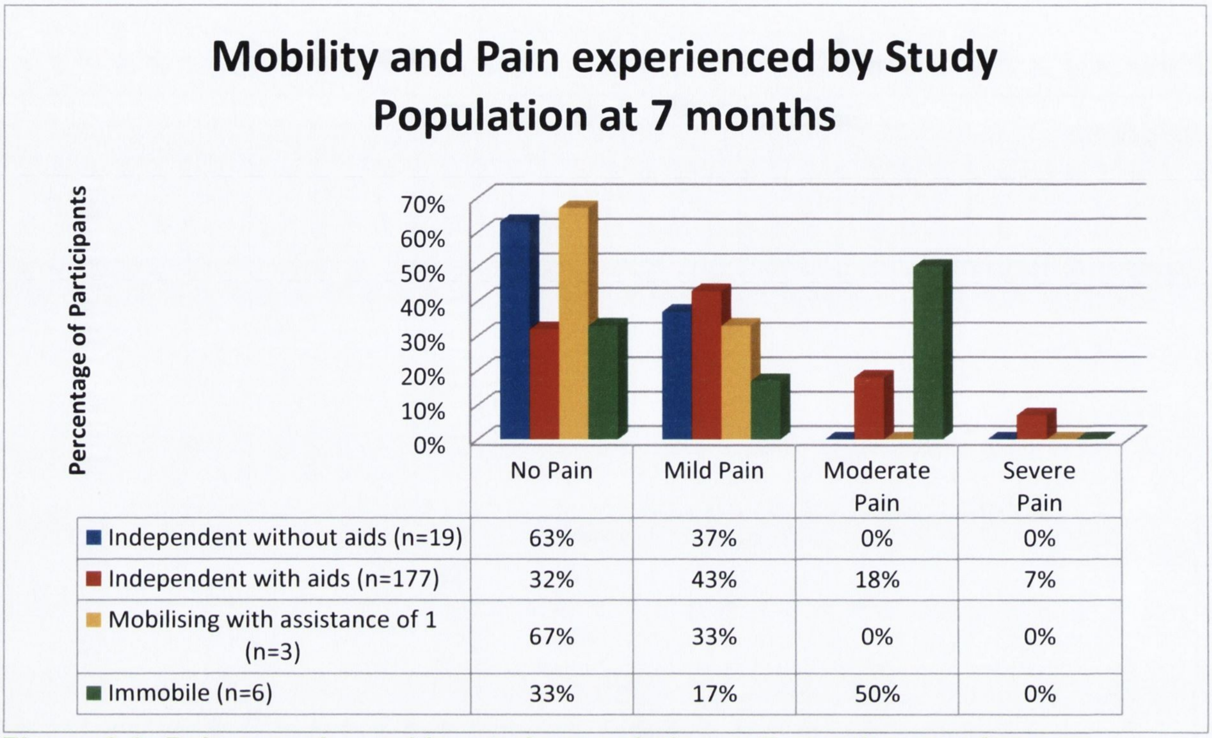


	3 Months (n=215)	7 Months (n=211)	11 Months (n=205	15 Months (n=198)
🟦 None	34	77	119	132
🟥 Mild	90	87	48	38
🟨 Moderate	75	35	26	14
🟩 Severe	16	12	12	14

Figure 8.8: Pain experienced by the study population throughout the study period.

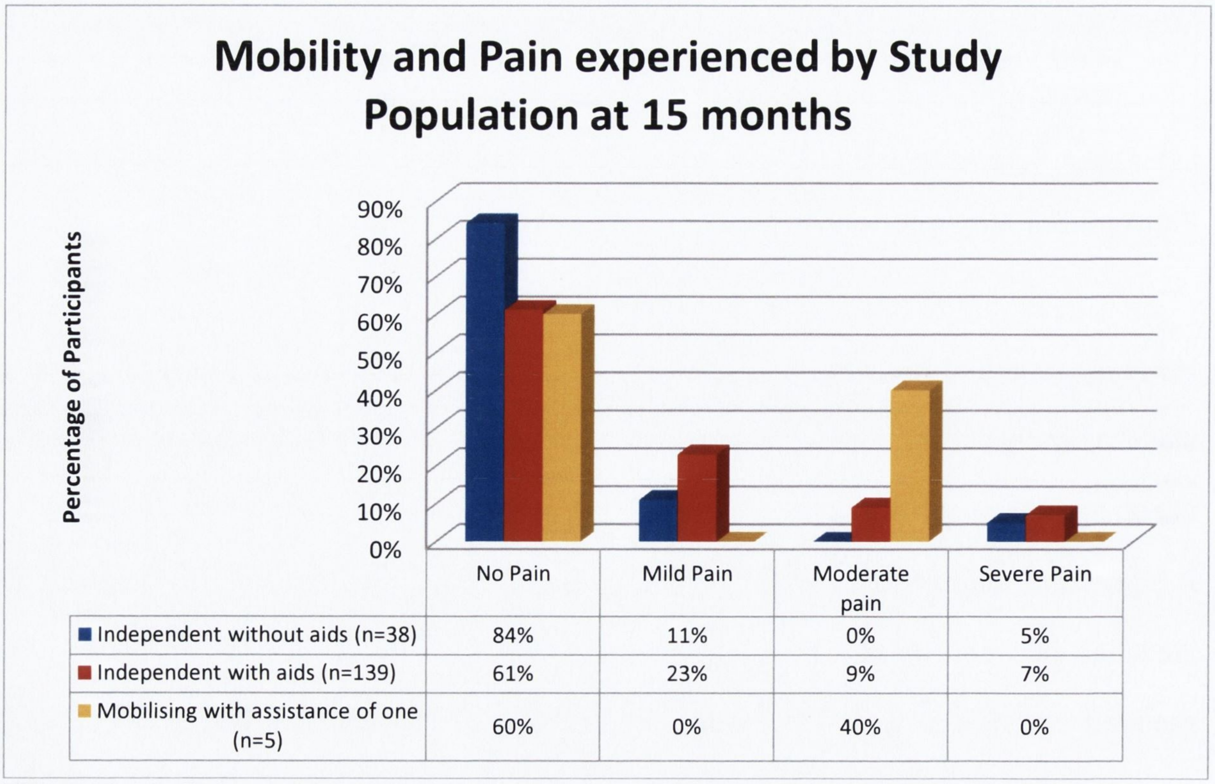
However repeated measure analysis using Greenhouse-Geisser approach identified a statistically significant improvement in pain experienced by the participants from three to fifteen months post hip fracture, F (2.3) =74.64, p = 0.001.

A significant difference between pain experienced at 7 months and 15 months was identified between those who were independently mobile without aids and those who required assistive devices. The latter experiencing more pain than the former at both time frames. Data was analysed using Pearson's Chi Square; χ^2 (27) = 47.2, p = 0.009 at 7 months and χ^2 (21) = 35.1, p = 0.03 at 15 months.



	No Pain	Mild Pain	Moderate Pain	Severe Pain
■ Independent without aids (n=19)	63%	37%	0%	0%
■ Independent with aids (n=177)	32%	43%	18%	7%
■ Mobilising with assistance of 1 (n=3)	67%	33%	0%	0%
■ Immobile (n=6)	33%	17%	50%	0%

Figure 8.9: Pain experienced by study population at 7 months post fracture



	No Pain	Mild Pain	Moderate pain	Severe Pain
■ Independent without aids (n=38)	84%	11%	0%	5%
■ Independent with aids (n=139)	61%	23%	9%	7%
■ Mobilising with assistance of one (n=5)	60%	0%	40%	0%

Figure 8.10: Pain experienced by study population at 15 months post fracture

Chapter 9

Fracture History, Presentation and treatment

In this chapter we will include the study participant's fracture history, the type of hip fracture they presented to the study site with, the treatment of the hip fracture as well as falls experienced by the participants in the follow up period of the study and readmission to hospital rates.

9.1: Introduction

Proximal femoral fractures either involve bone which is enveloped by the ligamentous hip joint capsule (intracapsular), or involve bone below the capsule (extracapsular). Intracapsular fractures include subcapital (below the femoral head), transcervical (across the mid-femoral neck), or basicervical (across the base of the femoral neck) while extracapsular fractures include intertrochanteric and subtrochanteric fractures. The type of hip fracture is important as it will dictate the surgical procedure to repair it. The aims of surgical repair of hip fractures are to reduce pain and promote early mobilisation according to the British Orthopaedic Association (BOA 2007).The method of repair of hip fractures depends on the site of fracture. For Intracapsular fractures internal fixation is recommended (BOA 2009) with parallel screws or sliding hip screw most frequently used for undisplaced fractures and arthroplasty for displaced fractures. For Intertrochanteric fractures a Sliding hip screw or Dynamic hip screw is the foremost implant and should be regarded as gold standard according to BOA (2007) as Intermedullary nails are to subtrochanteric fractures.

Numerous studies have highlighted the role that previous fractures can have on future fracture incident. While Colles/wrist fractures have been highlighted as been predictive hip fractures by Barret-Connor et al 2008, Bogoch et al 2008, Rozental et al 2008 and Schousboe et al (2006) Haentjens et al (2003) suggests that a previous spine fracture has an equally important impact on the risk of a subsequent hip fracture in both genders.

9.2: Results

Of the 226 participants in this study 46% (n=103) have had one or more previous fractures. 7% (n=15) had a previous hip fracture while 37% (n=57) had a vertebral fracture and 12 (n=27) suffered Colles fractures.

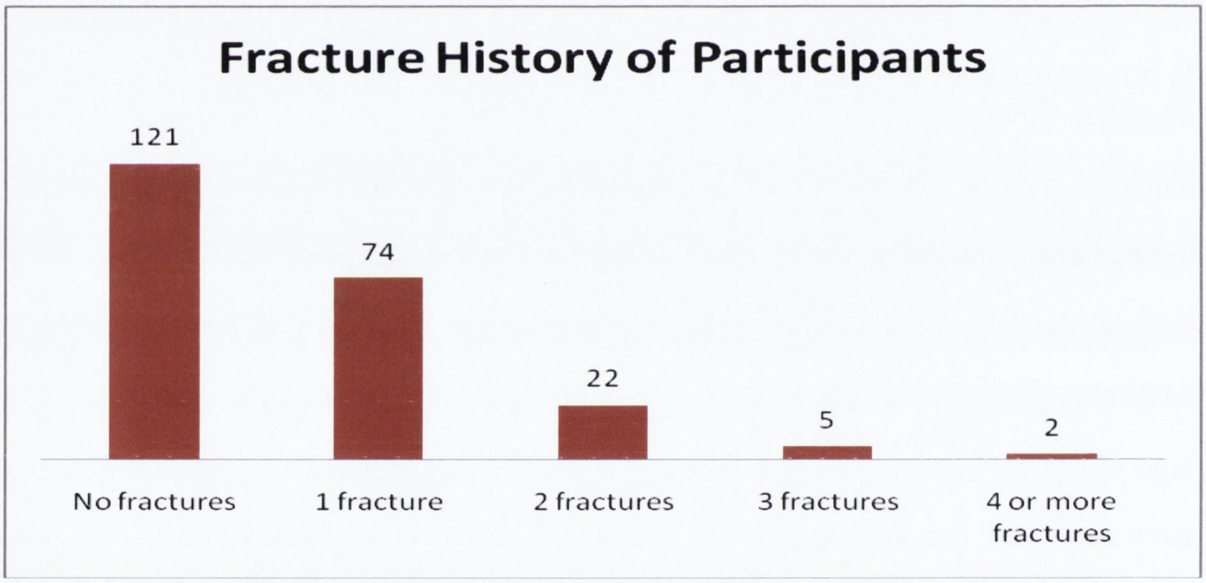
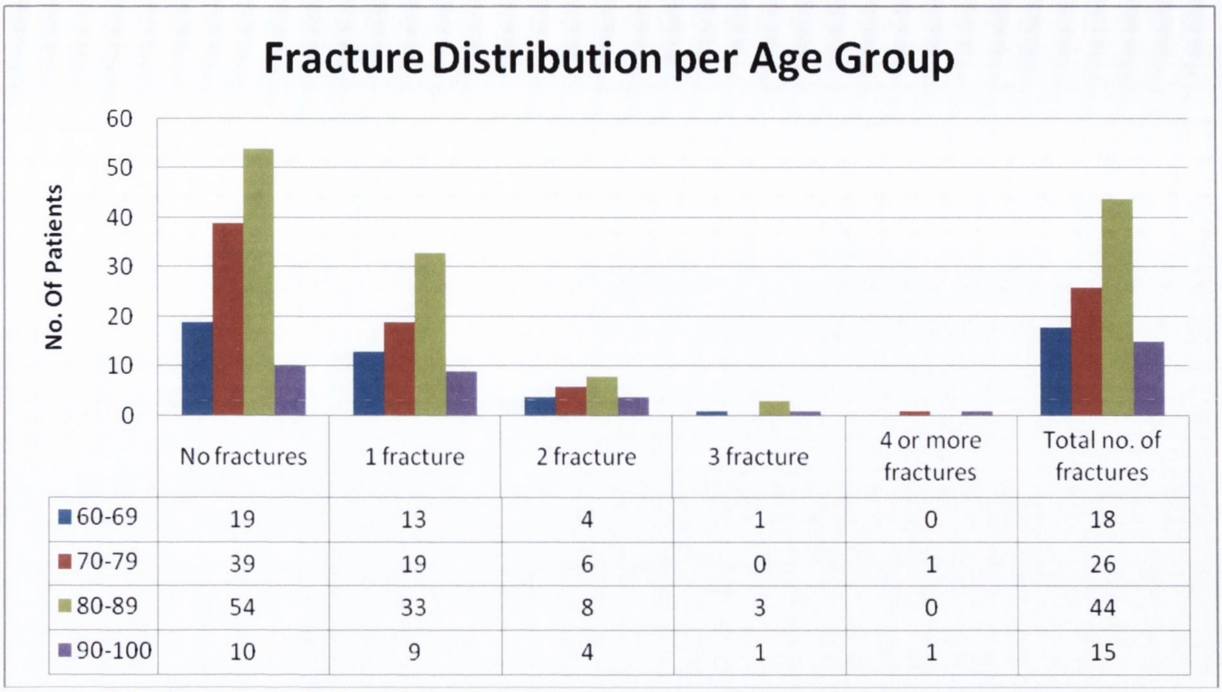


Figure 9.1: Number of fractures experienced by study population prior to hip fracture.

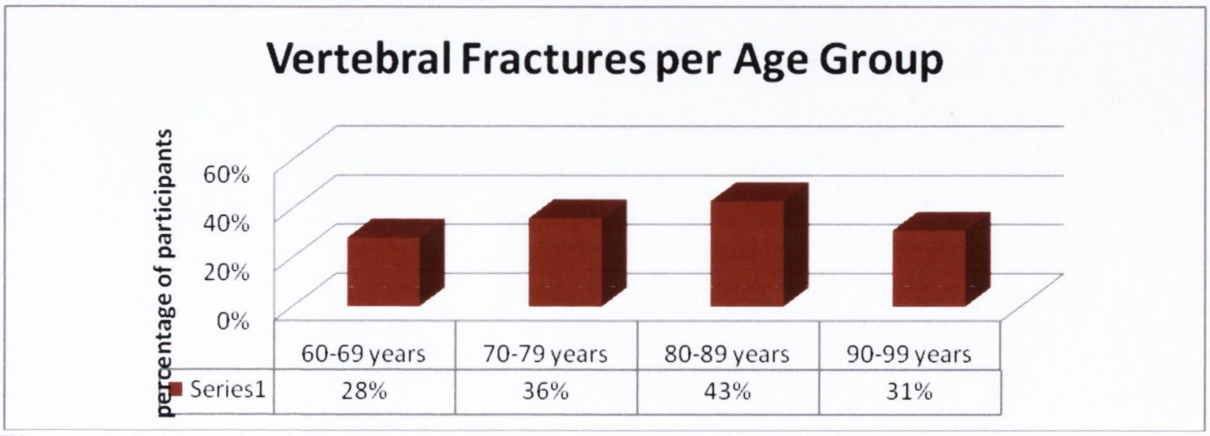
Fracture history increased with age, with 43% (n=44) of participants between the ages of 60 and 79 years suffering one or more previous fractures compared to 57% (n=59) of 80 year old and over, however this is not statistically significant, χ^2 (18) =19.3, p > 0.05.



	No fractures	1 fracture	2 fracture	3 fracture	4 or more fractures	Total no. of fractures
■ 60-69	19	13	4	1	0	18
■ 70-79	39	19	6	0	1	26
■ 80-89	54	33	8	3	0	44
■ 90-100	10	9	4	1	1	15

Figure 9.2: Fracture distribution through the age groups as experienced by the study population.

In this study only 3% of study population stated, or had a history of vertebral fractures, however 37% (n=57) had a vertebral fracture as diagnosed by Lateral Vertebral Assessment (LVA) on dual emission x-ray absorptiometry (DXA) scan. Vertebral fractures increased with age with most vertebral fractures occurring in the 80-89 year age group. There was a non significant difference between vertebral fractures experienced by men and women with the latter experiencing more vertebral fractures. Thirty one percent (n=13) of men had vertebral fractures compared to 40% in women.



	60-69 years	70-79 years	80-89 years	90-99 years
■ Series1	28%	36%	43%	31%

Figure 9.3: Vertebral Fractures experienced in each age group of study population.

Vertebral	Colles	Hip	Multiple non Vertebral	Vertebral and non vertebral	Other *
6 (3%)	27 (12%)	15 (7%)	18 (8%)	4 (2%)	32 (14%)

*Other= lower limb, upper limb (exclusive of Colles), Pelvic, Ribs, Metatarsal and Clavicle fractures.

Table 9.1: Types of Fractures previously suffered by study population prior to admission for hip fracture.

9.3: Type of Hip Fracture

Intertrochanteric fractures were by far the most common type of fracture encountered in this study with 58% (n=132) of participants suffering them.

Subcapital	Intertrochanteric	Transcervical	Subtrochanteric	Other
53 (24%)	132 (58%)	11 (5%)	20 (9%)	5 (2%)

Table 9.2: Type of hip fractures experienced by study population.

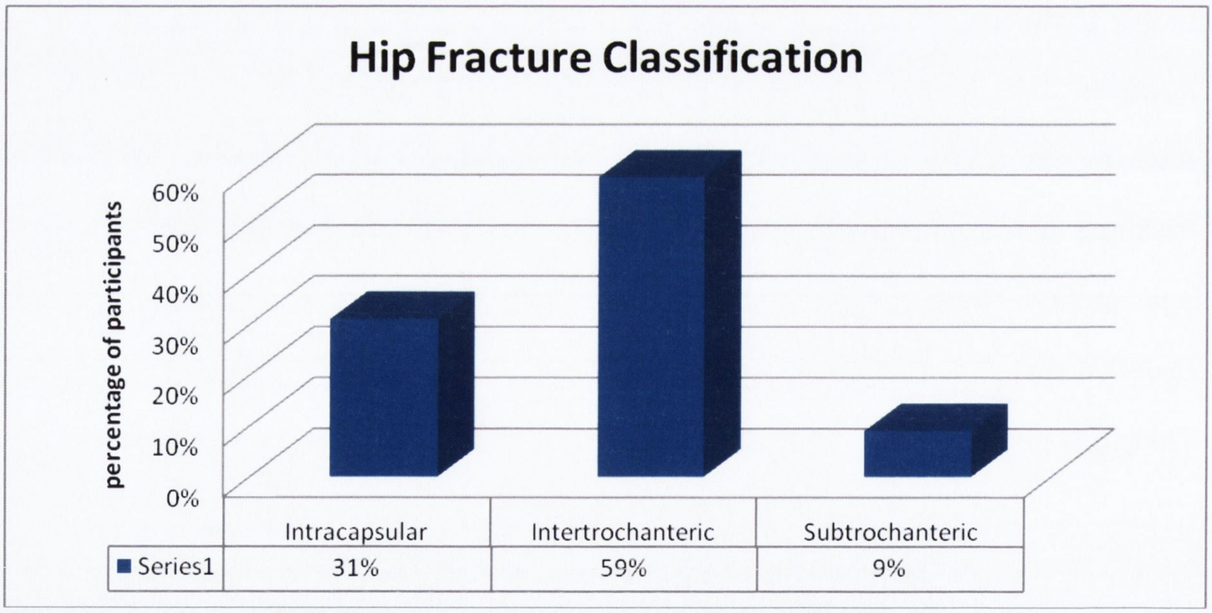


Figure 9.4: Type of hip fracture experienced by study population.

9.4: Surgical Repair

In this study 82% (n-175) patients were operated within 24-48 hour period post admission while 18% (n=39) were delayed past this period. Intertrochanteric fractures were the most common with 59% (n=132) followed by Subtrochanteric fractures, 24%

(n=53). Dynamic hip Screw was the most common implant used for repairing hip fracture with 46%(n=103) of fractures repaired using this implant. 41% (n=91) were repaired using hemiarthroplasty while 8% (n=17) were repaired with Gamma nails.

DHS	Hemiarthroplasty	Gamma nail	Total Hip Replacement	Other
103 (46%)	91 (41)%	17 (8%)	8 (4%)	2 (1%)

Table 9.3: Type of operation performed.

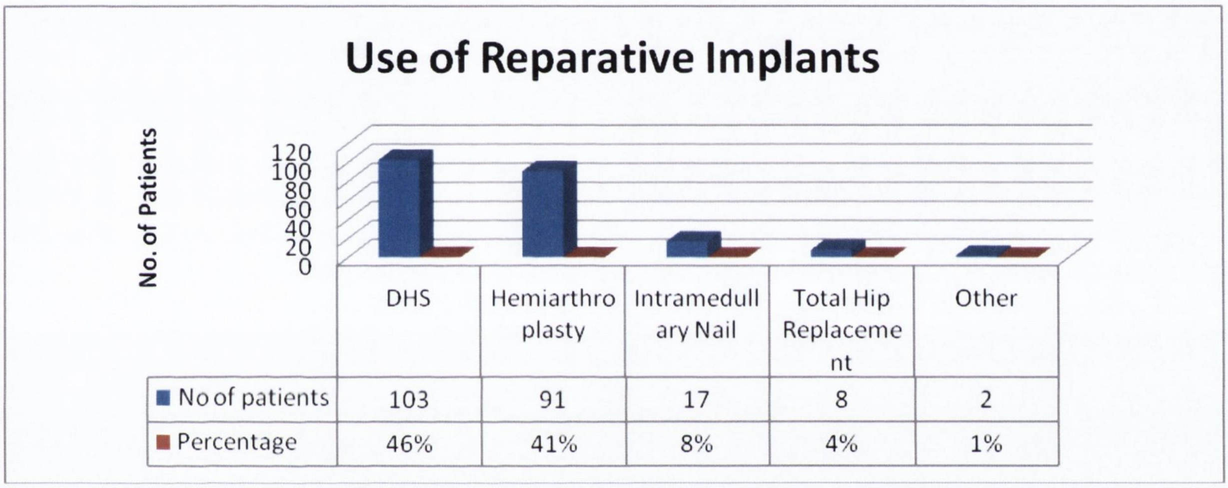


Figure 9.5: Use of reparative implants to repair hip fracture of study population.

82% (n=175) of participants went to theatre within 48hrs of admission.

9.5: Readmission to Hospital

38% (n=85) of participants were readmitted to the hospital within the 15 months post hip fracture. The data was analysed using the Chi Square test and showed a significant difference between the groups and readmission rates. The intervention group participants were more likely to be readmitted to hospital than the control group. (χ^2 (1) = 6.037, p = 0.014). The majority of participants readmitted came from home 29% (n=65), with 5% (n=10) readmitted from a rehabilitation unit and 4% (n=8) from a Nursing Home. The reasons for readmission are tabulated below. There was no difference between the groups and reasons for readmission, χ^2 (7) = 11.172, p= 0.131.

Fracture related	Medical	Surgical	Another fracture/Orthopaedic	Post Fall	No response
12 (5%)	52 (23%)	5 (2%)	14 (6%)	2 (1%)	2 (1%)

Table 9.4: Reason for readmission to hospital

9.6: Falls History since fracture

Sixty two percent (n=133) reported no falls since fracture. However 16% (n=32) reported 1 fall and 22% (n=43) reported more than 1 falls in the 15 months following the initial hip fracture. Overall 38% (n=75) of participant reported having fallen since their initial fracture. Increasing age appeared to increase falls with but this was not statistically significant using Chi Square test χ^2 (9) = 15.6, p = 0.07.

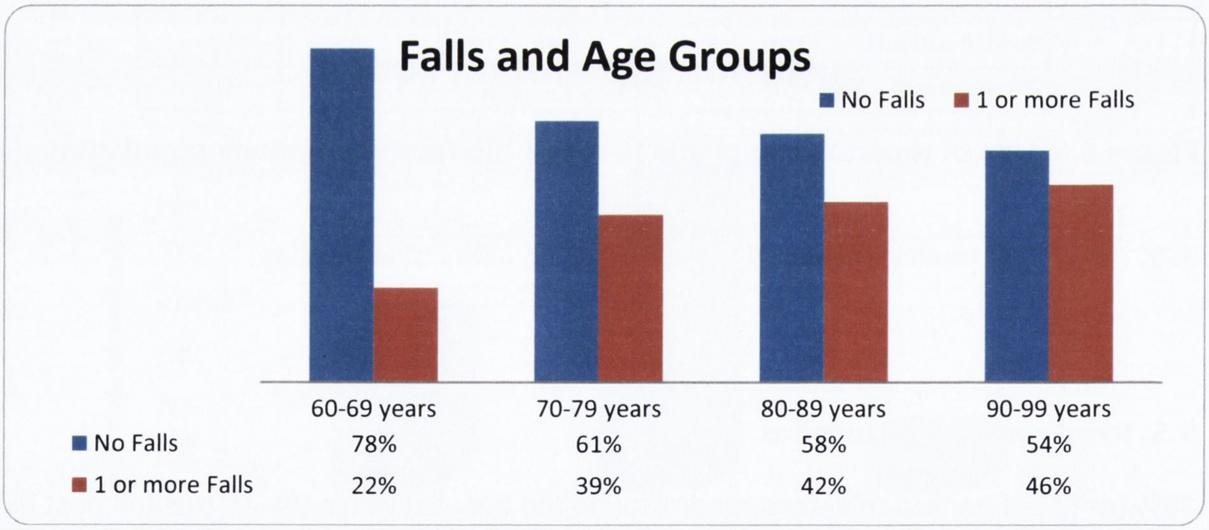


Figure 9.6: Falls experienced by study population throughout the study period by age groups.

There was no difference between gender and number of falls, χ^2 (3) = 3.7, p = 0.29. Participants who fell since initial hip fracture were at increased risk of readmission to hospital, however this was not significant using Chi Square testing, χ^2 (3) =6.8, p = 0.07. Those who were discharged to long term care facilities were at increased risk of falling with 61%(n=17) having 1 or more falls within the 15 months follow up period compared to 34% (n=16) and 35% (n=44) of those discharged home and to rehabilitation sites respectively. This was statistically significant using chi square testing χ^2 (2) = 7.04, p = 0.02

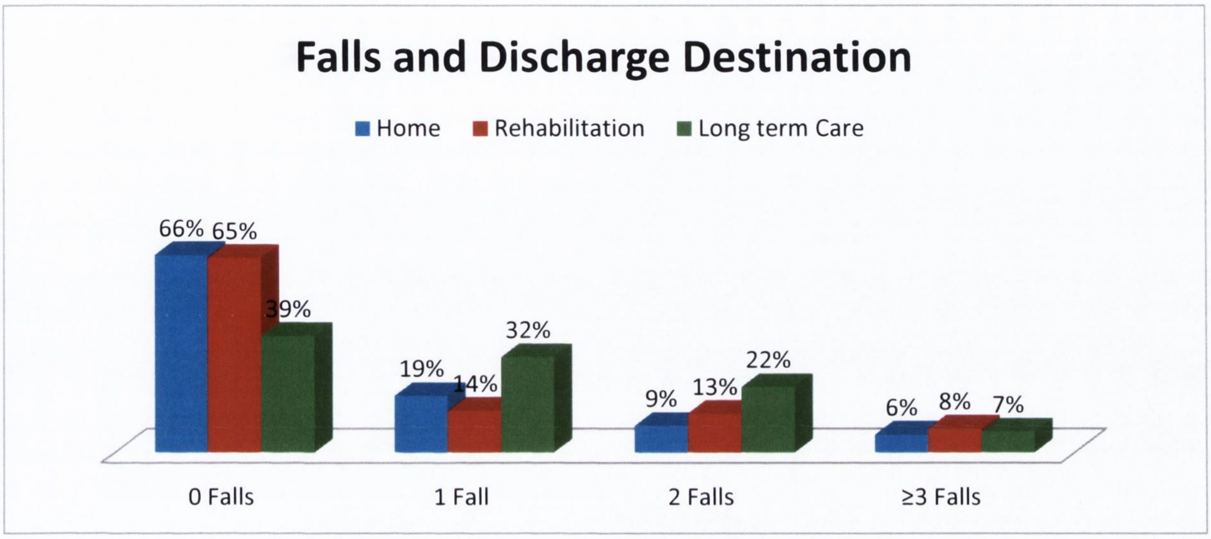
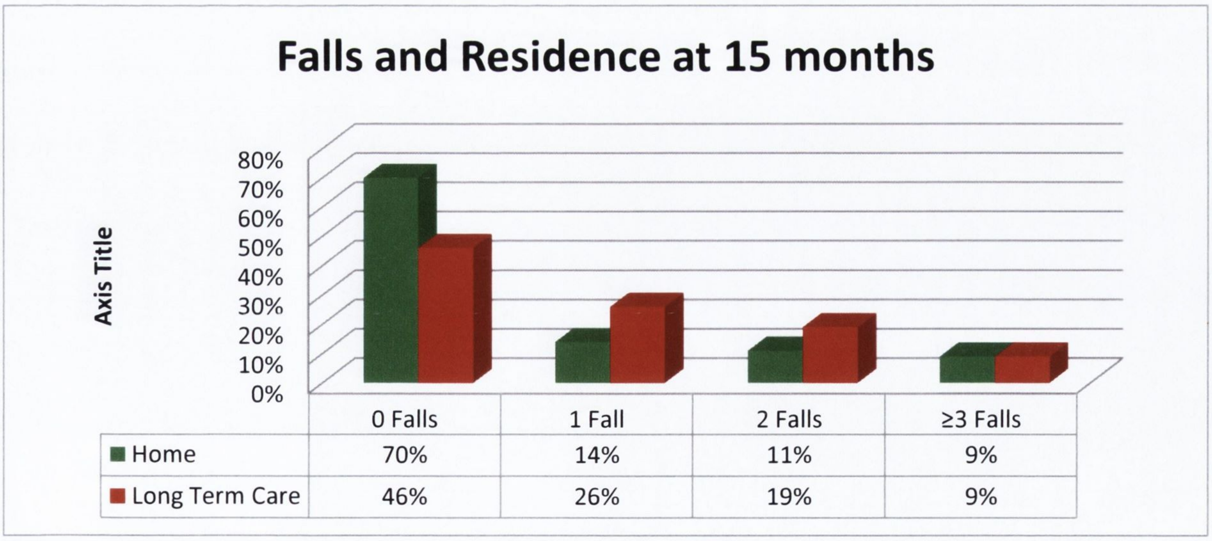


Figure 9.7: Number of falls and discharge destination for study population.

Similarly, those who resided in long term care facilities at 15 months were significantly more likely to have fallen than those residing at home, χ^2 (15) = 28.8, p = 0.01.



	0 Falls	1 Fall	2 Falls	≥3 Falls
🟩 Home	70%	14%	11%	9%
🟥 Long Term Care	46%	26%	19%	9%

Figure 9.8: Place of residence and the number of falls expericenced by study population at 15 months post fracture.

39% (n=26) with 1 to 3 medication on admission had 1 or more falls within the fifteen month follow up period compared to 35% (n= 24) with 4 or more medication and 47% (n=26) of participants with 7 or more medication.This was not statistically significant using Chi Square test. χ^2 (12)= 16.7, p= 0.16. Similarly, there was no difference between Vitamin D levels or Calcium levels and the number of falls experienced by the participants. Data analysed using chi square testing, χ^2 (6) = 2.6, p = 0.85 (Vitamon D levels) χ^2 (6) =0.90, p = 0 .98 (Calcium levels).

Mobility did however influence the amount of falls experienced by participants.There was a significant difference between those participants who were independently mobile at 15 months and those who required a mobility aid, with the latter at increased risk of falling; χ^2 (1)=4.0, p= 0.04 Interestingly, those with a reduced NEADL score had a significant increased risk of falls χ^2 (198.5), p= 0.03, however there was no difference between the ABS score and number of falls experienced, χ^2 (63) = 76.3, p= 0.121.

Reduced cognition was also associated with increased falls over the 15 months follow up period. With participants with impaired cognition at increased risk of falling. χ^2 (57) = 89.9, p= 0.003.

Depression also influenced the risk of falling with those who had above normal level of depression at increased risk of falling over the 15 months follow up period, χ^2 (51) = 76.1, p<0.01. This was not the case with anxiety. There was no significant difference between the number of falls experienced by the participants and the level of anxiety expressed by them, χ^2 (48) = 59.5, p = 0.12.

Chapter 10

Bone Health

In this chapter we will document and discuss the bone health status of the study population as well as their attendance at the bone health clinic, their serum Calcium and Vitamin D levels, bone protection medication, their compliance and persistence with it and their knowledge of osteoporosis. We will also discuss the nutritional status of the study population as measured by the Mini Nutritional Assessment (MNA).

10.1.1:Introduction

Osteoporosis is a skeletal disease characterized by a loss of bone mass and microarchitectural deterioration of the skeleton leading to an increased risk of fracture (Consensus Development Conference 1991). The World Health Organisation (WHO) has defined osteoporosis in menopausal women as a BMD 2.5 or more SD below peak bone mass, 'osteopaenia' or 'low bone mass' as bone mass between 1.0 and 2.5 SD below peak, and normal as 1.0 SD below normal peak bone mass or higher. Osteoporosis is a significant cause of morbidity and mortality in older adults in the Western world, leading to large numbers of fractures of the hip, spine and wrist. Of all the fractures due to osteoporosis, hip fractures are the most serious and associated with the highest level of morbidity and mortality. Various studies have deemed the mortality rate post hip fracture to be between 18-33%.(Magaziner et al 2000, Resnick et al 2002, Peterson et al 2006, Panula et al 2011).

A predicted global increase in the elderly population will result in a substantial increase in the prevalence of osteoporosis and subsequent increased risk of fracture.

10.1.2: Bone Health Clinic appointment

All participants were invited to attend the pre-assessment clinic (PAC) followed by a bone health clinic appointment. The intervention group was given an allotted appointment within three months of their fracture date to the PAC while the control group received usual care which included a next available appointment dictated by the availability of a DXA scan slot.

27% (n=61) of the study group invited to attend a bone clinic appointment did not attend. 66% (n=75) of intervention group patients attended the BHC within 120 days post hip fracture. 16% (n=18) attended the clinic at a later stage ranging from 123 to 238 days post hip fracture. Mean length of time between hip fracture and bone clinic appointment was 93 days post hip fracture. 18% (n=21) of intervention group did not attend the Bone Health Clinic while 39% (n=40) of control group did not attend for Bone Health Clinic. 61% (n=63) of control group attended a bone clinic appointment ranging from 147 days to 405 days post hip fracture. Median length of time between hip fracture and attendance at bone health clinic was 166 days.

Data analysis using Pearson's Chi-square test showed there to be a significant difference between groups and attendance at their Bone Health Clinic appointment with the control group less likely to attend for their appointment than intervention group. 18% (n=21) of intervention group versus 39% (n=40) of controls did not attend their Bone Health Clinic appointment, χ^2 (104) = 155.7, p = 0.001.

Inpatient in Rehabilitation or Acute ward	22 (36%)
Medically unfit	6 (10%)
Housebound secondary to pain or inability to use transport	7 (11%)
Reduced mobility	14 (23%)
Refused	6 (10%)
RIP	6 (10%)

Table 10.1: Reasons for non attendance of study group at Bone Health clinic.

10.1.3: Bone Health Status

Bone Mineral Density (BMD) measurements form the cornerstone of osteoporosis diagnosis and management. The gold standard for the diagnosis of osteoporosis and low bone mass in adults is dual emission x-ray absorptiometry (DXA). All participants had their bone mineral density (BMD) measured using a Lunar DXA system. Two primary sites were used to measure BMD. They were the hip and L1-L4 spine. If the one site was unavailable (e.g patients with bilateral hip replacements) the distal one third of the radius was assessed. 69% (n=156) participants received a DXA scan. The remaining 31% of participants either didn't attend or were deceased.

70% (n=108) of those participants were diagnosed with osteoporosis while a further 28% (n=45) had osteopaenia. Only 2% (n=3) had normal bone. 60% (n=65) of the intervention group compared to 43% (n=40) of the control group had osteoporosis. Data analysed using Chi Square showed there to be no statistical significance between age group or gender and prevalence of osteoporosis.

65% (n=42) of the male study population received a DXA scan. 62% (n=26) had osteoporosis while 36% (n=15) had osteopaenia. 71% (n=114) women who received a DXA, 72% (n=82) had osteoporosis, with 26% (n=30) having osteopaenia. Data analysed using Chi-Square showed there to be no significant difference between the prevalence of osteoporosis or osteopaenia between men and women.

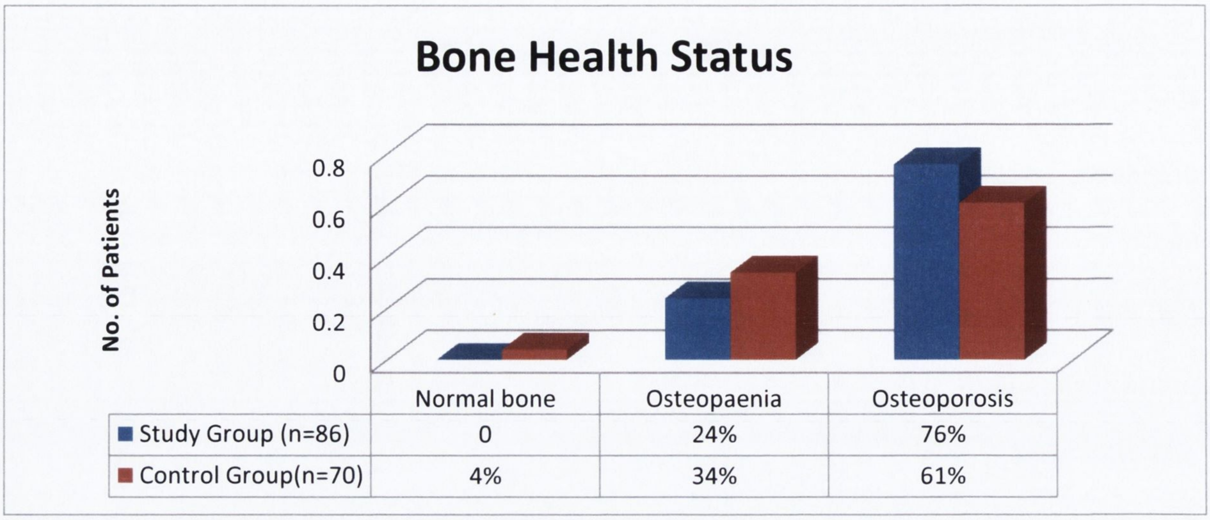


Figure 10.1: Bone Health Status of study population.

10.1.4: Vertebral fractures

In this study vertebral fractures were diagnosed by lateral vertebral assessment (LVA) on dual emission x-ray absorptiometry (DXA) scan, which the participant received at the pre-assessment clinic appointment. 37% (n=57) participants had vertebral fractures while 63% (n=96) had no vertebral fractures. The risk of vertebral fracture increased with a diagnosis of osteoporosis. Of those with osteoporosis 44% (n=46) had vertebral fractures while 22% (n=10) of participants diagnosed with osteopaenia had vertebral fracture. This was statistically significant using Chi Square test χ^2 (2) = 8.32, p = 0.01.

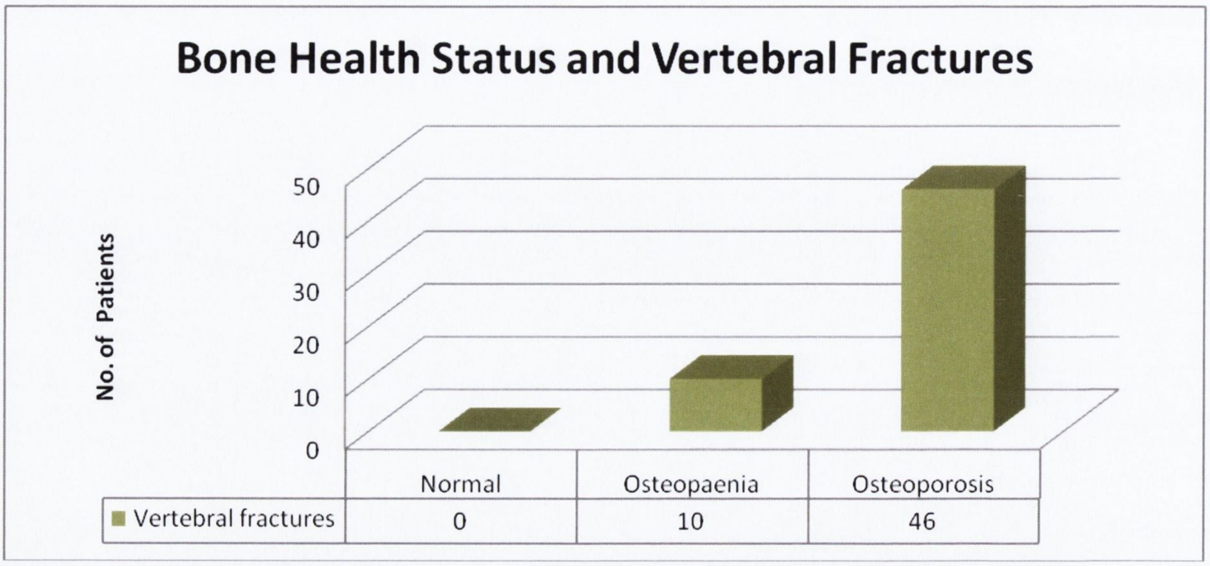


Figure 10.2: Bone health status of study population and vertebral fractures.

10.1.5: Calcium and Vitamin D Levels

Serum 25-hydroxyvitamin D (25(OH)D) is the most common biomarker used to assess Vitamin D status. In this study the Vitamin D status of each participant was assessed at the pre-assessment clinic appointment. Only 30% (n=48) of all participants (n=185) had normal Vitamin D levels while 70% (n=110) were deficient. Of those with Osteoporosis, 31% (n=29) had normal Vitamin D levels while 66 (69%) were deficient.

The normal range for serum calcium is 2.25-2.5 mmol/L. In this study one hundred and nineteen (60%) of all participants (n=197) had normal calcium levels while 77 (39%) had below normal levels. Of those with osteoporosis 71% (n=72) had normal Calcium levels while 29% (n=29) had low Calcium levels.

Bone Health Status	Low Calcium (<2.25)	Low Vitamin D (<75nmol/L)
Normal (n=3)	1 (50%)	3 (100%)
Osteopaenic (n=45)	19 (42%)	26 (62%)
Osteoporosis (n=101)	29 (29%)	66 (69%)

Table 10.2: Bone Health Status and Calcium and Vitamin D levels of study population.

10.1.6: Bone Protection Medications

Each participant was asked if they were taking medication such as anti-resorptive or anabolic agents as distinct from Calcium and Vitamin D, for the purpose of bone protection on admission, at 3 months and at 15 months. Sixteen percent of participants were on bone protection medication on admission while 82% were not. There was no significant difference between the intervention group and control group on admission and at three months however there was a significant difference between the groups at 15 months with the intervention group more likely to be on bone protection medication. Data was analysed by using Pearson Chi Square test, χ^2 (2) = 8.4, p = 0.02. There was no significant difference between groups for Calcium and Vitamin D supplementation at these time points.

69% (n=144) of participants were taking bone protection medication (Bisphosphates, Serms or Anabolic agents) at 15 months

	On Admission		At Three Months		At Fifteen Months	
Group Assigned to	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
Intervention	20 (17%)	92 (81%)	79 (72%)	30 (27%)	85 (77%)	12 (11%)
Control	16 (14%)	95 (86%)	62 (62%)	38 (38%)	58 (59%)	23 (23%)

Table 10.3: The number of the Intervention and Control groups taking bone protection medication on admission, at 3 months and at 15 months post fracture.

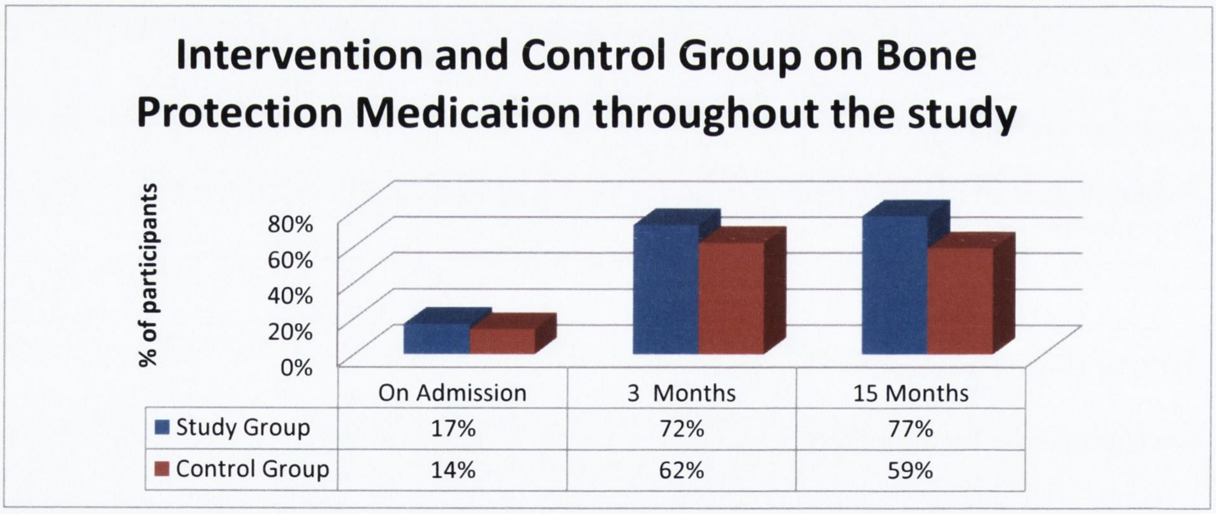


Figure 10.3: The number of the Intervention and Control groups taking bone protection medications on admission, at 3months and at 15 months post fracture.

Of those participants who had one or more previous fractures prior to admission, 80% (n=82) were not on bone protection medication on admission.

Oral Bisphosphonates were the most common bone protection medication prescribed.

10.1.7: Medication Adherence Report Scale

The medication adherence of the participants was assessed using the Medication Adherence Report scale (MARS) at 3 and 15 months with the intervention group and at 15 months with the control group. Those who did not attend the bone health clinic were request by telephone call to complete the questionnaire which was sent to them by post with a stamped addressed envelope in which to return the completed questionnaire.

Both the intervention group and control group reported a high adherence to medication rate at 15 months, 92% of intervention group, 91% control group.

A paired-sample t-test was conducted to compare medication adherence in the intervention group at 3 months and 15 months. There was no significant difference between the adherence rate reported by the intervention group at 3 months 1.9 ± 0.3 (M±SD) and 15 months 1.9 ± 0.28 (M±SD).

Data analysed using Pearson Chi Square shows a

significant difference between the medication adherence rates between both groups at 15 months. χ^2 (1) = 0.636, $p > 0.05$.

10.1.8: Knowledge of Osteoporosis

Each participant was requested to complete the Facts on Osteoporosis Quiz. This is a questionnaire consisting of 20 questionnaires. The intervention group completed this at 3 months and again at 15 months while the control group completed this at 15 months only. Those who did not attend the bone health clinic were request by telephone call to complete the questionnaire which was sent to them by post with a stamped addressed envelope in which to return the completed questionnaire. Information on their DXA scan result, osteoporosis, dietary and lifestyle changes and weight bearing exercises, both verbally and in written form was given to the participants when they attended the bone health clinic by the clinical nurse specialist.

No respondent scored 100% on the quiz. Knowledge of osteoporosis increased in the intervention group with a mean score of 8 ± 5 (M±SD), at 3 months compared to 10 ± 5 (M±SD) at 15 months. A paired samples t-test showed there to be a significant difference between the measures taken at the two time frames, t (61) = -3.9, p = 0.001. There was no significant difference between the intervention and control group at 15 months. Data analysed using chi square test, χ^2 (18) = 23.1, p = 0.185.

There was no significant difference between osteoporosis knowledge and age or gender using chi square test for data analysis; χ^2 (54) =56.2, p = 0.95 (age), χ^2 (18) = 7.2, p = 0.98 (gender). Likewise there was no significant difference between osteoporosis knowledge and those with or without a diagnosis of osteoporosis. χ^2 (34) = 25.5, p = 0.85.

A significant difference was found in the level of knowledge between participants who were on bone protection medication at 15 months compared to those who were not on it with an increased knowledge in those with medication than without; χ^2 (36) = 51.5, p = 0.04. Similarly, there was a difference, although not significant, between osteoporosis knowledge and attendance at the bone health clinic with those participants who attended being more knowledgeable than those who did not. Data analysed using Leven's Test for equality of variance, t (23.7) = 1.9, p = 0.067.

10.2: Section Two-Nutritional Status of Study Population

10.2.1: Introduction

Malnutrition can be described as an under- or over-consumption of food (Hickson 2006). For the purpose of this study, malnutrition will refer to the state of undernutrition as this remains the common use throughout the published literature. Malnutrition is common in the elderly patient. Prevalence rates have been estimated for the general hospital population to be between 11% and 44%, but this rises in elderly groups to 29%–61% (Corish and Kennedy 2000). It is particularly common in elderly hip fracture patients and is associated with increased risk of complications after surgery as reported by Pérez et al (2010). The prevalence of malnutrition for hip fracture patients on admission to hospital ranges from 2% (Maffulli et al 1999) to 63% (Murphy et al 2000). Various studies have highlighted the negative affect malnutrition can have on hip fracture outcomes. O'Daly et al (2010) reported that there was an increase in mortality in patients who were malnourished compared to those well nourished while Lumbers et al (1996) identified an association between malnutrition and impaired muscle function, disability, loss of independency, lower mental function and decreased quality of life. Delayed wound healing, higher complication rate and prolonged rehabilitation time was identified by Paillaud et al (2000) as a consequence of malnutrition in hip fracture patients.

10.2.2: Results

Mini Nutritional Screening at 3 months carried out on the intervention group (n = 92) showed 40% (n=37) to be at risk of malnutrition. At fifteen months 28% (n=24) of the intervention group were at risk of malnutrition when screened. This proved not to be a statistically significant difference using paired t test for data analysis; t (82) =-1.070,

p = 0.288.

Further assessment of the 'at risk of malnutrition group' showed that while 22 (25%) were at risk of malnutrition, 14% (n=12) were malnourished at 3 months and 21% (n=18) were at risk of malnutrition and 7% (n=6) were malnourished at 15 months. Using the Greenhouse-Geisser repeated measures design, analysis of variance showed there to be a statistically significant difference between the nutritional levels of the intervention group at 3 months and 15 months with nutritional levels improving between the two time frames, F(1)= 19.2, p = 0 .001.

Comparing the two groups at fifteen months the Mini Nutrition Screening showed 28% (n=24) of intervention group to be at risk of malnutrition compared to 55% (n=37) of controls. This data was analysed using Pearson Chi Square test revealing a significant difference between the groups with the control group more likely to be at risk of malnutrition than the intervention group, χ^2 (1) = 4.186, p = 0.041.

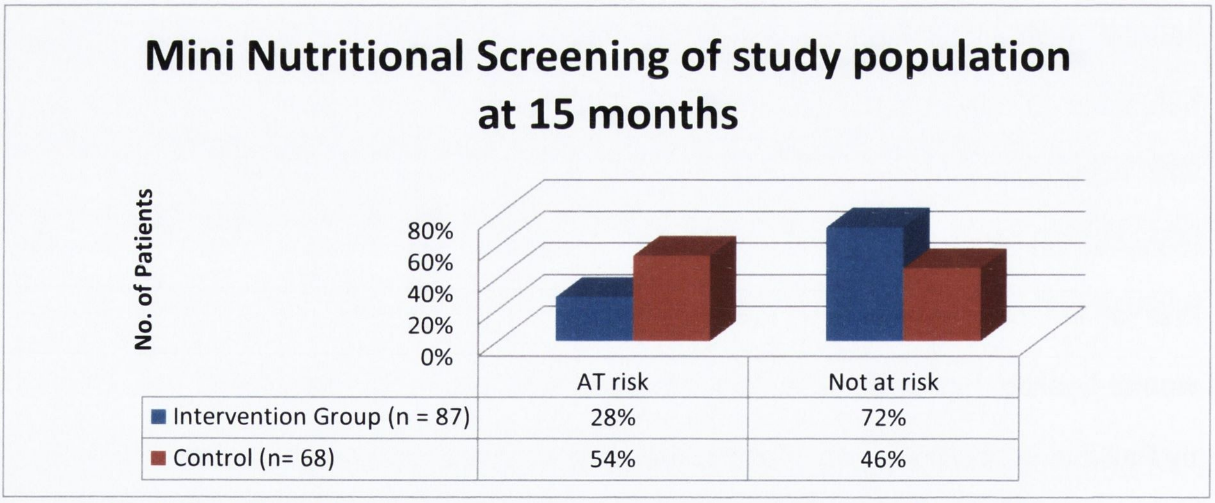
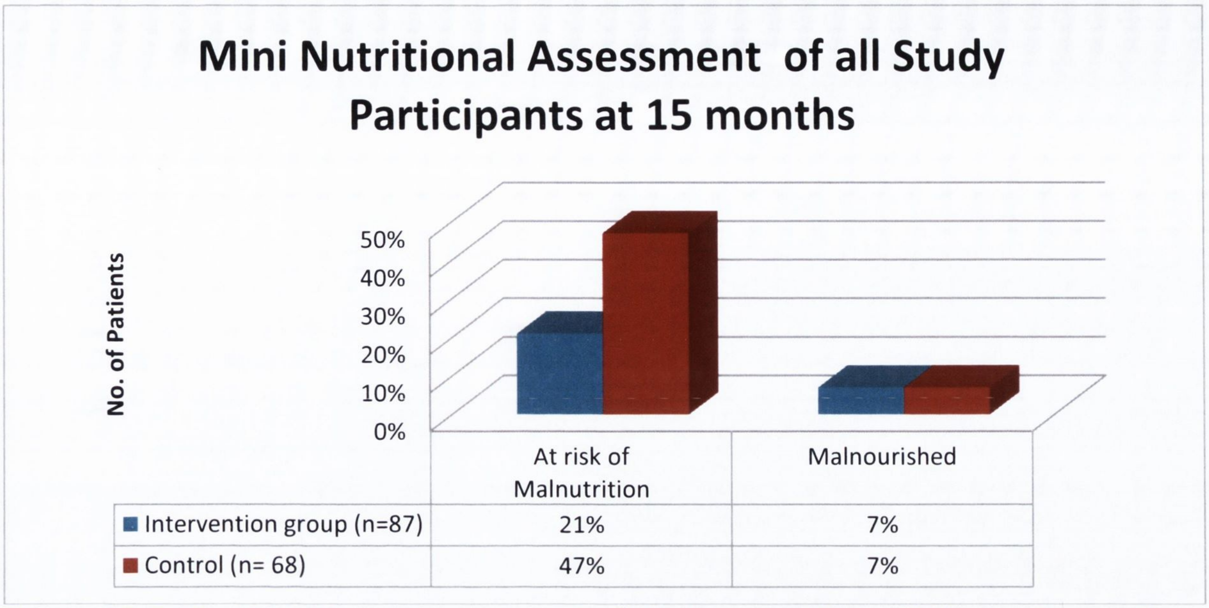


Figure 10.4: Mini Nutritional Screening of study population at 15 months

Further assessment at 15 months showed 7% (n=6) of the intervention group and 7% (n=5) of the control group were malnourished. However 28% (n=24) of the intervention group were at risk of malnutrition compared to 54% (n=37) of the control group. This was statistically significant using Pearson Chi Square test to analyse, χ^2 (2) = 12.98, p =.001



	At risk of Malnutrition	Malnourished
🟦 Intervention group (n=87)	21%	7%
🟥 Control (n= 68)	47%	7%

Figure 10.5: Mini Nutritional assessment of study population at 15 months post fracture.

The number of participants identified as at risk of malnutrition increased with the participant's dependency in activities of daily living prior to fracture as measured by the Amended Barthel Score. Data analysed using Pearson's Chi Square identified a statistically significant difference between independent participants and those less so with the later more likely to be at risk of malnutrition than the former χ^2 (11) = 22, p = 0.02. Eighty three percent of moderate to high dependent participants were at risk of malnutrition compared to forty seven percent of low dependent and thirty four percent of independent participants being at risk of malnutrition. Dependency at fifteen months also increased risk of malnutrition, χ^2 (6) = 17.8, p = 0.007.

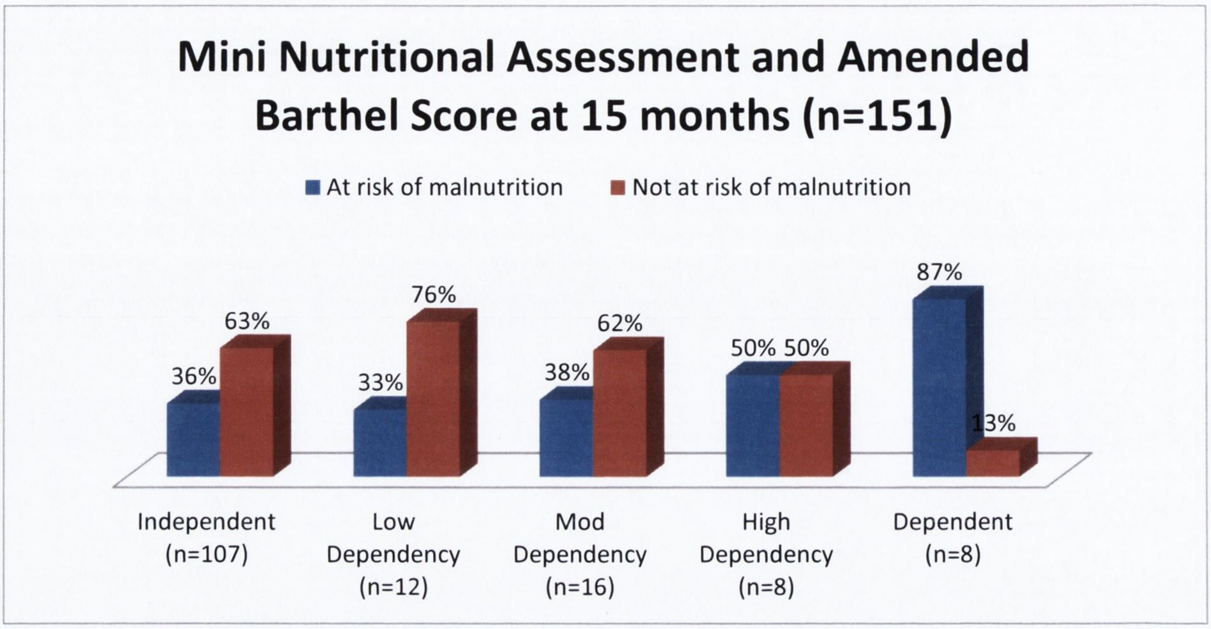


Figure 10.6: Nutritional Assessment and Amended Barthel scores for study Population at 15 months.

Likewise the number of participants identified as at risk of malnutrition increased with age, showing a near statistical significant difference; χ^2 (3) = 6.59. p = 0.086.

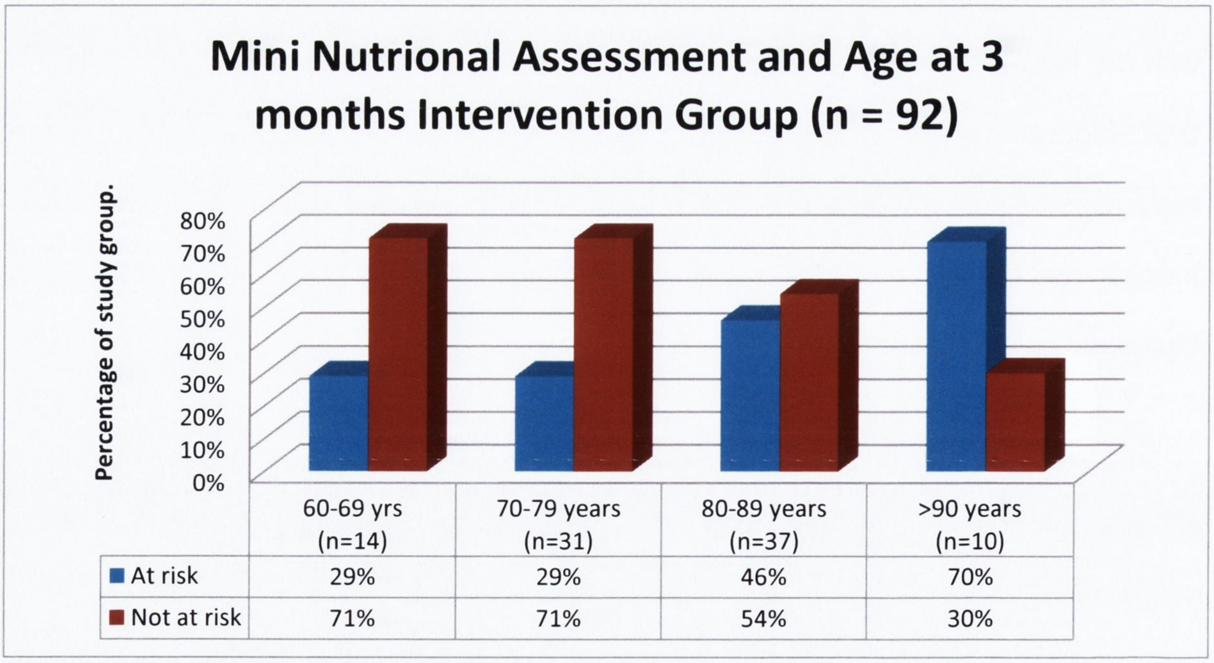


Figure: 10.7: Mini Nutritional Assessment and age groups of the Intervention Group.

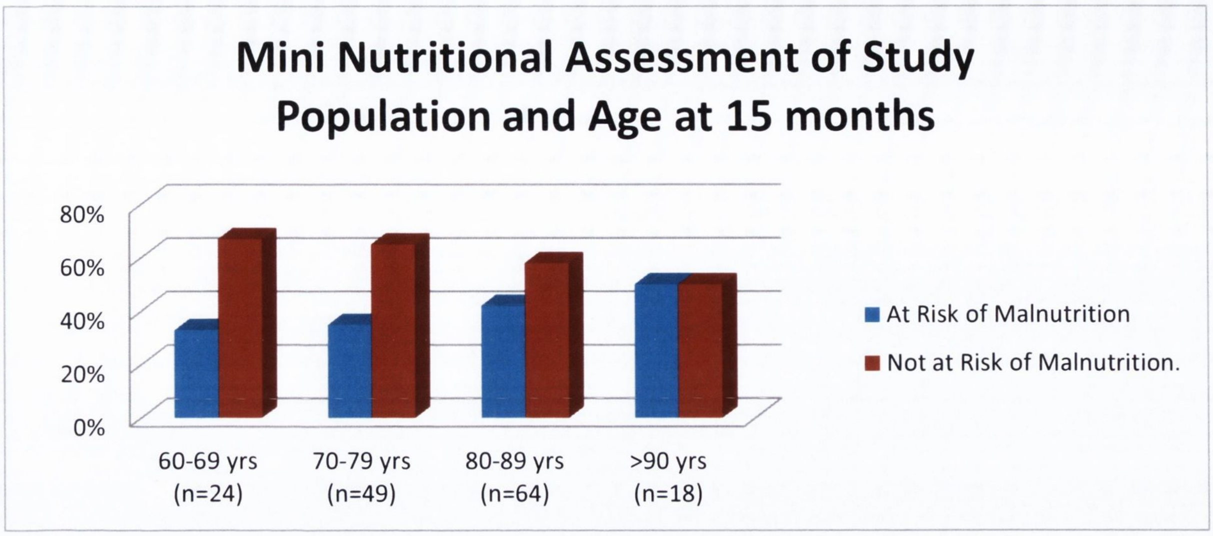


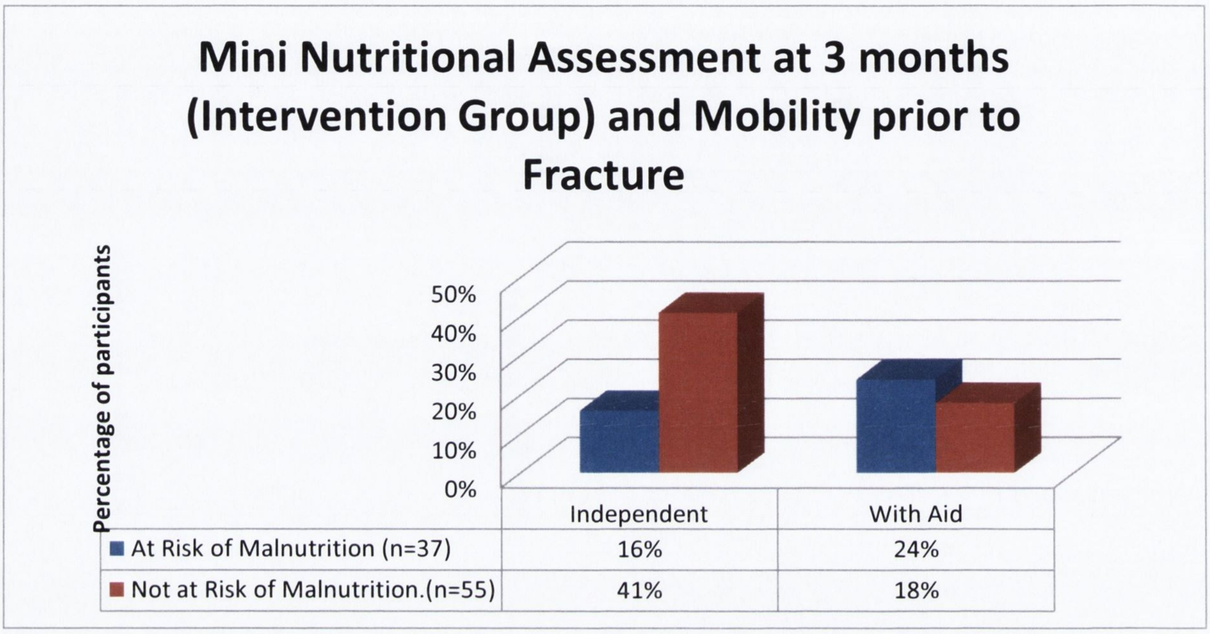
Figure 10.8: Mini Nutritional Assesment of the study population and age at 15 months.

Women were more likely to be at risk of malnutrition at three months post fracture than men, 46% and 24% respectively. Data analysed using Pearson's Chi Square identified a statistical significance between the genders. χ^2 (1) = 3.75, p = 0.05. The difference between the genders reduces at fifteen months post fracture to 41% females compared to 35% of males being at risk of malnutrition.

Although there was an increase in mortality at 15 months this was not statistically significant. Nine percent of those at risk of malnutrition at three months died within fifteen months compared to 0% of 'not at risk' participants. Data analysed using Pearson's Chi Square, χ^2 (3) = 4.866, p = 0.182.

Mobility levels prior to fracture would appear to influence nutritional status at three months following fracture. There was a near statistically significant difference between those who were independent and those requiring assistive devices to mobilise prior to admission with the latter more likely to be at risk of malnutrition. Data analysed using Pearson's Chi Square, χ^2 (5) = 10.28, p = 0.068. However mobility levels at three and fifteen months did not appear to influence nutritional status. There was no statistically significant difference in nutritional status between independent participants and those requiring assistive devices at these time frames. Data analysed using Pearson's Chi

Square, χ^2 (7) =7.5, p= 0.371 at three months and χ^2 (7) = 11.57, p = 0.116 at fifteen months.



	Independent	With Aid
🟦 At Risk of Malnutrition (n=37)	16%	24%
🟥 Not at Risk of Malnutrition.(n=55)	41%	18%

Figure 10.9: Mini Nutritional Assessment and pre fracture mobility of the intervention group.

Participants with lower NEADL scores at fifteen months were more likely to be at risk of malnutrition. Data analysed using Pearson's Chi Square showed a significant difference between those with higher dependency compared to those who were more independent in activities of a daily living, with the former at increased risk of malnutrition; NEADL Mobility score χ^2 (6) = 11.39, p = 0.077, NEADL Kitchen score χ^2 (6) = 17, p = 0.009, NEADL Domestic score χ^2 (5) = 11.2, p = 0.047.

Chapter 11

Quality of Life

In this chapter we will document and discuss the findings of the quality of life (QOL) reported by the study population as measured by the SF-36 Health Survey. Will also report and discuss the mortality rate experienced by the study population and possible indicators relating to mortality.

11.1: Quality of Life

11.1.1: Introduction

Quality of life is considered a subjective phenomenon, which is often assessed through self-report and thereby supplements objective factors associated with disease, in this context hip fracture. Quality of life is widely regarded as an indicator of successful ageing and has been used to measure effectiveness of health care, social policies and welfare programmes. Older people most commonly define successful ageing by reference to good health and functioning, although these aspects are rarely mentioned in isolation (Bowling et al 2005). Other concepts such as life satisfaction, social functioning and participation are equally important (Montross et al 2006), as it is not uncommon for older people to have serious illness or disability and yet rate their quality of life as good. In the HeSSOP (Health and Social Services for Older People) surveys of older people in Ireland, Garavan and colleagues (2001) reported that although 78% of participants rated their quality of life as good or very good only 14% had been free from any medical condition in the preceding year. This was reiterated by Bowling and colleagues (2007) who noted that 62% of participants who had fairly severe or severe restrictions in daily living nevertheless reported good quality of life. Any loss to living independently in the community has a significant detrimental effect on their quality of life, and it follows that a reduction in the incidence of hip fractures will not only save lives but will prevent a considerable reduction in their quality of life.

11.1.2: Results

Quality of life using the SF-36 was measured at 3 and 15 months for the Intervention group and at 15 months for the control group. A paired samples t-test was conducted to compare the QOL of the intervention group at 3 months and that of the same group at 15 months. There was no significant difference between scores for each of the 8 domains at the two time frames.

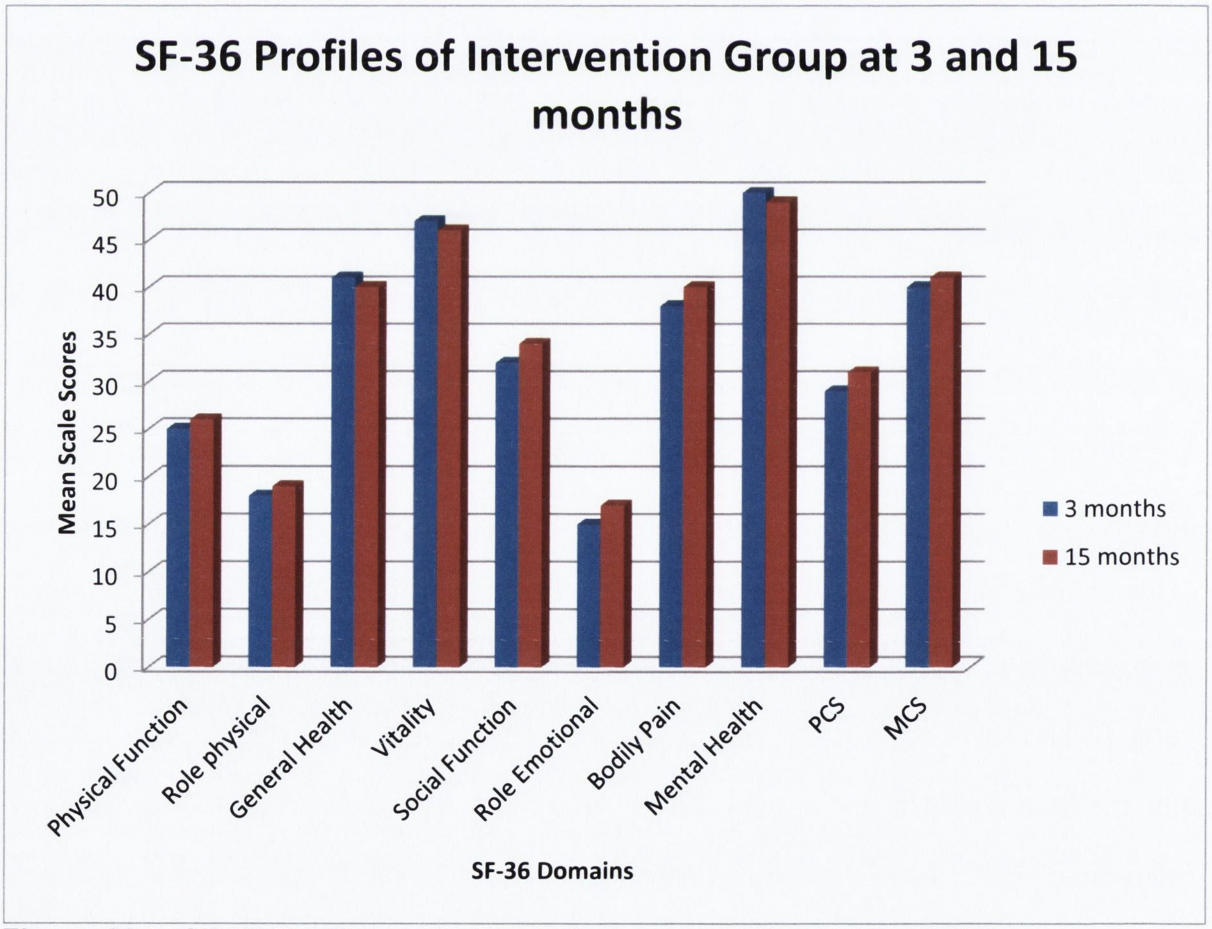


Figure 11.1: SF-36 Profiles for Intervention group at 3 and 15 months.

However a significant difference was identified between the intervention and control group at 15 months in each of the 8 domains with the intervention group scoring higher in each domain, using Levene's test for Equality of Variance,. Results tabulated below

SF-36 Domains	Intervention Group	Control Group	Chi- Square Test
Physical Function	M=26, SD=14	M= 21, 14	t(151)=2.3, p<0.02
Role- Physical	M= 19, SD=8	M=17, SD= 9	t(147)=2.0, p<0.04
Bodily Pain	M=40, SD= 18	M= 33, SD=21	t(142)=1.9, p< 0.05
General Health	M= 40, SD = 19	M=33, SD= 21	t(144)= 2.0 p< 0.03
Vitality	M= 46, SD=21	M=39, SD 24	t(140)=2.0, p<0.03
Social Function	M= 34, SD=18	M=29, SD=20	t(143)=1.8, p<0.06
Role Emotional	M=17, SD=10	M=13, SD=8	t (161)=3., p < 0.002
Mental Health	M=41, SD=17	M=44, SD=26	t (139)=1.2,p<0.19
Physical Component Score	M=31,SD=15	M=25, SD=15	t(152)=2.7, p< 0.008
Mental Component Score	M=41, SD=17	M=35, SD=21	t(135) = 2.1, p<0.03

Table 11.1: Differences in the SF-36 Profiles of the Intervention and Control group using Levene's test for Equality of Variance

The Physical and Mental Component Summary scores are summary scores of the items measured relating to physical and psychological functioning of the participant.

Physical Component Summary Score; t (151.7) = 2.7, p = 0.008.

Mental Component Summary Score; t (135) = 2.104. p = 0.037.

This difference is indicative of the intervention group being both physically and mentally healthier than the control group at 15 months. This increased physical and mental health perception is confirmed by the intervention group's assessment of their 'health in general' and 'their health now compared to a year ago' being better than that reported by the control group. Data analysed using Levene's test of Equality of variance showed significant differences between the two groups;

Health in general; t (152) = 2.475, p = 0.014

Health, now compared to a year ago; t (153.6) = 2.883, p = 0.005.

The interpretation of SF-36v2Health Survey results has been greatly simplified with the norm-based scoring of its health domain scales and component summary measures. It is recommended that users base their interpretations on norm-based scores, Mean = 50, SD= 10 (Ware et al 2002). Blake et al (2000) suggested that there was no evidence to suggest a difference between an Irish population and the published norms for the US population. In this study the mean values for all domains except Vitality and Mental Health are below the norm based value of 50 ± 10 at 15 months. Physical function and role limitations due to emotional problems (role emotional) of hip fractured elderly patients (mean ± SD=28.6 ±11; 17.7 ± 7.3) were the two subscales that deviated the most from the norm.

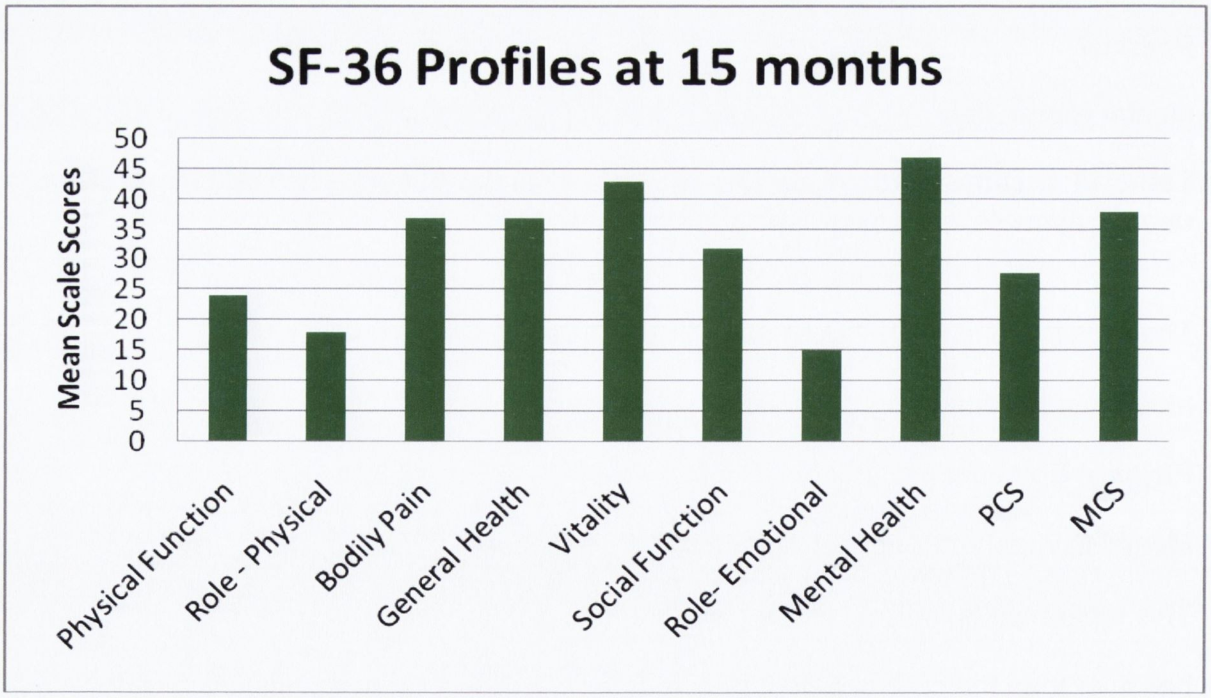


Figure 11.2: SF-36 Profiles for study population at 15 months.

Gender did not influence quality of life. There was no statistically significant difference between quality of life reported by men or women at 15 months for each of the 8 domains. Data was analysed using a paired samples t-test.

There was no significant difference between age and Physical Function, Role- Physical, Bodily Pain, General Health, Social Function, and Mental Component Score however there was a statistically significant difference between age and the domains Role-Emotional, Mental Health and Physical Component Score identified with older participants reporting lower levels for each of these three domains. Data analysed using Pearson's Chi Square test. Results tabulated below.

SF-36 Domains	**Age V SF-36 Domains Chi square**
Physical Function (PF)	χ2 (1700)= 1656.4, p = 0.771
Role – Physical (RP)	χ2 (918)= 930.2, p = 0 0.382
Bodily Pain (BP)	χ2 (1530)=1516, p = 00.595
General Health (GH)	χ2 (2142)=2171.6, p = 0.322
Vitality (VT)	χ2 (1700)=1780.3, p = 0.086
Social Function (SF)	χ2 (1224)=1206.8, p = 0.631
Role –Emotional (RE)	χ2 (816)= 888.8, p = 0.038
Mental Health (MH)	χ2 (1632)=1834.1, p < 0.0001
Physical Component Score (PCS)	χ2 (3740)=3987.7, p <0.002
Mental Component Score (MCS)	χ2 (3774)=3868.1, p <0.140

Table 11.2: Pearson's Chi Square results for the SF-36 Domains and age of the study population at 15 months

Place of residence at 15 months did not influence the RP, BP, SF, RE, MH, or PCS of those living at home compared to those in long term care. However there was a significant difference in PF, VT, and MCS. More people in long term care (LTC) reported reduced physical function than those at home, 16 (84%) compared to 54(45%) respectively. Data analysed using Pearson's Chi Square test showed a statistically significant difference; χ^2 (1) = 10.1, p = 0.001 while all participants living at home and in LTC reported a below normal role limitations level secondary to physical function. More people at home reported below normal Vitality and Mental component Score; χ^2 (1) = 5.02, P = 0.02, χ^2 (1) = 5.86, p = 0.01.respectively.

SF 36 Domains	***Below Normal at home (n=118)***	***Below Normal in LTC (n=19)***	***Normal at Home (n=118)***	***Normal in LTC (n=19)***	***Chi Square Result.***
Physical Function	53 (45%)	16 (84%)	65 (55%)	3 (16%)	$\chi^2\ (1)=10.1,$ $p=0.001$
Role-Physical	118(100%)	19 (100%)	0 (0%)	0 (0%)	
Bodily Pain	51 (43%)	10 (53%)	67 (57%)	9 (47%)	$\chi^2\ (1)=0.58,$ $p=0.44$
General Health	46 (39%)	6 (31%)	73 (61%)	13 (69%)	$\chi^2\ (1)=0.34,$ $p=0.55$
Vitality	35 (30%)	1 (5%)	83 (70%)	18 (95%)	$\chi^2\ (1)=5.02,$ $p=0.02$
Social Function	58 (49%)	11(58%)	61 (51%)	8 (42%)	$\chi^2(1)=0.957,$ $p=0.32$
Role- Emotional	116 (98%)	19 (100%)	2 (2%)	0 (0%)	$\chi^2(1)=0.326,$ $p=0.56$
Mental Health	15 (12%)	3 (16%)	103 (88%)	16 (84%)	$X^2(1)=0.135,$ $p=0.712$
PCS	89 (75%)	11 (58%)	29 (25%)	8 (42%)	$X^2(1)=2.55,$ $p=0.110$
MCS	88 (75%)	9 (47%)	30 (25%)	10 (53%)	$X^2(1)=5.86,$ $p=0.01$

Table 11.3: Pearson's Chi Square test results for the SF-36 domains and place of residence at 15 months post fracture for study population.

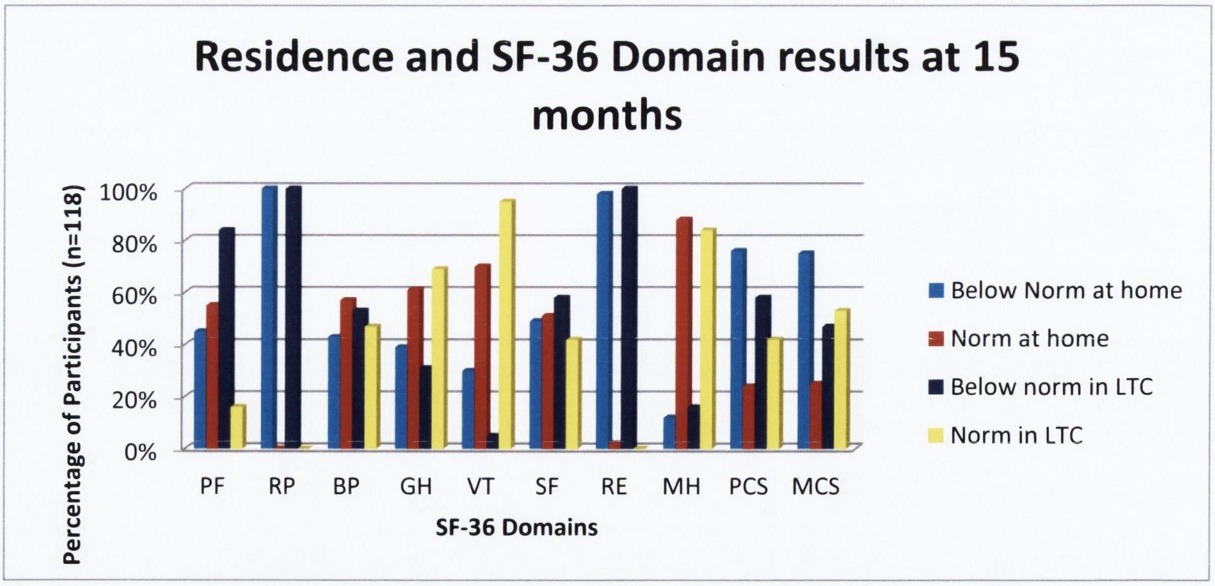


Figure 11.3:Place of residence of the study population at 15 months and SF-36 domains result.

There was a statistically significant difference between the NEADL score prior to hospital and some of the domains of the SF 36 at 15 months. Data analysed using Pearson's chi square test revealed that participants with lower NEADL scores prior to hospitalisation had lower scores in some domains of the SF-36 at 15 months.

SF-36 Domain at 15 months	Pearson's Chi Square test
Physical Function	χ^2 (1372)=1371.7, p = 0.497
Role - Physical	χ^2 (756)=870.4, p = 0.002
Bodily Pain	χ^2 (1260)=1363.5, p = 0.02
General Health	χ^2 (1764)=2012.9, p = 0.0001
Vitality	χ^2 (1372)=1493.5, p = 0.012
Social Function	χ^2 (1008)=1227.2, p = 0.0001
Role - Emotional	χ^2 (672)=848.3, p = <0.0001
Mental Health	χ^2 (1316)=1478.9, p= 0.001
Physical Component Score	χ^2 (3052)=0361.1, p = 0.450
Mental Component Score	χ^2 (3080)=3070, p = 0.546

Table 11.4: Pearson's Chi Square test results for the SF-36 domains at 15 months and the study population's ability to self care as measured by the Nottingham Extended Activities of Daily Living Index prior to fracture.

Similarly, there was a statistically significant difference between Amended Barthel Score prior to hospital and SF-36 score at 15 months with participants with lower scores in the ABS having lower scores in some of the 8 domains of the SF-36 at 15 months.

SF-36 Domains at 15 months	**ABS prior to hospital and SF-36 Domains Pearson's Chi Square**
Physical Function	χ^2 $(450)=571.1, p=0.0001$
Role - Physical	χ^2 $(243)=361.8, p=0.0001$
Bodily Pain	χ^2 $(405)=436.4, p=0.135$
General Health	χ^2 $(567)=575.9, p=0.388$
Vitality	χ^2 $(450)=544.2, p=0.001$
Social Function	χ^2 $(324)=445.2, p=0.0001$
Role Emotional	χ^2 $(216)=197.1, p=0.817$
Mental Health	χ^2 $(432)=468.8, p=0.107$
Physical Component Score	χ^2 $(981)=1108.1, p=0.003$
Mental Component Score	χ^2 $(990)=921.7, p=0.940$

Table 11.5: Pearson's Chi Square test results for the SF-36 domains at 15 months and the study population's ability to self care prior to fracture as measured by the Amended Barthel Score

There was a statistically significant difference between the HADS Anxiety score and SF-36 score at 15 months with participants who had higher levels of anxiety having lower scores in some of the domains of the SF-36. Results tabulated below.

SF-36 Domains at 15 months	Domains Pearson's Chi Square
PF	χ^2 $(688)=719.5, p = 0.196$
RP	χ^2 $(336)=436.3, p = 0.0001$
BP	χ^2 $(624)=69.02, p = 0.030$
GH	χ^2 $(880)=949.6, p = 0.051$
VT	χ^2 $(688)=783.0, p = 0.007$
SF	χ^2 $(512)=579.9, p = 0.020$
RE	χ^2 $(336)=442.8, p = 0.0001$
MH	χ^2 $(656)=736.2, p = 0.016$
PCS	χ^2 $(1584)=1553.4, p = 0.704$
MCS	χ^2 $(1600)=1575.4, p = 0.662$

Table 11.6: Pearson's Ch Square test results for the SF-36 domains at 15 months and levels of anxiety experienced by the study population at 15 months post fracture as measured by the Hospital Anxiety and Depression Scale (HADS).

Similarly there was a statistical significant difference between the HADS depression score and the SF-36 scores at 15 months with those participants with higher than normal levels of depression having lower QOL ratings in bodily pain, vitality and social functioning domains of the SF-36. Results tabulated below.

SF-36 domains at 15 months	HADS Depression score at 15 months and SF=36 Chi square test
Physical Function	χ^2 (645)=658.9, p = 0.344
Role - Physical	χ^2 (315)=288.0, p = 0.860
Bodily Pain	χ^2 (585)=658.4, p = 0.019
General Health	χ^2 (825)=887.4, p = 0.065
Vitality	χ^2 (645)=819.5, p = 0.0001
Social Function	χ^2 (512)=720.4, p = 0.0001
Role - Emotioal	χ^2 (315)=317.8, p = 0.445
Mental Health	χ^2 (615)=648.9, p = 0.166
Physical Component Score	χ^2 (1485)=1459.6, p = 0.676
Mental Component Score	χ^2 (1515)=1574.7, p = 0.139

Table 11.7: Pearson's Ch Square test results for the SF-36 domains at 15 months and levels of depression experienced by the study population at 15 months post fracture as measured by the Hospital Anxiety and Depression Scale (HADS).

11.1.3: SF-6D

Preference-based measures of health have become an important set of instruments for estimating the health state values used to calculate quality adjusted life years (QALYs) and are widely used in economic evaluations alongside clinical trials to value the benefits of health care. The SF-6D is a generic preference-based single index measure of health derived from the SF-36 that can be used to generate QALYs and hence can be used in cost-utility analysis. It has a possible range from 0 to 1 on a scale where 0 = dead and 1.0 = perfect health. The SF-6D score norms for a US population were identified ranging from a low of 0.75 for 85 year old males to a high of 0.81 for 35 year old females. Walters and Brazier (2003) have provided guidance that differences of 0.033 or more in mean SF-6D scores are clinically important.

In this study health SF-6D scores were calculated from responses on the SF-36. Related quality of life would appear to have improved over the course of the study in the intervention group. A comparison between 3 month SF-6D measures and 15 month SF-6D measures using a paired t-test, showed a significant difference in scores (3 month M=.58, SD =0.116, 15 month M = .66, SD 0.129), t (35) = -4.172, p = 0.001.

A repeated measures design using the Greenhouse Geisser approach carried out on each of the 6 domains showed there to be a significant difference in QOL between 3 and 15 months in each domain in the intervention group as seen below.

Physical Function: F(1) = 12.7, p = 0.001
Role limitation due to Physical health; F(1) =6.2, p = 0.017
Social Function: F(1) = 10.4, p = 0.003
Pain; F(1) = 11.4, p = 0.002
Mental Health; F(1) = 4.73, p = 0.036
Vitality; F (1) = 1.38, p = 0.247
SF Index; F(1) = 17.4, p = 0.001

Table 11.8: The Greenhouse Geisser results for the SF-6D domains comparing 3 and 15 month Quality of Life as reported by the Intervention group

The SF-6D Mean for both groups at 15 months was 0.64, SD = 0.13. There was no significant difference shown between the two groups at 15 months using Pearson Chi Square $X^2(84) = 85$, $p<0.451$.

11.2: Mortality

11.2.1: Introduction

Increased mortality following hip fracture has been well documented in numerous previous studies (Alegre-Lopez et al 2005, Parker and Johansen 2006, Beringer et al 2006, Paksima et al 2008). These studies, carried out in Spain, UK, Northern Ireland and America respectively, state that mortality following hip fracture is about 5-10% at one month and up to 30% at one year Part of this excess mortality is due to co-morbidity (Marks et al 2003). While hip fracture patients tend to have more co-morbidities than the general population it has been estimated that 25% of the death rate following hip fracture are due to the hip fracture itself (Johnell and Kanis 2005).

11.2.2: Results

The mortality rate for all participants of this study was 2% (n=4) at 1 month, 3% (n=7) at 3 months, 5% (n=11) at 6 months, 8% (n=18) at 12 months and 14% (n=31) at 2 years. There was a significant difference between the two groups at 6 months with more of the control group participants deceased than intervention group at this time point, χ^2 (1) = 5.2, p = 0.02. This difference continued at 15 months (6% Intervention group versus 15% of the control group) although was not significant χ^2 (1) = 2.7, p= 0.09.

In this study various conditions were associated with increased mortality. These include reduced cognition, gender, age, pre-admission residence, length of stay in hospital, discharge destination, reduced prefracture mobility and ability to self care, polypharmacy, reduced BMD at spine and presence of vertebral fractures.

There was a significant difference in the death rate of those with cognitive impairment and those with normal cognitive status. Fourteen percent of the cognitively impaired participants died within the 15 months compared to 9% of the cognitively intact participants, χ^2 (780) = 1221, p = 0.001.

The mortality rate at each time point was higher in males than females but was not statistically significant except at 6 months when there was a statistically significant difference.

1 month	χ^2 (1) = 1.22, p = 0.26
6 months	χ^2 (1) = 4.42, p = 0.03
12 months	χ^2 (1) = 1.50, p = 0.21
24 months	χ^2 (1) = 0.62, p = 0.42

Table 11.9: Pearson's Chi Square test results comparing mortality rate and gender in the study population.

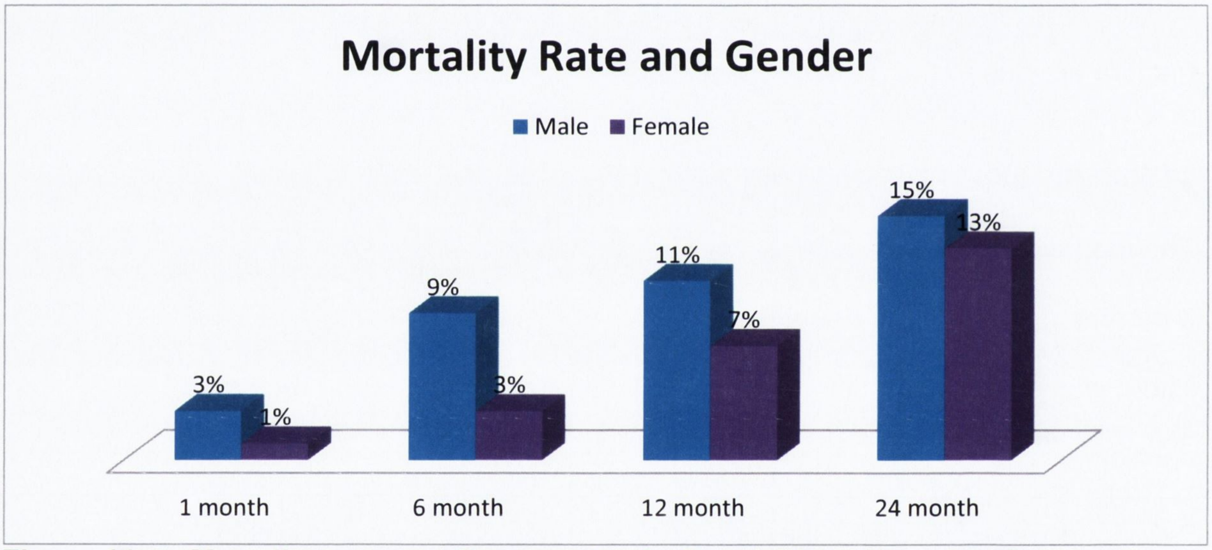


Figure 11.4 : Mortality rate and Gender at 1, 6,12,and 24 months post fracture in the study population.

Of those 79 years and younger 9% (n=8) died compared to 21% of those 80 years and older died within 2 years, this was statistically significant using Chi Square testing of data; χ^2 (1) = 6.7 p = 0.009.

Participants who initially were admitted from a long term care institute had a higher mortality rate than those admitted from home. 37% (n=3) compared to 14% (n=28); χ^2 (31) = 75.1, p = 0.001. Similarly, 32% (n=43), those who were discharged to a long term care institute died within 2 years while 16% (n=7) and 10% (n=13) of those discharged home and to a rehabilitation unit respectively died within 2 years from fracture date; χ^2 (189) = 418, p = 0.001.

Length of stay in hospital increased mortality rate with those with a longer stay at increased risk of dying within years post fracture, χ^2 (1134) = 1833, p = 0.001.

Significant difference was identified between those who had reduced mobility and reduced ability to self care prior to hospitalisation and those who were independent, with participants who experienced reduced mobility or ability to self care prior to admission at increased risk of dying within 1 year of fracture. χ^2 (90) =341, p = .001 (mobility) and χ^2 (666) = 1051, p = 0.001(NEADL) and χ^2 (195) = 403, p = 0.001 (ABS).

Polypharmacy also increased mortality. Those on 4 or more medications had an increased risk of dying than those on less medications, χ^2 (357) = 497.8, p = 0.001. Participants with lower bone mineral density (BMD) at the spine had an increased rate of mortality at 15 months post fracture as did those with vertebral fractures compared to those with normal BMD and no vertebral fractures.; χ^2 (702) = 773, p = 0.03 (reduced BMD at spine) and χ^2 (90) = 222, p = 0.001 (Vertebral fractures). Interestingly there was no significant difference BMD of the hip and mortality rate.

Chapter 12

General Discussion and Conclusion

12.1: General Discussion

In this study the main hypothesis we sought to test was that a multidisciplinary bone health and falls assessment and intervention, co-ordinated by a Clinical Nurse Specialist, at three months following hip fracture can improve post fracture outcomes, particularly fear of falling, in elderly persons over the course of one year. The secondary research questions included whether the above intervention could result in

- reduced disability and improved quality of life,
- increased osteoporosis knowledge, osteoporosis medication prescribing and adherence to this medication,
- reduced re-admission rate to acute hospital and placement in long term care facilities,

To establish this, a randomised control trial was carried out on hip fracture patients attending the study site from June 2008 to June 2010. Three hundred and ninety six patients were admitted to the study site in those two years of which two hundred and twenty six patients participated in the study. The overview of the excluded patients and the patients unwilling to participate in this study shows that those who were included were probably the healthiest and cognitively brighter. The majority of the excluded patients were excluded because of dementia or because they were unable to give informed consent. Two thirds of hip fracture patients admitted from long term care facilities were excluded from this study mainly for the previously mentioned reason.

The two hundred and twenty six participants of this study were randomised into intervention and control groups by means of a computerised minimisation programme.

Because of the selection criteria used, the group of patients recruited for the study tended to be cognitively bright, with those who had a MMSE score of 18 or under, excluded. This was to facilitate the completion of the various questionnaires. Gregory et al (2007) reported optimal specificity and sensitivity was obtained using a cut off of 18 on the MMSE, in assessing a person's capacity to create an Enduring Power of Attorney. As there were seven questionnaires to be completed by each participant in this study, this cut off point was enforced to ensure capacity to complete the questionnaires. Hence sixty seven (17%) of all hip fracture patients presenting to the study site were excluded on grounds of having a MMSE of 18 or below. As a result of this, very few participants in this study were classified as moderate or severe cognitive impairment. The majority of the participants recruited to this study had no cognitive impairment, while a third showed mild to moderate impairment on admission. This is below the previously reported prevalence of cognitive impairment in hip fracture patients of 42% and 54% as sited by Seitz et al (2011) and Schaller et al (2012) respectively. As cognitive function decreases with age (Deary et al 2009), it is unsurprising to observe it in this study. The proportion of participants with normal cognitive function markedly reduced with age. For example the vast majority of the 60-70year age group have normal cognition in this study compared to 67% of the over 80 year olds. Pre-fracture cognitive impairment and incident cognitive impairment during hospitalization are risk factors for poor functional outcomes (Gruber-Baldini et al 2003). In the UK, cognitive impairment is the cause for fourty percent of all cause admissions to institutional care (Deary et al 2009). Schaller et al (2012) found that hip fracture patients with mild to moderate cognitive impairment had a 7-fold increased risk of nursing home admission. In this study, over half of participants with any degree of cognitive impairment resided in long term facilities fifteen months post hip fracture compared to just over a third living at home.

Hip fracture has been recognised as being a major cause of morbidity and mortality for older adults and a contributor to the patient's loss of independence and reduction in their quality of life. They are a major and growing concern for future health systems. As the population ages, the number of fractures worldwide will double, and in some places triple, in the next 50 years. In addition, older patients are more likely to experience a hip fracture as they have the highest prevalence of osteoporosis and highest risk of falling. The vast majority of hip fractures are a result of a fall. Older people are more likely to fall secondary to poor muscle strength, gait disorders, impaired balance, poor nutritional status, poor vision, cognitive impairment, medications and co-morbidities, all of which can increase with age. Falls are common in the elderly population with one third of older adults falling at least once a year. This increases for people with previous falls and in this study we have identified a falls rate of thirty eight percent in patients following hip fracture. Considering that falls can have devastating effects for older people, leading to significant morbidity, mortality and increased use of health care services, assessment and instigation of treatment for risk factors is of utmost importance.

The vast majority of participants recruited for this study were admitted from home, with only 5% from long term care. Nearly half lived alone with the majority of those being women. The number of participants from long term care is lower than that reported in the UK NHFD (2010) where 17% of hip fracture patients were admitted from long term care. This may be accounted for by the exclusion of hip fracture patients with severe cognitive impairment as patients in long term facilities are more likely to have cognitive impairment compared to those living independently at home.

Of those admitted from home, a fifth resided in long term care facilities at 15 months post fracture. This is somewhat higher than the discharge rate to long term care from hospital in this study. Similar values were found by Gaughan et al (2013) in the UK who found that 14% of patients were discharged to long term care but somewhat lower than the UK's National Hip Fracture Database (NHFD) 2010 where the discharge to long term care rate was 23%. However, when place of residence was evaluated at three months, only 8% resided in such facilities, thus indicating that not all patients discharged from hospital to nursing homes, stay in these facilities long term. This suggests that it is important to evaluate the complete journey of care of hip fracture patients to provide a complete picture of recovery, and should be an important consideration when identifying ways to reduce mortality and morbidity following hip fracture. It also suggests that Nursing Home facilities in the UK are used as step-down or community rehabilitation facility which differs from Ireland where nursing homes facilitate long term care. Further evaluation of place of residence at 4 monthly intervals, identified an increase in placement in long term care at each time frame, with a quarter of study population living in a nursing home facility at fifteen months post fracture. Residence in a long term care facility at 15 months was associated with increasing age, reduced pre-fracture mobility and ability to self-care as measured by the Amended Barthel Score and Nottingham Activities of daily Living and reduced cognition in hospital.

This study identified women as being twice as likely to have a hip fracture as men. The high prevalence of hip fracture in men is an important finding as there is a fracture-related excess mortality, morbidity and institutionalisation which may be greater for men than for women according to Cummings et al 2006, Pande et al 2006. This excess mortality was identified in this study with men three times more likely to die in the first year post fracture. The reasons for this are unclear and further investigation into it was not in the scope of this study but would make an interesting basis for future study.

The average age of the patients included in our study was low (79 years) compared to the UK where the mean age was reported as 83 an 84 years respectively for men and women (NHFD 2010). Reasons for this are unclear, but influences such as nutritional status and socio-economic differences may play a role. The study site catchment area is deemed an economically deprived area with a large percentage of deprived elderly, 12,736 (51.1%). However, this mean age is similar to studies carried out in Europe (Haentjens et al 2001, Lonnroos et al 2006). Both age and pre-fracture residence strongly predict mortality as seen in this study. This may explain the lower mortality rate found in the study population which was 2% at 1 month, 5% at 6 months, 8% at 1 year and 16% at 2 years. Mortality following hip fracture has been the focus of many investigations carried out over the past 25 years. Although numerous studies have highlighted the increased mortality rate following hip fracture (Cauley et al 2000, Melton 2003, Richmond et al 2003, Empana et al 2004) controversy remains regarding the extent to which mortality may be reduced through hip fracture prevention because those at highest risk of hip fracture are frail and elderly and already at increased mortality risk. According to Haleem et al (2008) in a review of all articles published on the outcome after hip fracture over a four decade period (1959-1998), mortality after a hip fracture remains significant, being 11–23% at 6 months and 22–29% at 1 year from injury. Beringer et al (2006) and one year mortality of 22% in Northern Ireland. Trombetti et al (2002) reported that excess mortality occurred mainly in the first 6 months following fracture however Empana et al (2004) in the Epidos Study noted a continued excess risk. As seen in previous studies (Fransen et al 2002, Piirtola et al 2008, Panula et al 2011) men experience increased mortality risk in this study. Haentjens et al (2010) reported an absolute annual mortality rate of 8% for women compared to 18% for men in the first year following fracture, a trend that continues throughout the 10 years included in the study. The low mortality rate in this study is probably an underestimation because the sample probably contained the healthiest and least cognitively impaired subset of hip fracture patients. Mortality rate for all hip fractures admitted to the study site was 5% at one month which is in keeping with previous studies although the rate of 15% at 1 year is lower to a comparable study carried out by Beringer et al (2006) in Northern Ireland where a 12 month mortality rate of 22% was reported. Reasons for this are unclear but early access to surgery has been identified as one factor in decreasing mortality rates (Simunovic et al 2010). Eight two percent of participants in this study were operated on within 48 hours hence reducing complication rates. Also previous studies carried out by Thwaites et al (2005) and Vidan et al (2005) have shown that integration of clinical and multidisciplinary care pathways can decrease mortality and length of stay in hospital. More recently the Cochrane collaborative (Handoll 2009) has reviewed the evidence for multidisciplinary care in older adults with hip fracture and have indicated that there was a tendency to have overall better results in a multidisciplinary approach to hip fracture. Since 2004, the study site has had an orthogeriatric fracture liaison service available to all patients with a hip. Patients are reviewed post-operatively and the appropriate treatments are initiated by the orthogeriatric liaison team and all patients are followed up by the geriatricians in the bone health clinic which may have reduced complications and improved outcomes for patients.

According to Johansen et al (2010) every 10-year increase in age increased risk of death by 41% and the risk of death was reduced by 40% for patients admitted from their own home. In this study, age did appear to influence mortality as less participants under 79 years of age died within the year compare to those over 80 years. While this was not a significant difference, the difference between the two increased in the second year post fracture with 9% of the younger participants dying within 2 years of fracture compared to 21% of the older group. The reason for this is unclear but may again be due to the sample being probably the healthier and cognitively brighter subset of hip fracture patients and younger than their UK equivalent, hence surviving the first year. Where the participant was admitted from did have a significant influence on mortality however, with those admitted from long term care at increased risk of dying within the first year. Likewise, discharge destination, length of hospital stay and polypharmacy appeared to influence mortality rate. Those who spent longer in hospital, were discharged to a long term care facility and were on more than 4 medications had a higher mortality rate within 2 years of fracture. This may be explained by the fact that participants with increased co-morbidities will require more medications to stabilise their illnesses and are therefore more likely to be medically unstable and frail. They not only require longer hospitalisation but more than likely require long term care following stabilisation.

Likewise cognitive status also plays a role in mortality. Increased mortality in post hip fracture patients with reduced cognition has been highlighted in the literature. Schaller et al (2012) found that mild to moderate cognitive impairment hip fracture patients had a more than 5-fold increased risk of mortality while Bentler et al (2009) stated that patients with dementia were 45% more likely to die. This increase in mortality in patients with cognitive impairment was also identified in this study with cognitively impaired participants more likely to die within the first year than those with normal cognition.

Dubljanin-Raspopović and colleagues (2012) reported that pre-fracture motor FIM independently predicted mortality. In this study participants ability to mobilise and self care was associated with mortality with a reduced pre-fracture NEADL and Amended Barthel scores increasing the risk of mortality within 1 year post fracture compared to those participants with normal prefracture NEADL and ABS scores. Similarly, reduced bone mineral density has been cited as being predictive of increased mortality (Van Der Klift et al 2002, Mussolino et al 2003). Mussolini and Gillan (2008) found that low bone mineral density was associated with increased risk of death regardless of race or ethnicity. In this study reduced bone mineral density was associated with increased mortality with participants with lower bone mineral density (BMD) at the spine and with increased vertebral fractures having an increased mortality rate at fifteen months post fracture compared to those with normal BMD and no vertebral fractures. The reason for this association is unclear but some investigators have suggested that low BMD serves as a nonspecific indicator of frailty, ill health or other comorbidities (Browner et al 1991, Johansson 1998). It is notable that there was a significantly difference in mortality rate between the intervention group and control group at six months post fracture, with more deaths in the control group. However this difference had reduced somewhat by one year. Overall it would appear that the older, more frail and cognitively impaired participants had a higher mortality rate.

Total length of hospital stay is important largely because it is the main determinant of the overall cost of hip fracture care. In this study the mean length of stay (LOS) is higher than that reported in the UK which had mean length of stay of 26 days ranging from 12 to 38 days as reported in the NHFD National Report (2010) and also higher than that reported by Dodds and Mulhall (2009) who found an average LOS of 28 days. Why the LOS was longer in this study than in the previous studies is unclear but may be explained by some of the participants remaining on site for the rehabilitation period. Those who remain on site for rehabilitation tend to be medically unwell, have increased frailty and /or have more complex social problems. It may also be a reflection of the implementation and more comprehensive community support networks in the UK, which facilitates early discharge.

Osteoporosis is a skeletal disorder characterized by compromised bone strength, which predisposes the individual to an increased risk of fractures of the hip, spine, and other skeletal sites. Due to its prevalence worldwide, osteoporosis is considered as a serious public health concern. Approximately 40-50% of postmenopausal women and 13-20% of men over 50 years of age will suffer an osteoporotic fracture in their lifetime (Johnell and Kanis 2005). In this study, the vast majority of participants were diagnosed with osteoporosis and many had a previous fragility fracture. Advancing age and prior fragility fractures are markers of low bone mass in our patients. Lateral vertebral assessment

(LVA) was used as a diagnostic tool for the identification of vertebral fractures in patients attending for DXA. While vertebral fractures are common in the elderly (Ensrud 2000), it has been demonstrated that between two thirds to three quarters of people with vertebral fractures are unaware of their presence and do not come to clinical attention (Angeli et al 2006). In this study a third of participants had vertebral fractures diagnosed for the first time. Not all those vertebral fractures had osteoporosis as just over a fifth were diagnosed with osteopaenia. This highlights the need for LVA to be performed on all patients attending for DXA scan to ensure all patients who require bone protection therapy receive it. Suboptimal treatment of osteoporosis is well highlighted in the literature (Kiebzak et al 2002, Luthje et al 2009). However in this study the percentage of participants on bone protection medication at three months is high which is encouraging and may be attributed to the commencement of therapy by the orthogeriatric liaison team in hospital.

Bone protection therapy, usually in the form of antiresorptive medication that increases bone mineral density has been shown to be both effective and cost effective in the prevention of future fractures. Assessment of all patients following fracture, for the need of such medication has been recommended by the BOA and BGS (http://www.nhfd.co.uk/003/hipfractureR.nsf/) in their evidence based standards on care for patients with fragility fractures. In this study, while the number of participants taking bone protection medication prior to fracture was higher than that reported by the NHFD (2010) it remains suboptimal. Of those who had a previous fragility fracture only a fifth were on bone protection medication on admission, representing a missed opportunity to treat these patients. Clearly this care gap needs to be bridged. Possible remedies may include better education for healthcare professional on osteoporosis and the efficacies of treatment, better communication between tertiary and primary care teams and clearly defined care pathways that involve patients and their carers. The proportion of patients on bone protection medication increased greatly at the three months assessment, with the vast majority taking calcium and Vitamin D supplements and this was maintained at 15 months. This three month rate is higher than that reported by the NHFD (2010) of 57% of patients on discharge on bone protection. This high rate of treatment is probably due to the fact that all hip fracture patients are seen by an orthogeriatric registrar and clinical nurse specialist within a week of admission when they are usually started on bone protection medication unless it is contra-indicated. The high adherence of the study population on bone protection medication and calcium and Vitamin D supplementation at fifteen months is encouraging and may, in part, be due to the four monthly telephone calls made to the study participants to complete the questionnaires. It represents a higher adherence rate than the 50% reported in developed countries published by WHO (2003).The control group were less likely to be taking such medication at fifteen months compared with the intervention group. This may be explained by more of the intervention group attending earlier appointments to the bone health clinic. This reflects findings by Ho et al (2009) who reports increased compliance with medication with increased number of contacts with the healthcare system.

The most common bone protection medication prescribed was oral bisphosphonates follow by intravenous bisphosphonates. Adherence or compliance to medication usually refers to whether patients take their medications as prescribed while persistence refers to the overall duration of drug therapy (Ho et al 2009). High adherence with bisphosphonates decreases fracture risk at both hip and major fracture sites as stated by Curtis et al (2012). In this study the vast majority of participants reported a high adherence rate at fifteen months. The high rate of persistence found in this study may be due to the fact that the participants were attending a specialised bone health clinic following their hip fracture and also received four monthly telephone calls requesting information on what osteoporosis medication they were taking. A previous study carried out in the study site identified an increase in primary care prescribing of anti-osteoporotic medication after fragility fracture following the introduction of the osteoporosis clinic in the study site (McGowan et al 2011).The rate of prescribing of calcium/vitamin D supplementation and bone protection both prior to admission and on discharge, while higher than the UK average, however, remains suboptimal. Reasons for not commencing anti-osteoporotic medication following hip fracture include unwillingness or inability to attend for follow-up treatment or not requiring treatment based on risk factors and BMD levels as reported by Cuddihy et al (2002) and Kuo et al (2007)

Vitamin D deficiency is a major health problem for adults over 50 years (Mithal et al 2009) and higher levels have been associated with optimal bone health, regulating bone turnover and reduction in falls (Kinyamu et al 1997, Holick 2004).It has been linked to the pathogenesis of osteoporosis and is increasingly thought to play a role in muscle strength, certain cancers, multiple sclerosis and diabetes. Serum 25-hydroxyvitamin D (25(OH)D) is the most common biomarker used to assess vitamin D status. Cauley et al (2008) reports that low serum 25(OH)D concentrations are associated with a higher risk for hip fracture while Gerdham et al (2005) found that Swedish women with 25(OH) vitamin D <52.5 nmol/L had a two-fold increased risk of fracture. There is much debate on the optimal level of serum 25(OH)D. In 2010, the International Osteoporosis Foundation (IOF) published recommendations for the optimal serum vitamin D level to be above 75nmol/L while vitamin D deficiency is considered to be a serum level of (25(OH)D) <50 nmol/L (Dawson-Hughes 2010). Only a third of participants in this study had serum 25(OH)D levels above this optimal value with seventy percent deficient. Low levels of vitamin D is thought to contribute to increased fracture risk by influencing muscle mass and balance, both of which contribute to falls and disability (Dhesi et al 2004), and by increasing bone turnover and bone loss which influences bone quality (Lips 2001).

Serum Calcium levels can reflect calcium intake and absorption. Normally serum calcium is very stable, however when dietary calcium levels is inadequate (<600mg /day in young adults) and /or intestinal calcium level is abnormal, serum calcium is kept stable by gradual depletion of bone calcium stores. (Houillier et al 2006). Low serum calcium results in an increase in PTH secretion which in turn simulates calcium release from bone tissue. In this study forty percent of participants had low serum calcium levels. Calcium is one of the main bone-forming minerals and an appropriate supply to bone is essential at all stages of life. Unsurprisingly, thirty three percent of these participants had reduced BMD. Supplementation of both Calcium and vitamin D is important for patients following hip fracture. However the dose of vitamin D required depends on several factors such as baseline serum 25 (OH)D levels, exposure to sunlight, body mass index and vitamin D metabolism. According to Dawson-Hughes et al (2010), for individuals with effective sunlight exposure, a dose of 800 IU/day vitamin D3 may be sufficient. However, patients with obesity, a history of falls, known osteoporosis and limited sun exposure may require higher doses of vitamin D3. Because of the variability in individuals responses to supplementation it is important to retest serum 25(OH)D levels. All our patients were followed up in the bone health clinic where serum and urinary calcium levels were measured as well as vitamin D levels and supplementation altered as required.

Fractures are the most devastating problem facing people with osteoporosis (Leibson et al 2002) with hip fractures being the most disabling type of fracture (Kanis and Johnell 1999) Fractures and their related complications can trigger a downward spiral in health with hip fractures resulting in two million person-years of permanent disability (Chrischilles et al 1994). Therefore the prevention of osteoporosis and fractures must be of utmost importance for healthcare providers. Although some studies have found there to be no relationship between knowledge and preventative actions (Jalili et al 2007) many studies have highlighted the positive effect knowledge has on preventative measures. (Yu and Huang 2003, Werner 2005). However, while education improves knowledge, behaviourial changes do not always follow (Sedlak 2000). Likewise Edmonds et al (2012) states that while knowledge of osteoporosis is limited in all populations, even if an individual has knowledge of osteoporosis, it does not increase the likelihood he/she will engage in the preventative behaviours. Other important issues to be considered are the person's feelings of susceptiblity, the person's feelings of severity of osteoporosis and their view of the benefits and barriers to medication intake. In this study there was a high medication adherence and persistent rate which may reflect the participant's perceived seriousness of osteoporosis and its consequences. It may also reflect participant's belief in the benefit of taking of anti-osteoporotic medication. Osteoporosis knowledge was comparable between the two groups at 15 months however attendance at the bone clinic did increase knowledge which may indicate that the supply of written and verbal information was beneficial to osteoporosis knowledge regardless of who gave it.

Research studies have shown that recovery in physical functioning occurs in the first 4-6 months after hip fracture with little gain after 6 months (Shyu et al 2004) while recovery in social functioning continues up to 1 year after hip fracture. Contrary to this, we found that mobility improved throughout the year following fracture particularly in the intervention group. Pre fracture independence in mobility was high in our study group compared to UK hip fracture patients (NHFD 2010). This may be a reflection of our participant's younger age than the UK and increased cognitive status than the overall population of hip fracture patients attending the study site. Only twenty percent of our participants returned to independent mobility at 15 months which, while disappointing is comparable to previous studies (Visser et al 2000, Bertram et al 2011). This reduction highlights the huge impact hip fracture can have on the elderly person's ability to mobilise post fracture and poises the question as to whether hip fracture patients in the study site are receiving enough rehabilitation or community resources. The mobility section of the Nottingham Activities of Daily Living Scale which includes ability to walk outside, climb stairs, cross roads and travel on public transport amongst others showed a significant sustained reduction in mobility at 15 months. Reduction in this area reflects a reduction in a person's ability to carry out instrumental activities of daily living and may identify increased social isolation experienced by hip fracture patients.

Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADLs) were measured using the Nottingham Extended Activities of Daily Living (NEADL) and the Amended Barthel Score (ABS) in this study. The ABS measured the basic activities of daily living such as eating, bathing, toileting and dressing while the NEADL measured IADLs. The latter are tasks that, in addition to activities of daily living, a person must be able to perform without the assistance or substantial supervision of another person, in order to live independently. Examples include grocery shopping, meal preparation, using the telephone, laundry, light housekeeping, bill paying, and managing medications. The capacity to handle these complex functions normally is lost before basic "activities of daily living" e.g., eating, bathing, toileting. Therefore, assessing IADLS may identify incipient decline in older adults or other individuals who are otherwise capable and healthy (Graf, 2008). Lin and Chang (2004) identified IADLs such as walking outdoors and doing house work as predictors for outcome following hip fractures. Several studies have highlighted a reduction in a person's ability to carry out ADLs and IADLs following hip fracture (Lin and Chang 2004, Soderqvist et al 2006, Bentler et al 2009, Bertram et al 2011) which in turn can reduce a person's ability to remain at home independently.

This study identified a statistically significant reduction in all domains of the NEADL i.e mobility, kitchen activities, domestic tasks and leisure activities. Such reductions indicated substantial declines in functional status and highlights the huge impact hip fracture can have on an older person's ability to live independently at home. Overall the older hip fracture patient experienced more disability in activities of daily living at 15 months following hip fracture particularly in the domains of grooming, mobility, dressing, stairs and bathing. This is important as it may represent an increase in frailty that could negatively influence a person's ability to live at home independently and suggests the need for prolonged rehabilitation programmes in the community for older adults following hip fracture.

Reduced mobility and ability to self care can result in, and be exacerbated by, fear of falling (FOF). Fear of falling is common in older adults, even in people who have not had a fall (Scheffer et al 2008). Several studies have revealed that the prevalence of the fear of falling in the older population varies from 20% to 85% (Legters et al 2002, Zijlstra et al 2007, Scheffer et al 2008) and that a history of falls is considered the main risk factor for the manifestation of fear (Salkeld 2000). This fear may be protective initially, motivating some people to take precautions against falls such as gait adaptations that increase stability. For others, fear can lead to a decline in overall quality of life and increase the risk of falls by imposing limitations and increasing lack of confidence. As expected, similar to other studies, FOF was high in this study with older women reporting FOF more than men at 3 months post fracture. This difference decreases by 15 months presumably because the rate of FOF at 15 months in the intervention group had significantly reduced while remaining high in the control group. This difference between the groups may be due to the intervention group having more contact with the multidisciplinary team in the form of day hospital attendance and physiotherapy sessions than the control group.

Kumar et al (2008) showed an association between the fall efficacy, balance performance and the functional mobility in the elderly people. This association was identified in this study with those who were using assistive devices to mobilise at 3 months reporting greater FOF than those who were independent. Similarly, reduced mobility as measured by the NEADL, was associated with increased FOF. Cumming and colleagues (2000) reported that low baseline FES scores in community-dwelling elderly people were associated with greater declines in self-reported ADL performance over a 12-month period. This was reflected in all domains of the NEADL, where a reduction in a person's ability to carry out tasks was associated with increase in FOF. Likewise a reduction in Amended Barthel score at 15 months was associated with increased FOF in this study as was depression at 15 months. This relationship between reduced mobility and ability to self care and FOF has important implications for the development of rehabilitation programmes for older adults following hip fracture. The high level of FOF in participants of this study at 15 months would indicate the need for ongoing measures to assess and treat FOF well after the initial fracture. Overall it would appear that older women with reduced mobility and ability to self care and with low mood experience greater FOF.

An increase in depression in older adults has been shown in previous studies. Depression is a mood disorder, characterized by cognitive, behavioural, somatic and affective impairments that affect functional activity and social participation of a person. It is common in patients with hip fracture with prevalence ranging from 9%-47% (Oude-Vashaar et al 2007) and when associated with hip fracture it can greatly reduce functional outcomes according to Lolascon et al (2011). Anxiety, according to Bruggemann et al (2007) has been largely overlooked in studies that specifically measure illness perceptions. According to Phillips et al (2013), depression following hip fracture is associated with greater physical frailty and poorer long term recovery post-injury. Both depression and anxiety, while common in older adults in Ireland as reported by O'Regan et al (2011) as part of the Irish longitudinal study on ageing, would appear to be under diagnosed and hence under-treated. They report that ten percent of the Irish population report clinically significant depressive symptoms while thirteen percent report clinically significant anxiety symptoms. Also, they found an association between depression and increased disability, increased medication use and increased health service utilisation. In this study both depression and anxiety were commonly reported both at three and fifteen months following fracture with approximately a third of participants reporting above normal levels of anxiety and depression at three months. While the levels of anxiety and depression improved in the intervention group over the study period they remained high in both groups at fifteen months. The overall level of anxiety (27%) and depression (28%) expressed at fifteen months is higher than the 13% and 10% respectively reported by O'Regan et al (2011) in the older general Irish population. This highlights the detrimental effect hip fracture and its outcomes can have on the mood of patients. The control group were more anxious at fifteen months than the intervention group. The reason for this is unclear but may be explained by the control group having less health service contact than the intervention group participants over the study period.

Current evidence in the literature suggests a strong bi-directional relationship between depression and disability (Blazer 2009). Pinninx et al (1999) identified that depression was associated with reduced activity of daily living and mobility levels. This association was seen in this study. Seventy nine percent of those who expressed higher than normal levels of anxiety and depression required assistive devices to mobilise compared to sixteen percent of those who were independent in mobility. Likewise, there was an association between higher than normal levels of anxiety and depression and a person's ability to self-care. Those who had above normal levels of anxiety and depression tended to have lower scores in each domain of the NEADL and ABS. Higher than normal levels of depression in particular was significantly associated with lower scores in the Kitchen domain of the NEADL and Amended Barthel Scores. This highlights the negative impact anxiety, but in particular depression can have on patient's outcomes post hip fracture. More woman than men reported higher than normal levels of depression. This is consistent with findings in psychiatric epidemiology studies which show that the prevalence of depression is higher in older women than in older men, but the sex difference diminishes in older adults compared to the twofold difference seen in younger adults. (Hasin et al 2005).

In this study participants who had above normal anxiety and depression levels reported lower scores in some of the domains of the SF-36. Previous quality of life studies in patients with hip fracture have shown that health related quality of life (HRQOL) decreases after a hip fracture (Randell et al 2000, Peterson et al 2002, Brenneman et al 2006, Pande et al 2006, Hallberg et al 2009). Salkeld et al (2000) stated that hip fractures can have a profound effect on quality of life among older women while reporting that eighty per cent of women surveyed would rather be dead than experience the loss of independence and quality of life that results from a bad hip fracture and subsequent admission to a nursing home. Any reduction in independent living in the community has a detrimental effect on the person's quality of life. A similar reduction was seen in the study with reported quality of life below the norm based values for all domains of the SF-36 except for vitality and mental health domains. This differs to results of the Irish Longitudinal Study (2011) which reported a high quality of life in the general ageing population (50 years and over) highlighting the detrimental effect hip fracture can have on an older person's quality of life. As reported by the participants of this study age, pre fracture function and increased anxiety and depression were associated with lower scores in quality of life. This is reflective of previous study results were these parameters were associated with reduced quality of life after hip fracture (Young et al 1997, Shyu et al 2003, Lenze et al 2007, McGee et al 2011, Phillips et al 2013). Likewise, the effects of impaired mobility along with reduced functional and social independence are reflected in the diminished QOL perceived by participants. The adverse impact of hip fracture on quality of life and functionality needs to be recognized by health personnel in the community, so that adequate health resources can be devoted to preventing and treating this debilitating condition. While there was a significant difference identified between the two groups at fifteen months in all except one (mental health) of the domains of the SF-36, both groups disappointingly remained below the normative values. Reasons for this may be the reduction in functional outcome experienced by both groups and the high level of pain, anxiety and depression, reported by both groups at fifteen months. Hence, it is important that caretakers and professionals recognize not only the physical, but also the psychosocial repercussions on the elderly with a hip fracture. Physical rehabilitation programs and emotional and social support should be provided early and continued long after the initial fracture. The negative impact on the HRQOL observed in our patients can guide programs for the rehabilitation and health care of elderly people with a hip fracture.

Malnutrition is common in elderly patients attending hospital and in hip fracture patients in particular (Lumbers et al 2001, Eneroth 2005). Aging itself, is associated with malnutrition due to reduction in taste and smell, impaired oral health and deterioration in physical activity. Also medical factors such as various diseases, lifestyle factors such as poverty and factors such as dementia or depression have been described as risk factors for malnutrition (Hickson 2006). Malnutrition is especially common in hip-fracture patients and is associated with postoperative complications, (Pérez et al 2010) and increased mortality (Carpintero et al 2005, Pioli et al 2006). Although malnutrition rates were high in this study with 40% at risk of malnutrition at 3 months, of which 14 % were malnourished it compares well to previous studies. The European Nutrition for Health Alliance (2008) reported that up to 40% of older adults were undernourished on admission to hospital while Best (2011) reports that more than one in three adults are malnourished on admission to hospital or care homes in the UK. Deterioration in nutritional status during a hospital stay has been well documented in the literature (Braunschweig et al 2000, Norman et al 2008). Previous studies have highlighted gender difference in the risk of malnutrition with men more likely to have a poorer nutritional status (Carpintero et al. 2005). In this study we found that women were more likely to be at risk compared to men particularly at 3 months after fracture. However this gender difference was reduced at 15 months. Overall findings from this study would suggest that reduced pre-fracture mobility, reduced ability to self care, increasing age and female gender are associated with malnutrition. The intervention group were significantly less likely to be at risk of malnutrition at 15 months than controls, possibly because they received referral to a dietician. Pre-fracture nutrition was not assessed in this study however those with longer hospital stays were more likely to be malnourished at 3 months. Whether these patients were malnourished prior to, or during their stay, or whether the length of stay decreased their nutritional state we cannot say. We can report that being at risk of malnutrition at three months following fracture did increase mortality rates in this study though not significantly, with one in ten patients who were at risk of malnutrition at three months dying within the 15 month study period compared to none with normal nutritional status.

Malnutrition and increased risk of malnutrition is common in our hip fracture patients and is seen to have detrimental effects on outcomes. Causes of malnutrition in older people are not only clinical, they are social and psychological as well. Malnutrition is under-recognised and under treated therefore screening is essential.

12.2: Limitation

This study had some limitations. Firstly, the lack of data collection on pre-fracture function particularly on health related quality of life, cognition, nutritional status, fear of falling and anxiety and depression levels limits the analysis of these assessments. Also, pre fracture mobility and ability to self care was assessed retrospectively in hospital which may have been over or under reported by the patients.

Secondly, because there were eight questionnaires to be completed by participants it was decided that a MMSE of 18 and above would be utilised in this study. This, added to the age restriction and other exclusion criteria had the effect of excluding one hundred and seventy hip fracture patients attending the study site. This had the effect of reducing the amount of data collected in the very old and frail patients, those with dementia and young patients who fractured their hip.

Thirdly, comparing between countries has its own difficulties as geriatric rehabilitation and long term care differs between countries. Nursing homes in the UK and some European countries provide ongoing inpatient rehabilitation with a onward plan for patients to go home eventually whereas in Ireland nursing homes are largely used for long term care only, hence comparing discharge destinations between countries can be misleading.

The study site has trained medical staff in osteoporosis which may not be reflective of other hospitals in the country. Few hospitals in Ireland have a dedicated orthogeriatric liaison team to assess patients with hip fractures or follow up of these patients in a dedicated bone health clinic. All hip fracture patients in the study site are invited to attend a bone clinic appointment under the care of geriatricians with a special interest in bone health. Therefore, the comparison between the intervention and control group in this study is somewhat limited to the time period between first pre-assessment appointment with a clinical nurse specialist and fast tracking to the bone health clinic.

12.3. Recommendations

Whilst this study is an extensive assessment of physical and psychological aspects of recovery from hip fracture in older adults in Ireland, it should be used as a base from which to build upon, to provide a more complete picture of hip fracture outcomes throughout the island of Ireland. This study has provided a unique insight into the outcomes of an older Irish population following hip fracture and, as such, provides a basis for recommendations for practice and education.

12.3.1: Practice

Early assessment of hip fracture patients in a bone health clinic under the auspices of geriatricians, can be seen from this study, to improve mobility, quality of life, mortality, fear of falling, medication persistence and nutrition and hence should be incorporated into the follow up of these patients. All hip fracture patients should be cared for under the shared care of the orthopaedic and care of the elderly teams as this has been identified as the optimal care package for these patients. While some of the larger centres in Ireland have an orthogeriatric service, it is important that it is extended to all units caring for hip fracture patients.

Service providers should develop a dedicated fracture liaison service in all hospitals providing treatment for people who fracture. This would allow for the provision of cost effective targeting of secondary fracture prevention. While this is an area under active development in Ireland it is important that it is extended to all hospitals as a matter of urgency. Clinical Nurse Specialists are ideally positioned to fulfil the role of fracture Liaison Leader. The role of the Clinical Nurse Specialist was central in this study in coordinating care, providing continuity of care and maximising the teams impact on patient outcomes. This role needs to be introduced and developed in all centers treating hip fracture patients.

Registered Nurses (orthopaedic, geriatric and Public Health) should develop a professional network at local, regional and national level to provide a platform for discussion on acute, rehabilitative and ongoing community care issues arising when looking after patients who fracture, particularly hip fracture patients. This could be facilitated through the National Council for the Professional Development of Nurses and Midwives.12.3.2: Education

Third level colleges should develop an orthogeriatric programme at higher diploma level. Until this is developed, the introduction of an orthogeriatric care of older adults who fracture, particularly hip fractures module should be incorporated into the MSc. in Gerontology course.

A Clinical Nurse Specialist role in orthogeriatrics should be developed to cater for the unique needs of the older person who fractures, particularly for those who fracture their hip. Advanced Nurse Practitioners should be encouraged to practice in a clinical nursing role in fast tracking admission of hip fracture patients, identifying post operative complications, providing information to patients, their carers and staff in direct care of these patients and co-ordinating care from the many disciplines hip fracture patients require. It is the opinion of the researcher that co-ordination of the multiple aspects of care required for these complex patients is the key to obtaining best possible outcomes for all hip fracture patients.

Hip fractures are costly for both the patient and healthcare provider. Implementation of a quality cost effective service based on the above recommendations would improve outcomes for all involved in the care of older people who fracture their hip.

12.4. Recommendations for Further Research

Some areas of concern have come to light in the results of this study. It is important that further research is conducted in these areas to attempt to find solutions to rectify them. The areas of concern that came to the fore in this study are discussed below.

12.4.1: Pain Management

Pain would appear to be a longstanding problem reported by a third of the study population at 15 months post fracture. Because of the negative effects of pain on quality of life, mobility and functional status, it is important that adequately powered multi-center research studies provide a comprehensive assessment of safe, effective, and appropriate pain management following a hip fracture. These studies need to assess pain for long periods post fracture to identify if early pain management improves functional recovery and quality of life.

It is also important that those with reduced cognition and those in nursing home facilities, who make up a substantial proportion of the overall hip fracture patient population and who tend to be the frailest and the highest risk for subsequent fractures, are included in these studies.

Standardised and validated measures of pain assessment would allow for meaningful comparison across different studies and interventions.

12.4.2: Management of Hip Fracture patients

Hip fracture occurs mainly in older adults and is associated with morbidty, increased mortality and reduced quality of life. Whilst geriatric and orthopaedic collaboration (orthogeriatric) co-management of older fracture patients has been highlighted as beneficial and recommended by the organisations such as the Cochrane Collaboration, NICE and British Orthopaedic Association & British Geriatrics Society in their Blue Book on the Care of Patients with Fractures, the extent of this practice in Ireland is unknown.

By establishing a high level of care for older adults with hip fracture, a reduction in morbidity and mortality that is associated with hip fractures would be expected. As orthogeriatrics has been organized in different ways it is important that further study is carried out to determine the best model of orthogeriatric collaboration and whether these partnerships improve functional outcomes in an Irish setting.

The study site is a tertiary centre with an established model of care for looking after people with hip fractures. It is a good example of where geriatricans and orthopaedic surgeons work closely together in looking after hip fracture patients to good effect with a significant reduction in mortality rates as seen in this study (Mortality rate in this study was 8% for the study population and 12% for the hip fracture population attending the study site at 12 months). Although there are areas that require improvement, this model of care could be replicated in other hospitals to produce similar reductions in mortality following hip fracture in older adults.

12.4.3: Follow up of Hip fracture Patients

As highlighted in this study, hip fracture has a devastating effect on an older person's ability to mobilse, self care and ultimately their ability to live independently at home. Whilst assessing the availability of community physiotherapy and occupational therapy was not within the remit of this study, it is an important area for hip fracture patients as much of their recovery occurs over an extended period of time, most for which the patient is community dwelling. Further research into the availability and utilisation of these services is required to ensure that the best outcomes for each individual are obtained. While there is no strong consensus for hospital based or home based physiotherapy, the latter would be more suitable to those who are more frail or unable to attend for outpatient physiotherapy. It has been shown that home physiotherapy is preferential to no physiotherapy (Mehta and Roy 2011) hence the availability of these services is imperative for these people to ensure best outcomes. Whether this therapy is delivered as community care or as part of an outreach programme from the acute hospital should be researched in the near future.

12.4.4: Psychological Aspect of Hip Fracture Recovery

Many studies concentrate on the physical recovery after hip fracture. This study has also reported on the psychological effects experienced by hip fracture patients. These psychological effects include an increase in fear of falling (61% of the study population at 15 months reported moderate to severe fear of falling), increased anxiety (27% reported increased anxiety levels) and increased depression levels (28% reported increased levels of depression). These are important findings as each one of these psychological states can reduce independence in activities of daily living and have a negative effect on quality of life.

Further research into alternative therapies to reduce fear of falling and anxiety should be pursued. Possibly, trials on what effect a clinical psychologist would have on reducing such negative psychological effects would produce interesting data in this area and add to the knowledge base. Likewise, research into the early treatment of depression and its effect on patient's outcomes would be welcomed.

12.4.5: National Hip Fracture Audit

The introduction of the National Hip Fracture Databases in the UK and other European countries have resulted in improved care and reduced healthcare costs. Audit of care delivered in individual hospitals has been proven to improve hip fracture care both locally and nationally. While there is a national hip fracture database in Ireland there is a need for more hospitals to participate in the downloading of information on their hip fractures. This data collection system is principally concerned with data from the acute phase of hip fracture care. While this is very important data to be collected, there is a national shortfall in the collection of longitudinal data on hip fracture outcomes, on follow up of hip fractures, and on services availability and utilisation beyond the acute phase. This study has brought to light the long term effects experienced by hip fracture patients. It is important that one and even two year follow up data and mortality rates are included in this data collection so that an extensive country wide picture can be formulated to allow for good quality cost effective treatment to be delivered nationally.

12.4.6: Non Attendence at Bone Health Clinic

Outpatient non-attendance is a source of inefficiency, wasting of time and resources and the lengthening of waiting lists. Non-attendance at outpatient appointment is considered an indicator of poorer access to health care services and may lead to worse health outcomes, increasing health costs and waiting times. Nearly one third of the study population did not attend for their bone health clinic appointment as a result of reduced mobility, cognitive impairment or long term care residence.

Further research is required to identify not only the reasons for non attendance but also possible solutions such as outreach programmes in the community and nursing homes to improve physical and psychological outcomes following hip fracture and /or the provision of suitable transport to enable these patients to be brought to and from the hospital for follow up.

In order for health service providers to be able to allocate adequate resources to the management of hip fractures, accurate figures for fracture rates and outcomes should be measured. Given the current economic climate, methods need to be employed to reduce non-attendance.

12.5. Conclusion

Hip fracture has major contributor to mortality, morbidity and reduced quality of life in older adults. In this study we sought to establish if a multidisciplinary bone health and falls assessment and intervention, co-ordinated by a Clinical Nurse Specialist, at three months following hip fracture can improve post fracture outcomes in elderly persons over the course of one year. From the findings, it would appear that a Clinical Nurse Specialist's coordinated care package involving the multidisciplinary team did improve some aspects of recovery for hip fracture patients including those of mobility, fear of falling, anxiety, nutrition, quality of life, medication adherence and mortality.

Improved mobility - more of the intervention group (22%) were independent without aids at fifteen months post fracture compared to controls (17%). **Improved Fear of falling** – the control group had a greater fear of falling than the intervention group. Severe fear of falling was experienced by 56% of the control group at 15 months compared to 17% of the intervention group. **Improved anxiety levels** - there was a tendency for more of the control group to have above normal levels of anxiety (30%) compared to the intervention group (23%), however this was not statistically significant. **Less risk of malnutrition** - the control group was at increased risk of malnutrition compared to the intervention group at 15 months (55% versus 28% respectively). **Improved quality of life**: At 15 months the intervention group reported a higher quality of life in each of the SF-36 domains than the control group. **Improved mortality** - the control group had a higher mortality rate at 15 months (15%) compare to the intervention group (6%) however this was not statistically significant. **Improved medication persistence** - the intervention group were more likely to be taking bone protection medication than the control at 15 months following fracture.

While these results are encouraging and may be used to enhance rehabilitation efforts, much is needed to improve overall outcomes for older people with hip fractures. This study has highlighted the detrimental effect hip fracture can have on the older person. It showed a significant reduction in mobility and ability to self care in these patients which can lead to reduced independence and ultimately increased admission to long term care facilities. It identified a reduced quality of life reported by these patients with a third reporting persistent pain and over one third reporting severe fear of falling fifteen months post fracture and it highlighted the high incidence of osteoporosis and vertebral and non vertebral fractures experienced by this group of patients. The high numbers of participants reporting pain fifteen months post fracture is worthy of in depth investigation to identify if the pain is specifically fracture related or more generalised in nature. While the participants were asked about specific fracture related pain, the use of the numerical rating scale alone is limited to the reporting of the severity of the pain and does not allow for the timing of the pain i.e, if it is persistent or intermittent, activity related or positional. Similarly the high rate of non attendance to the bone clinic is a worrying aspect of the study which will require further study to identify the reasons for and possible remedies of this phenomenon. But while the non attendance rate was similar to that of the general outpatients for the study site, non participation in the study was an interesting and unexpected result of this study. Fourteen percent of hip fracture patients attending the study site declined to participate for various reasons. While it was not the remit of this study to decipher the reasons why, unfavourable attitudes towards research, uncertainty about ability to participate and transport barriers seemed to dominate. Further study of this aspect of research in older adults could provide helpful insight which may enhance participation rates in future studies of this population.

On the positive side, this study has highlighted the fact that an early coordinated assessment involving the multidisciplinary team will result in better outcomes for older hip fracture patients. The improvements in quality of life, mobility, fear of falling, osteoporosis treatment and mortality are important findings in this study and highlight the need for the establishment of a fracture liaison service in all hospitals treating people who fracture. Due to the complex nature of the older person with hip fracture, a coordinator of care would allow for more integrated, supervised passage of care for the older person through the health system from fracture to rehabilitation and beyond. The clinical nurse specialist has been identified as the discipline most suitable to coordinate this care package. The role of the clinical nurse specialist is of utmost importance in this service and as such needs to be supported and expanded. This role should be incorporated into the orthogeriatric service which should always underpin care for the older fracture patient. The specific orthogeriatric package for each hospital will depend on the services and facilities available to them but should include a fracture liaison service. This package should also include primary care where the assessment, onward referral and treatment of osteoporosis and falls prevention will reduce future fractures.

The challenge is therefore to formulate research-based strategies with the most efficient mix of possible interventions, such as improved rehabilitation, falls prevention, use of medication to protect and strengthen bone and control and manage pain and psychological measures to improve fear of falling, anxiety and quality of life.

This is the first comprehensive study on the medical, social and psychological impact of hip fractures on older adults carried out in Ireland. Therefore, it is imperative that findings such as reported in this study are addressed when planning future care of hip fracture patients in Ireland.

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Appendices

Appendix I

Facts on Osteoporosis Quiz

Osteoporosis refers to weakened bone strength. It is commonly called 'brittle bone' because this disease increases the risk of bone fractures. Please read the following statements and tick the appropriate answer.

	True	False	Don't Know
1. Physical activity increases the risk of osteoporosis			
2. High impact exercises (weight training) improves bone health			
3. Most people gain bone mass after 30 years of age			
4. Low weight women have osteoporosis more than heavy women.			
5. Alcoholism is not linked to the occurrence of osteoporosis			
6. The most important time to build bone strength is between 9 and 17 years of age.			
7. Normal bone loss speeds up after menopause.			
8. High caffeine combined with low calcium intake increases the risk of osteoporosis			
9. There are many ways to prevent osteoporosis.			
10. Without treatment 1 in 5 women older than 50 years will break a bone due to osteoporosis in their lifetime.			
11. There are treatments for osteoporosis after it develops			
12. A lifetime of low intake of calcium and vitamin D does not increase the risk of osteoporosis			
13. Smoking does not increase the risk of osteoporosis.			
14. Walking has a great effect on bone health			
15. Osteoporosis affects men and women.			
16. Early menopause is not a risk factor for osteoporosis.			
17. Replacing hormones after menopause cannot slow down bone loss.			
18. Children 9 to 17 years of age get enough calcium from 1 glass of milk a day to prevent osteoporosis			
19. Family history of osteoporosis is not a risk factor for osteoporosis.			

Appendix II

Nottingham Extended ADL index

Name: MRN: Date:

Please read the following questions and tick the most appropriate box.

QUESTIONS	Not at all	With Help	Alone with difficulty	Alone easily
Mobility Do you: walk around outside? climb stairs? get in and out of the car? walk over uneven ground? cross roads? travel on public transport?				
In the Kitchen Do you: manage to feed yourself? manage to make yourself a hot drink? take hot drinks from one room to another? do the washing up? make yourself a hot snack?				
Domestic tasks Do you: manage your own money when you are out? wash small items of clothing? do your own shopping? do a full clothes wash				
Leisure Activities Do you read newspapers or books? use the telephone? write letters? Go out socially? Manage your own garden@ Drive a car?				

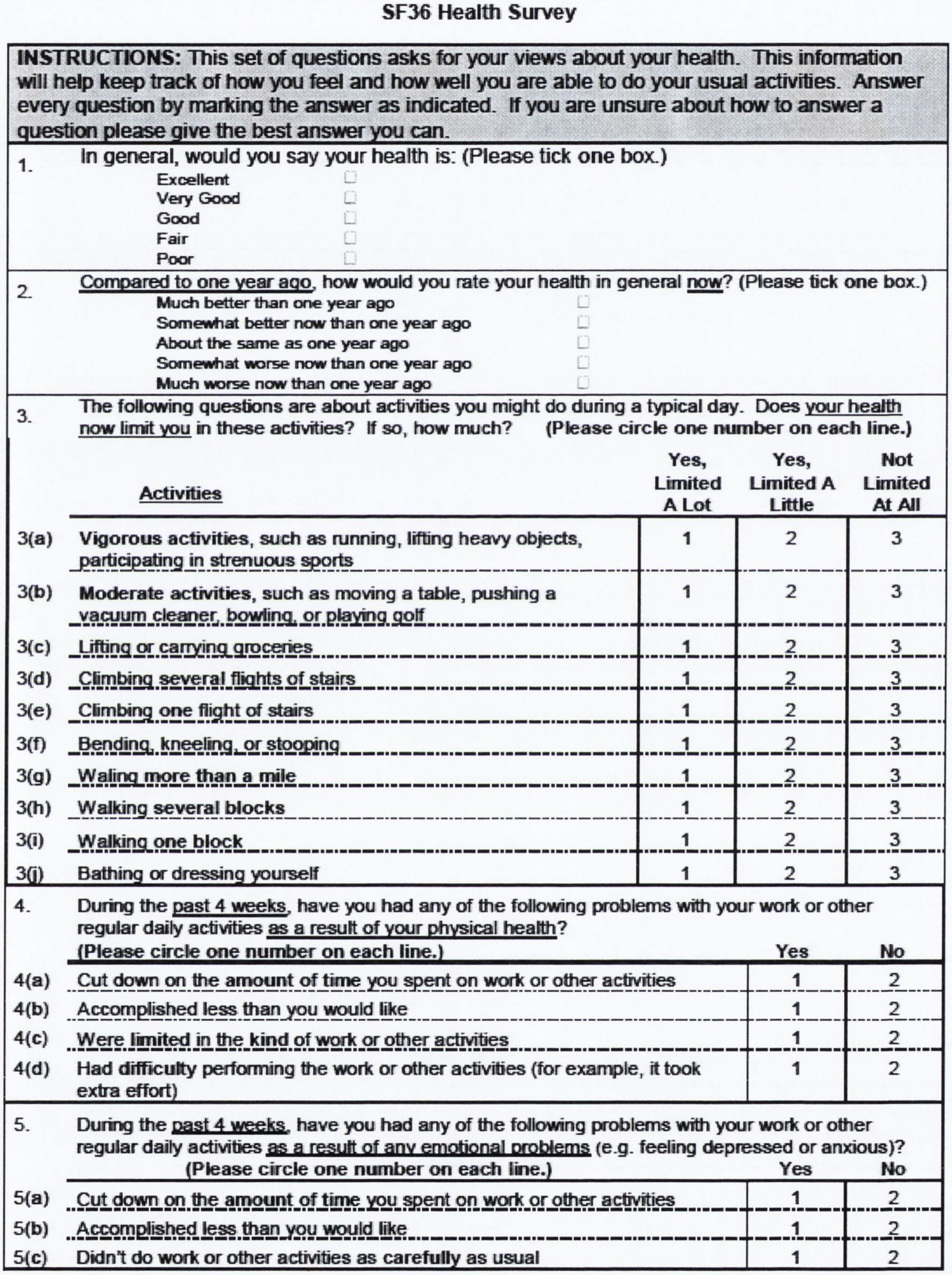
Appendix III

FES-I: Prof Lucy Yardley and Prof Chris Todd FES-I

Now we would like to ask some questions about how concerned you are about the possibility of falling. Please reply thinking about how you usually do the activity. If you currently don't do the activity (e.g. if someone does your shopping for you), please answer to show whether you think you would be concerned about falling IF you did the activity. For each of the following activities, please tick the box which is closest to your own opinion to show how concerned you are that you might fall if you did this activity.

		Not at all concerned 1	*Somewhat concerned 2*	*Fairly concerned 3*	*Very concerned 4*
1	Cleaning the house (e.g. sweep, vacuum or dust)	*1* ⏲	*2* ⏲	*3* ⏲	*4* ⏲
2	Getting dressed or undressed	*1* ⏲	*2* ⏲	*3* ⏲	*4* ⏲
3	Preparing simple meals	*1* ⏲	*2* ⏲	*3* ⏲	*4* ⏲
4	Taking a bath or shower	*1* ⏲	*2* ⏲	*3* ⏲	*4* ⏲
5	Going to the shop	*1* ⏲	*2* ⏲	*3* ⏲	*4* ⏲
6	Getting in or out of a chair	*1* ⏲	*2* ⏲	*3* ⏲	*4* ⏲
7	Going up or down stairs	*1* ⏲	*2* ⏲	*3* ⏲	*4* ⏲
8	Walking around in the neighbourhood	*1* ⏲	*2* ⏲	*3* ⏲	*4* ⏲
9	Reaching for something above your head or on the ground	*1* ⏲	*2* ⏲	*3* ⏲	*4* ⏲
10	Going to answer the telephone before it stops ringing	*1* ⏲	*2* ⏲	*3* ⏲	*4* ⏲
11	Walking on a slippery surface (e.g. wet or icy)	*1* ⏲	*2* ⏲	*3* ⏲	*4* ⏲
12	Visiting a friend or relative	*1* ⏲	*2* ⏲	*3* ⏲	*4* ⏲
13	Walking in a place with crowds	*1* ⏲	*2* ⏲	*3* ⏲	*4* ⏲
14	Walking on an uneven surface (e.g. rocky ground, poorly maintained pavement)	*1* ⏲	*2* ⏲	*3* ⏲	*4* ⏲
15	Walking up or down a slope	*1* ⏲	*2* ⏲	*3* ⏲	*4* ⏲
16	Going out to a social event (e.g. religious service, family gathering or club meeting)	*1* ⏲	*2* ⏲	*3* ⏲	*4* ⏲

Appendix IV



SF36 Health Survey

INSTRUCTIONS: This set of questions 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 every question by marking the answer as indicated. If you are unsure about how to answer a question please give the best answer you can.

1. In general, would you say your health is: (Please tick one box.)

Excellent	☐
Very Good	☐
Good	☐
Fair	☐
Poor	☐

2. Compared to one year ago, how would you rate your health in general now? (Please tick one box.)

Much better than one year ago	☐
Somewhat better now than one year ago	☐
About the same as one year ago	☐
Somewhat worse now than one year ago	☐
Much worse now than one year ago	☐

3. 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? **(Please circle one number on each line.)**

	Activities	**Yes, Limited A Lot**	**Yes, Limited A Little**	**Not Limited At All**
3(a)	**Vigorous activities**, such as running, lifting heavy objects, participating in strenuous sports	1	2	3
3(b)	**Moderate activities**, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf	1	2	3
3(c)	Lifting or carrying groceries	1	2	3
3(d)	Climbing several flights of stairs	1	2	3
3(e)	Climbing one flight of stairs	1	2	3
3(f)	Bending, kneeling, or stooping	1	2	3
3(g)	Waling more than a mile	1	2	3
3(h)	Walking several blocks	1	2	3
3(i)	Walking one block	1	2	3
3(j)	Bathing or dressing yourself	1	2	3

4. 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?
(Please circle one number on each line.)

		Yes	**No**
4(a)	Cut down on the amount of time you spent on work or other activities	1	2
4(b)	Accomplished less than you would like	1	2
4(c)	Were limited in the kind of work or other activities	1	2
4(d)	Had difficulty performing the work or other activities (for example, it took extra effort)	1	2

5. 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 (e.g. feeling depressed or anxious)?
(Please circle one number on each line.)

		Yes	**No**
5(a)	Cut down on the amount of time you spent on work or other activities	1	2
5(b)	Accomplished less than you would like	1	2
5(c)	Didn't do work or other activities as carefully as usual	1	2

6. During the past 4 weeks, to what extent has your physical health or emotional problems interfered with your normal social activitieswith family, friends, neighbours or groups? (please tick one box)

Not at all ☐
Slightly ☐
Moderately ☐
Quite a bit ☐
Extremely ☐

7. How much physical pain have you had during the past 4 weeks? (please tick one box)

None ☐
Very Mild ☐
Mild ☐
Moderate ☐
Severe ☐
Very Severe ☐

8. During the last 4 weeks how much did pain interfere with your normal work(including both work outside the home and housework)? (please tick one box)

Not al all
A little bit
Moderately
Quite a bit
Extremely

9. These questions are about how you feel and how things have been with you during the past 4 weeks. Please give one answer that is closest to the way you have been feeling for each item.

Please circle one number on each line

		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
9a		1	2	3	4	5	6
9b		1	2	3	4	5	6
9c		1	2	3	4	5	6
9d		1	2	3	4	5	6
9e		1	2	3	4	5	6
9f		1	2	3	4	5	6
9g		1	2	3	4	5	6
9h		1	2	3	4	5	6
9i		1	2	3	4	5	6

10. During the past 4 weeks, how much of the time has your physical health or emotional problems interfere with your social activities(like visiting with friends, relatives etc) (Please tick one box)

All of the time ☐
Most of the time ☐
Some of the time ☐
A little of the time ☐
None of the time ☐

11. How TRUE or FALSE is each of the following statements for you?
(Please circle one number on each line)

	Definitely true	Mostly True	Don't Know	Mostly False	Definitely False
11a. I seem to get sick a little easier than other people	1	2	3	4	5
11b. I am as healthy as anyone I know					
11c. I expect my health to get worse					
11d. My health is excellent					

Appendix V

Barthel Index of Activities of Daily Living

Instructions: Choose the scoring point for the statement that most closely corresponds to the patient's current level of ability for each of the following 10 items. Record actual, not potential, functioning. Information can be obtained from the patient's self-report, from a separate party who is familiar with the patient's abilities (such as a relative), or from observation. Refer to the Guidelines section on the following page for detailed information on scoring and interpretation.

The Barthel Index

Bowels
0 = incontinent (or needs to be given enemata)
1 = occasional accident (once/week)
2 = continent

Patient's Score: ______________

Bladder
0 = incontinent, or catheterized and unable to manage
1 = occasional accident (max. once per 24 hours)
2 = continent (for over 7 days)

Patient's Score: ______________

Grooming
0 = needs help with personal care
1 = independent face/hair/teeth/shaving (implements provided)

Patient's Score: ______________

Toilet use
0 = dependent
1 = needs some help, but can do something alone
2 = independent (on and off, dressing, wiping)

Patient's Score: ______________

Feeding
0 = unable
1 = needs help cutting, spreading butter, etc.
2 = independent (food provided within reach)

Patient's Score: ______________

(Collin et al., 1988)

Transfer
0 = unable – no sitting balance
1 = major help (one or two people, physical), can sit
2 = minor help (verbal or physical)
3 = independent

Patient's Score: ______________

Mobility
0 = immobile
1 = wheelchair independent, including corners, etc.
2 = walks with help of one person (verbal or physical)
3 = independent (but may use any aid, e.g., stick)

Patient's Score: ______________

Dressing
0 = dependent
1 = needs help, but can do about half unaided
2 = independent (including buttons, zips, laces, etc.)

Patient's Score: ______________

Stairs
0 = unable
1 = needs help (verbal, physical, carrying aid)
2 = independent up and down

Patient's Score: ______________

Bathing
0 = dependent
1 = independent (or in shower)

Patient's Score: ______________

Total Score: ________________

Scoring:

Sum the patient's scores for each item. Total possible scores range from 0 – 20, with lower scores indicating increased disability. If used to measure improvement after rehabilitation, changes of more than two points in the total score reflect a probable genuine change, and change on one item from fully dependent to independent is also likely to be reliable.

Sources:

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Appendix VI

Mini-Mental State Examination (MMSE)

Patient's Name: ________________________________ Date: __________

Instructions: Score one point for each correct response within each question or activity.

Maximum Score	Patient's Score	Questions
5		"What is the year? Season? Date? Day? Month?"
5		"Where are we now? State? County? Town/city? Hospital? Floor?"
3		The examiner names three unrelated objects clearly and slowly, then the instructor asks the patient to name all three of them. The patient's response is used for scoring. The examiner repeats them until patient learns all of them, if possible.
5		"I would like you to count backward from 100 by sevens." (93, 86, 79, 72, 65, …) Alternative: "Spell WORLD backwards." (D-L-R-O-W)
3		"Earlier I told you the names of three things. Can you tell me what those were?"
2		Show the patient two simple objects, such as a wristwatch and a pencil, and ask the patient to name them.
1		"Repeat the phrase: 'No ifs, ands, or buts.'"
3		"Take the paper in your right hand, fold it in half, and put it on the floor." (The examiner gives the patient a piece of blank paper.)
1		"Please read this and do what it says." (Written instruction is "Close your eyes.")
1		"Make up and write a sentence about anything." (This sentence must contain a noun and a verb.)
1		"Please copy this picture." (The examiner gives the patient a blank piece of paper and asks him/her to draw the symbol below. All 10 angles must be present and two must intersect.) 
30		TOTAL

Appendix VII

QUESTIONS ABOUT USING YOUR MEDICINES

- **Many people find a way of using their medicines which suits them.**
- **This may differ from the instructions on the label or from what their doctor has said.**
- **We would like to ask you a few questions about how you use your medicines**

Here are some ways in which people have said that they use their medicines

For each of the statements, please tick the box which best applies to you

	Your own way of using your medicines	Always	Often	Sometimes	Rarely	Never
M1	I forget to take them					
M2	I alter the dose					
M3	I stop taking them for a while					
M4	I decide to miss out a dose					
M5	I take less than instructed					

Appendix VIII

Hospital Anxiety and Depression Score (HADS)

This questionnaire helps your physician to know how you are feeling. Read every sentence. Place an "X" on the answer that best describes how you have been feeling during the LAST WEEK. You do not have to think too much to answer. In this questionnaire, spontaneous answers are more important

A	**I feel tense or 'wound up':**	
	Most of the time	3
	A lot of the time	2
	From time to time (occ.)	1
	Not at all	0
D	**I still enjoy the things I used to enjoy:**	
	Definitely as much	0
	Not quite as much	1
	Only a little	2
	Hardly at all	3
A	**I get a sort of frightened feeling as if something awful is about to happen:**	
	Very definitely and quite badly	3
	Yes, but not too badly	2
	A little, but it doesn't worry me	1
	Not at all	0
D	**I can laugh and see the funny side of things:**	
	As much as I always could	0
	Not quite so much now	1
	Definitely not so much now	2
	Not at all	3
A	**Worrying thoughts go through my mind:**	
	A great deal of the time	3
	A lot of the time	2
	From time to time, but not often	1
	Only occasionally	0
D	**I feel cheerful:**	
	Not at all	3
	Not often	2
	Sometimes	1
	Most of the time	0
A	**I can sit at ease and feel relaxed:**	
	Definitely	0
	Usually	1
	Not often	2
	Not at all	3

D	**I feel as if I am slowed down:**	
	Nearly all the time	3
	Very often	2
	Sometimes	1
	Not at all	0
A	**I get a sort of frightened feeling like "butterflies" in the stomach:**	
	Not at all	0
	Occasionally	1
	Quite often	2
	Very often	3
D	**I have lost interest in my appearance:**	
	Definitely	3
	I don't take as much care as I should	2
	I may not take quite as much care	1
	I take just as much care	0
A	**I feel restless as I have to be on the move:**	
	Very much indeed	3
	Quite a lot	2
	Not very much	1
	Not at all	0
D	**I look forward with enjoyment to things:**	
	As much as I ever did	0
	Rather less than I used to	1
	Definitely less than I used to	2
	Hardly at all	3
A	**I get sudden feelings of panic:**	
	Very often indeed	3
	Quite often	2
	Not very often	1
	Not at all	0
D	**I can enjoy a good book or radio/TV program:**	
	Often	0
	Sometimes	1
	Not often	2
	Very seldom	3

Appendix IX

SJH / AMNCH RESEARCH ETHICS COMMITTEE.
CONSENT FORM

Title of research study:

This study and this consent form have been explained to me. My doctor has answered all my questions to my satisfaction. I believe I understand what will happen if I agree to be part of this study.
I have read, or had read to me, this consent form. I have had the opportunity to ask questions and all my questions have been answered to my satisfaction. I freely and voluntarily agree to be part of this research study, though without prejudice to my legal and ethical rights. I have received a copy of this agreement and I understand that, if there is a sponsoring company, a signed copy will be sent to that sponsor.
Name of sponsor:

PARTICIPANT'S NAME:

PARTICIPANT'S SIGNATURE:

Date:

Date on which the participant was first furnished with this form:
Where the participant is incapable of comprehending the nature, significance and scope of the consent required, the form must be signed by a person competent to give consent to his or her participation in the research study (other than a person who applied to undertake or conduct the study). If the subject is a minor (under 18 years old) the signature of parent or guardian must be obtained:-

NAME OF CONSENTOR, PARENT or GUARDIAN:__________________________

SIGNATURE:____

RELATION TO PARTICIPANT:____

Where the participant is capable of comprehending the nature, significance and scope of the consent required, but is physically unable to sign written consent, signatures of two witnesses present when consent was given by the participant to a registered medical practitioner treating him or her for the illness.

NAME OF FIRST WITNESS:______________________________________

SIGNATURE:____

NAME OF SECOND WITNESS:____________________________________

SIGNATURE:____

Statement of investigator's responsibility: I have explained the nature, purpose, procedures, benefits, risks of, or alternatives to, this research study. I have offered to answer any questions and fully answered such questions. I believe that the participant understands my explanation and has freely given informed consent.

Investigators signature:

Date:
(Keep the original of this form in the participant's medical record, give one copy to the participant, keep one copy in the investigator's records, and send one copy to the sponsor (if there is a sponsor).

Appendix X

PATIENT INFORMATION LEAFLET

All patients who attend St James's Hospital for treatment of a hip fracture are offered a screening for Osteoporosis. Osteoporosis is a condition where the bones are thinner than they should be and as a result can break easier. This screening consists of a DXA scan(a special x-ray that looks at the density or thickness of bones), special blood tests and an appointment in the Bone Health Clinic under the care of Professor JB. Walsh and Dr Miriam Casey. Because of demand on the DXA scan service this appointment may be delayed for between 6 and 8 months. It is the belief of the osteoporosis service that an early review of hip fracture patients by the medical, nursing and physiotherapy team can lead to increased mobility and improve quality of life for these patients. In conjunction with this screening you are invited to take part in a study. This study will assess the effect early review has on hip fracture patients by comparing them to patients who have not had early review. Please take time to read the following information carefully as it should help you decide whether or not you wish to take part.

Title of study.

Post hip fracture in older adults: interventions and strategies for improving outcomes.

The role and function of the CNS and Bone Health Unit in the Management of Hip Fracture Patients.

Why have you been chosen?

All patients attending St James's hospital for treatment of a hip fracture will be invited to participate in this study.

Do you have to take part?

No – it is entirely your decision. But if you wish to take part, you will need to sign a consent to participate. A decision not to take part will NOT affect any future visits to this hospital.

Reason for the study

As part of a PhD in Gerontological Nursing at the University of Dublin, Trinity College, I am looking to see if early review of hip fracture patients can improve their outcome. I am also hoping to improve the role of the Clinical Nurse Specialist in referring these people to specialist services.

Procedures

Should you agree to take part in this study you will be randomly assigned to either the control group or the study group. The control group will receive routine care, i.e. a Bone Health Clinic appointment for assessment of Osteoporosis between 4 and 7 months post fracture. The Study group will receive an appointment for the Bone Health Clinic at 3 months at which they will be assessed by Myself (a Clinical Nurse Specialist) and a medical doctor. This assessment will include

- A DXA scan. (an x-ray of your hip and spine to assess the density of you bones)
- A simple ultrasound of your heel will be performed to assess you risk of osteoporosis. Please wear socks/stockings to simplify this test.
- A nutritional assessment, which is a short questionnaire to help identify if you need to see a dietician.
- A eye test
- Questionnaires relating to your knowledge of osteoporosis, how you take your medication, whether or not you are nervous of falling, how mobile you are and how you feel the hip fracture has impacted on your quality of

life will be sent with your appointment letter for you to complete and bring with you to the appointment.

- Blood tests will be taken. These will include special blood tests called bone markers which will identify the effectiveness of the bone medication which you are on or will be put on.

This assessment will take place in the Falls and Osteoporosis clinic in Hospital 4 Top Floor, St James's Hospital. Following this assessment, an appointment for you to see either Professor JB. Walsh or Dr Miriam Casey will be made. I will continue to be in contact with you every 4 months by telephone to see how you are getting on and whether or not you are experiencing any problems.

We will ask you to return in 12 months time to complete these tests again to help us identify if there is any changes.

Are there risks from taking part?

It is guaranteed that your participation in the study will have no bearing on future attendances to the Bone Health Clinic in St. James's Hospital. The information that we receive from these tests may help us give a better service in future to patients who suffer a hip fracture with particular emphasis on follow up of these patients. There are no foreseen risks from taking part in this study.

Benefits of participation in this study

If you participate in this study, risk factors which may put you at increased risk of falling will be identified and treated. Referrals to required specialists, eg Phisiotherapy, eye specialist, dietician, memory clinic, etc will be made for you if it is deemed necessary. It is the belief of the Falls and Osteoporosis Service that participation in this study will lead to a more intense medical follow up post fracture and increase mobility and quality of life for hip fracture patients.

Will taking part in this study be kept confidential?

Yes – Your identity will remain confidential. Your name will not be published and will not be disclosed to anyone outside the hospital.

What will happen to the results of the research study?

The completed research study will be submitted to the University of Dublin, Trinity College, in June 2011 as part of a Phd(Doctorate) in Gerontological Nursing. There is a possibility that the results of this study may then be published in a professional journal, or at a meeting. You cannot be identified in any report or publication. The results of the tests and information that you give in the questionnaires will not be used for any other reason or in any other study.

Who has reviewed the study?

The study has been reviewed by, the Hospital Ethics Committee, the Patient Advocacy Committee, St. James's Hospital and the School of Nursing and Midwifery Ethics Committee, University of Dublin, Trinity College.

Contact for further information

You may contact me at this address or telephone number below for any further information, or problems you may have with this study.

Niamh Maher,
Clinical Nurse Specialist,
Falls and Osteoporosis Clinic,
St. James's Hospital. Contact telephone number:(01) 4162370.

A decision not to participate has no bearing on this bone clinic appointment. It is important that you keep this appointment

Thank you for taking the time to read this information sheet – I hope you will feel able to take part in this important study.

Appendix XI

Falls and Osteoporosis Service
Hospital 4 Top Floor,
St. James's Hospital,
James's Street,
Dublin 8
Tel: (01) 4162370 / 4284094.

Study Title:

Post hip fracture in older adults: interventions and strategies for improving outcomes. The role and function of the Clinical Nurse Specialist and Bone Health Unit in the management of hip fracture patients.

Dear

Thank you once again for agreeing to participate in this study. As was previously mentioned participants are randomly assigned to one of two groups, the intervention group or the control group. The people in the control group will receive routine care which all hip fracture patients receive. This consists of an appointment for a DXA scan and Osteoporosis screening followed by an appointment in the Bone Health Clinic.

You have been randomly assigned to the control group. An appointment for Dxa scan will be sent out to you by post. I will be in contact with you by phone every 4 months to see how you are getting on and whether or not you have had a fall. I would very much appreciate if you would complete the enclosed falls diary should you have a fall. This is to keep a record of any falls you might have. Also, it would be helpful if you would record any contact you have with the health system, eg, your GP, community health centre, public health Nurse, A& E, or hospital on this form Should you have any queries please do not hesitate to contact me at the above number. Thanking you,

Yours sincerely

Niamh Maher

Appendix XII

Falls and Osteoporosis Service
Hospital 4 Top Floor
St James's Hospital,
Dublin 8
Tel: (01)4162370 / 4284090

Study Title:

Post hip fracture in older adults: interventions and strategies for improving outcomes. The role and function of the Clinical Nurse Specialist and Bone Health Unit in the management of hip fracture patients.

Dear

Thank you once again for agreeing to participate in this study. As was previously mentioned participants are randomly assigned to one of two groups, the assessment group or the control group. You have been assigned to the intervention group which involves a detailed assessment by myself, Niamh Maher at the pre-assessment clinic in Hospital 4 Top Floor at 3 months following your fracture on

____.

Enclosed you will find some questionnaires which we ask you to complete and bring with you on the day of your appointment.

If you have any queries please do not hesitate to contact me at the above numbers.
Thanking you once again,

Yours sincerely

Niamh Maher.