Original Article

Arthritis Care & Research
DOI 10.1002/acr.21987

Title: Risk factors for falls in Adults with Rheumatoid arthritis: A Prospective Study.

Authors: Emma K Stanmore, Lecturer,[1]* Jackie Oldham, Professor of Rehabilitation Science,[2]Dawn A Skelton, Professor in Ageing and Health,[3] Terence O'Neill, Professor of Rheumatology and Clinical Epidemiology,[2] Mark Pilling, Statistician,[1] A John Campbell, Professor of Geriatric Medicine,[4] Chris Todd, Professor of Primary Care and Community Health.[1]

Affiliation: [1]School of Nursing, Midwifery and Social Work and MAHSC (Manchester Academic Health Science Centre), Jean McFarlane Building, University Place, U.K. M13 9LP. [2]Arthritis Research U.K. Epidemiology Unit, University of Manchester, UK M13 9LP. [3] School of Health and Life Sciences, Glasgow Caledonian University, Cowcaddens Rd, Glasgow, G4 0BA, U.K.[4]Department of Medicine, Dunedin School of Medicine, Dunedin, 9016, New Zealand.

*Correspondence: E Stanmore School of Nursing, Midwifery and Social Work and MAHSC (Manchester Academic Health Science Centre), Jean McFarlane Building, University Place, University of Manchester, Manchester. M13 9LP. U.K. Tel: (+44) (0)161 306 7645 Fax: (+44) (0)161 306 7894 Email: Emma.K.Stanmore@manchester.ac.uk

Received: Feb 14, 2012; Revised: Feb 11, 2013; Accepted: Feb 13, 2013

Abstract

Objectives

To investigate the association between potential risk factors and falls in community dwelling adults with rheumatoid arthritis (RA).

Methods

1 year follow-up in a prospective cohort study with monthly falls calendars and telephone calls. Lower limb muscle strength, postural stability, number of swollen and tender joints, functional status, history of falling, fear of falling, pain, fatigue, medication and use of steroids were assessed as risk factors for falls.

Results

386 women and 173 men with RA, aged 18–88 (n=559) completed baseline. 535 participants (96%) completed 1 year follow-up. Bivariate logistic regression showed that falls risk was not associated with age or gender. Multivariate logistic regression revealed that a history of multiple falls in the previous 12 months was the most significant predictive risk factor (OR=5.3, 95% CI 2.3 to 12.3). The most significant modifiable risk factors were swollen and tender lower limb joints (OR=1.7, 95% CI 1.1 to 2.7), psychotropic medication (OR=1.8, 95% CI 1.1 to 3.1) and fatigue (OR=1.13, 95% CI 1.02 to 1.2).

Conclusions

Adults with RA are at high risk of falls. In clinical practice high risk falls patients with RA can be identified by asking whether patients have fallen in the past year.

Important risk factors highlighted in this study included: swollen and tender lower limb joints; fatigue and use of psychotropic medicines.

Word count: 220

Keywords: Accidental falls, falling, rheumatoid arthritis, prospective, risk factors

Adults with rheumatoid arthritis (RA) have an increased falls risk[1 2 3]. Suggested reasons for this include impaired muscle strength, postural instability, fatigue, joint pain and reduced functioning. [2 3 4 5]The falls also lead to an increased risk of hip fractures due to disease related reduced bone mass. [5 6] other fall consequences include serious injuries, hospital admission or admission to care homes, fear of falling and reduced quality of life.

Estimates of the proportion of people who fall annually with RA range from to 10% to 54% [1-12] and this high variability may be due to the sample selection (women only, small samples or frail older patients), inconsistent definitions or no definitions of falls and use of different assessment measures**.** The risk factors for falls in patients with RA that have been drawn from previous studies include: tender joint counts; [11 12] swollen joint count; [2 4] pain in lower extremities; [9] or pain intensity; [4 7 8] HAQ disability score; [4 9 11 12] low levels of physical activity; [4] impaired general health; [4 12], antidepressant use; [3] impaired vision; [4] impairment in both walking and rising; [3] walk time; [8] impaired balance; [2] number of medicines; [3] number of co-morbidities, [8] and one year history of falls.[7] Some of these risk factors are common to older people (e.g. impaired vision, previous history of a fall, number and types of medicines) [13] but others appear to be disease specific (e.g. swollen or tender joints, pain, increased HAQ disability scores).

To date, there has not been a sufficiently large prospective study of adults of all ages with RA to provide a comprehensive investigation of the fall risk factors associated with RA. The identification of predictive and potentially modifiable risk factors is

essential for the development of effective falls prevention strategies. The aim of this study was to identify fall risk factors in adults with RA.

Subjects and methods

A consecutive sample of eligible patients was recruited from four rheumatology clinics in the Northwest of England. A variety of different clinics were accessed to ensure people with different levels of severity of disease were invited to participate. All participants were over 18 years of age with a diagnosis of RA based on the 2010 American College of rheumatology classification criteria for RA.[14] Participants were excluded from the study if they were under the age of 18 or if they were without the mental or physical capacity to give informed consent (assessed by research nurse).

Measurements were taken at baseline between the months of August 2008 and March 2009, and participants were followed up for falls and injuries for one year using preaddressed, prepaid daily falls calendars (posted monthly) and monthly follow-up telephone calls.

Data collection

Variables considered important in causing or predicting falls were assessed at baseline by trained research nurses experienced in undertaking joint counts.

RA status was assessed by the number of swollen/tender joints (shoulders, elbows, wrists, metacarpophalangeal joints, proximal interphalangeal joints and knees), Disease Activity Score (DAS28) and Stanford Arthritis Centre Health Assessment Questionnaire (HAQ). DAS28 has been extensively validated for use in clinical trials and practice.[15] It provides scores for the number of swollen and tender joints, Erythrocyte Sedimentation Rate (ESR) and a VAS global

disease scale. The total DAS28 range between 0-10, indicates the current activity of RA. Accepted cut offs are 5.1 for high disease activity, 3.2 for low disease activity. The HAQ is a self-administered arthritis-specific instrument that measures patients' perceptions of difficulties in performing activities in daily living, the need for equipment and physical assistance to perform tasks and has been extensively tested for validity and reliability.[16]

Fear of falling was recorded using the Short Falls Efficacy Scale-International (Short FES-I). The Short FES-I is a validated and reliable seven item tool which measures fear of falling related to a range of activities.[17]

Falls risk was measured by the validated Falls Risk Assessment Tool (FRAT) which includes questions on the history of any fall in the previous year, taking four or more prescribed medications, and diagnosis of stroke or Parkinson's disease[18] Vision was assessed using a self-reported question (which gives a score 0-4).[19] Patients were also asked questions about levels of pain and fatigue using visual analogue scales (VAS) [20 21]and about any co-morbidities (number and type), previous fractures, surgery or joint replacement(s) [4] and verified using medical records. Medical records were also used to check previous history and medication, including steroid use.[11]

Lower limb muscle strength and balance was assessed using the Chair Stand Test [22] and the Four-Test Balance Scale.[23] For the Chair Stand Test, participants were instructed to stand up and down from a chair as quickly as possible five times, with their arms folded. The time taken to complete was recorded. The Four Test Balance Scale comprised four timed static balance tasks of increasing difficulty using different positioning of the participants' feet. Participants were scored 0 for unsuccessful, 1 if

they could only stand with their feet together, 2 if they could only complete a semi-tandem stand, 3 if they could complete a tandem stand and 4 for participants who could complete a one-leg stand. The participant must hold each position for 10 seconds before progressing to the next more challenging task

The ProFaNE definition of, "an unexpected event in which participants come to rest on the ground, floor, or other lower level" was used to identify falls, rather than trips or stumbles. [24] Participants who reported a fall, failed to return a falls calendar or filled in the calendar incorrectly were contacted by telephone each month. Campbell et al.,s methods were used to collect information about the fall event during the follow-up telephone calls, [25] as recommended by Schwenk and colleagues.[26] Data included, date of fall, self-reported description of how fall occurred, consequences and injuries, and healthcare utilization (e.g. hospital admission, medical assistance, physiotherapy.

Data analysis

The ProFaNE consensus group recommended guidance on fall data analysis was utilized for the analysis of the data. [24] Analysis of variance (ANOVA) was used to test for differences between the groups of non-fallers, single fallers and multiple fallers. Levene's test of homogeneity of variance was initially applied. [27] When homogeneity of variances was met ($p>0.05$), ANOVA was undertaken and Tukey's post-hoc tests were used to compare the differences between pairs of groups. In cases when Levene's test was not met ($p<=0.05$) the Welch test [27] was used to determine overall significance between the groups, and Dunnett's T3 post-hoc tests [27] were used to compare between pairs of groups.

Chi squared tests of trend were used as appropriate for categorical data to examine differences in groups of non-fallers, single fallers and multiple fallers. Binary logistic regression was used to calculate odds ratios (OR) and 95% confidence intervals (CI) for age gender and all fall risk associated variables, with occurrence of falls during the study as the outcome. Variables were initially examined using bivariate analyses to estimate associations for each risk factor with fall outcomes. To avoid an underpowered logistic regression analysis, the three groups (non-fallers, single fallers and multiple fallers) were combined into two groups (non-fallers and all fallers) and a limited number of explanatory variables were selected based on statistical significance ($p<0.05$). These variables were selected using the Lemeshow-Hosmer approach. [28] The selected variables were entered into two multivariate analyses, using binary multivariate logistic regression to build predictive and explanatory risk models. As well as understanding the best predictive risk factors, it is clinically important to understand the risk factors that can potentially be modified to enable an effective falls prevention strategy to be implemented. Therefore as well as a predictive risk factor model, an explanatory risk factor model excluding a 12 month history of fall was added to the analysis to explore the potentially modifiable reasons for falls. Multi-collinearity was assessed using Variance Inflation Factor (VIF) >10. Statistical analysis was performed using SPSS (V. 16.0).[29]

Results

Subject characteristics

The baseline characteristics of the sample are provided in table 1. The mean age of the male participants was 62 years (SD=11.0) and the mean age of the female participants was 61.9

(SD=13.6). There were more than twice as many women (n=386, 69%) as men recruited to the study and 70% of participants were married (n=378). The majority of participants described themselves as white and British (n=544, 97%). Over half were retired from employment (n=327, 59%), with only a quarter in employment (n=134, 24%). The mean DAS28 score (mean=4.1, mode=3.9) of the participants fell within the moderate disease activity range (3.3 – 5.1). The majority of the participants had co-morbidities with hypertension (n=149, 29%), respiratory disease (n=92, 18%), cardiovascular disease (n=82, 16%) and osteoarthritis (n=78, 15%) being the most common. There were 19 variables used in the analysis, of which there were a total of 16 missing values amongst the 535 participants, leading to a missing data rate of 0.18%.

Among the 535 participants with RA, 195 (36%, 95% CI 32% to 41%) reported a fall during the 1 year follow-up. In the 1 year follow-up, there were 340 non-fallers (64%), 94 single fallers (those who fell once, 18%) and 101 multiple fallers (those who fell more than once, 19%). In the year preceding entry to the study,, there were 317 (57%) non-fallers, 120 single fallers (21%) and 122 (22%) multiple fallers. The probability of a 1 year follow-up fall significantly increased ($p<0.001$) if the participant fell during the previous 12 months. Of those with a 1 year history of falls 124 (53.4) reported a 1 year follow-up fall, whilst of those with no 1 year history of falls only 71 (23.4%) reported study falls.

Multiple fallers had a significantly higher mean Short FES-I score than single fallers (mean difference = 2.2, $p=0.03$) and non-fallers (mean difference=3.5, $p=<0.001$). There were no significant differences between the mean Short FES-I score in the groups of single fallers and non-fallers (mean difference=1.3, $p=0.19$) These results suggest that multiple fallers have significantly higher levels of fear of falling

compared to single or non-fallers, however in clinical terms these differences are small.

VAS Pain scores were significantly higher in multiple fallers (mean difference=1.5, p=<0.001, 95% C.I. 0.83 to 2.20) than non-fallers and single fallers (mean difference=1.1, p=0.006, 95% C.I. 0.28 to 2.01). However there were no significant differences between single fallers and non-fallers in baseline VAS pain scores (mean difference=0.4, p=0.44).

VAS Fatigue scores were significantly higher in single fallers (mean difference=1.1, p=0.005) and multiple fallers (mean difference=1.6, p=<0.001) than non-fallers. However there were no significant differences between single fallers and multiple fallers in VAS fatigue scores (mean difference=0.6, p = 0.34).

DAS28 mean scores were significantly higher in multiple fallers (mean difference=0.6, p=0.001,) than non-fallers. However there were no significant differences between single fallers and multiple fallers (mean difference=0.5, p= 0.07) and single fallers and non-fallers in DAS28 scores (mean difference=0.2, p=0.61).

Single fallers had a higher mean HAQ score than non-fallers (mean difference=0.2, p=0.06) and this was borderline significant. Multiple fallers had a significantly higher mean HAQ score than single fallers (mean difference=0.3) and non-fallers (mean difference= 0.5, p=0.04).

Compared to non-fallers and single fallers at follow-up, those experiencing multiple falls were more likely at baseline to use 4 or more types of medicines (p=0.013), use psychotropic medicines (p=<0.001), report feeling dizzy or unsteady (p = 0.01), have a history of stroke or Parkinson's disease (p=0.02), be less likely to be able to complete the chair stand test than non- fallers (p=<0.001), less likely to be able to complete the semi-tandem stand, the tandem stand or the one-leg stand (p=0.008), use steroid medication (p=0.03) or have a history of fracture (p=0.008) (table 1).

(Table 1 here)

Risk factors

Table 2 summarises the results comparing all fallers with non-fallers using logistic regression analyses. The variables were classified into groups of demographic, medical, self-report/functional ability, and postural factors.

(Table 2 here)

Medical risk factors (table 2)

There were no associations found between the number of tender joints and falls. Reporting any swollen or tender lower limb joints (hip, knee or ankle, feet not included) doubled the risk of falling during the follow-up period. The DAS28 score was another predictor of falls that could be useful in clinical practice (OR=1.2). Taking psychotropic medicines more than doubled the odds of falling. Polypharmacy was a significant predictor of falls; taking four or more medicines more than doubled the risk of falling. Taking steroids at baseline increased the risk of falling by half, as did a history of previous fracture(s). There were no associations found between a history of stroke or Parkinson's disease and falls. Both the VAS pain and VAS fatigue score showed similar positive predictive values for falling with the risk raised by 10%

for every point increase in the score. A positive self-reported history of falls in the previous 12 months at baseline was a strong predictor of falls. Reporting a single fall in the previous 12 months at baseline more than tripled the risk of falling during the reporting period of our prospective study and reporting multiple falls more than quadrupled the risk. Reporting 12 month previous injurious falls at baseline (OR=1.3) and a history of fracture(s) (OR=1.5) were also strong predictors of falls.

Self-report/functional ability risk factors (table 2)

The short FES-I score values ranges from 7 (no fear of falling) to 28 (very fearful of falling) and for each 1 unit increase there was a 10% increase in odds of falls. The bivariate analyses demonstrated that for each additional point attained in the final HAQ score (1.00 – 4.00) the risk of falling increased by 70%.

Postural risk factors (table 2)

The odds ratios between the groups in the Four-test balance scale, increased as the groups became more impaired. The odds of falling was 2-3 times higher for participants who could not complete the Four-test balance scale at all and 2.5 times higher for those who could only complete the feet together stand, however the 95% CIs spanned unity in this scale, possibly due to smaller numbers of participants.

A complaint of feeling dizzy or unsteady was also a strong predictor of falls with participants with positive reports having an 80% greater risk of falling than those without.

There was an association found with those who were able to complete the Chair Stand Test with an OR of 0.48, which means that there was a protective association for falls over the 1 year follow-up for those who were able to complete the test. Therefore, those able to complete the Chair Stand Test were half as likely to fall as those unable to complete the test. The time taken to complete the Chair Stand Test varied from 4 to 104 seconds. For every additional second taken to complete the test there was an increased risk of falling of 2%.

Multivariate analysis of predictive risk factors

Multivariate logistic regression was used to build a predictive model that could be useful to gauge fall risk. Due to the limited number of participants who fell (195) only a selected number of variables could be included in a multivariate regression in order to avoid model over-specification. The following variables were included in this multivariate analysis based on their statistical significance in the bivariate analysis: swollen or tender lower limb joints, taking psychotropic medicines, taking four or more medicines, a history of fracture or injuries, the ability and time taken to complete the Chair Stand Test, the ability to complete the Four Test Balance Scale, feeling dizzy or unsteady, fear of falling (Short FES-I score), history of single fall, history of multiple fall, DAS28 score, taking steroids, pain, fatigue and HAQ score. Multivariate logistic regression analysis initially showed that the results from the ability to complete the Chair Stand Test variable were highly correlated with the other variables causing spurious model estimates, (VIF >10). [22] Therefore the ability to complete the Chair Stand Test variable was excluded from the analysis. The same variables (excluding the ability to complete the Chair Stand Test but not the time to complete the Chair Stand Test) were entered into a multivariate logistic regression

analyses to build the best predictive model of falls. The results from the multivariate analysis for predictive risk factors are shown in table 3.

(Table 3 here)

Predictive risk model

The final model included all 16 selected risk factor variables in predicting the occurrence of falls during the study, and accurately explained 71% of the variation in the data. Statistically significant variables were the 12 month history of a single (OR 3.6, p=<0.001, 95% CIs 1.8 to 7.3) or multiple fall(s) (OR 5.3, p=<0.001, 95% CIs 2.3 to 12.3), swollen or tender lower limb joints (OR 1.7, p=0.02, 95% CIs 1.1 to 2.8) and increasing VAS fatigue (OR 1.11, p=0.03, 95% CIs 1.0 to 1.3).

Explanatory risk factor model

A multivariate logistic regression analysis of the risk factors excluding a 12 month history of fall was conducted to explore the potential reasons for falls. As well as understanding the best predictive risk factors, it is clinically important to understand the risk factors that can potentially be modified to enable an effective falls prevention strategy to be implemented. Although a history of a single or multiple fall was found to be the best independent predictor of falls this model does not help clinicians to prevent the initial fall and a history of a single or multiple fall(s) can be considered a marker of poor mobility or frailty.[30] Therefore a history of a single or multiple fall(s) was excluded from the analysis due to its lack of utility in designing an intervention. The 12 variables included in the multivariate logistic regression were chosen in advance from the 18 significant variables examined in the bivariate analysis. DAS28 and VAS pain score were included as covariates and swollen or tender lower limb joints, taking four or more medicines, HAQ score, Short FES-I score, use of

psychotropic medicines, taking steroids at baseline, time taken to complete the chair stand test, the four test balance scale, complaints of feeling dizzy or unsteady and VAS fatigue score were also included as the most clinically relevant for purposes of intervention. Table 4 shows the multivariate analysis for explanatory risk factors.

(Table 4 here)

Explanatory risk model

The multivariate logistic regression analysis for the explanatory fall risk factors showed that having any swollen or tender lower limb joints (hip, knee, ankle), taking psychotropic medicines and increasing VAS fatigue produced the best fitting risk factor model. The amount of variation explained by the explanatory risk factor model due to 12 variables was 68%.

Discussion

In this study, 36% of participants aged 18 years and older reported falling at least once in the one year follow-up period. This is slightly higher than the 30% reported by older people aged 65 years and over living in the community.[13 31] Due to the high risk of falls and the associated increased fracture risks it is important to highlight factors that may be modified to prevent falls in this group.

Falls in adults with RA are not just random events but may be predicted and possibly prevented by assessing and treating a number of independent risk factors. Asking a history of falls will highlight those at high risk of further falls, followed by the assessment of swollen and tender lower limb joints (hip, knee or ankle), taking psychotropic medicines and VAS fatigue levels. We suggest that targeting interventions towards these risk factors could reduce the burden of falls in patients

with RA, however further studies are required to confirm this. Patients should be prescribed psychotropic medicines with caution, with regular reviews and should take them no longer than necessary [32]. In older people, gradual withdrawal of psychotropic medication reduced the rate of falls [13] and this approach may also be effective in patients with RA. High fatigue levels are common in adults with RA and have been linked with pain and depression, [21 33] however there is some evidence that fatigue levels fall with disease-modifying antirheumatic drugs (DMARDS) and anti-TNF therapy.[34 35] Swollen and tender lower limb joints may be improved through good multi-disciplinary management of the patient. Drug management of RA to reduce swollen and tender joints is complex and includes the use of DMARDs, steroids and biologic agents. From this study, the use of steroids was associated with an increased risk of falls and for these reasons and due to their long-term effects, it is recommended that they are used with caution.

Poor balance and lower limb strength were significantly associated with an increased risk of falling as observed by previous RA studies.[2 3 8] Specific exercises adapted from research based falls prevention programmes could be used to improve muscle strength and balance in adults with RA and may reduce the risk of falls.[36] Exercise has been shown to reduce fatigue in adults with RA, and may also improve depression and sleeping problems.[37]

Increasing HAQ disability score and high DAS28 scores were significantly associated with an increased risk of falling as found in other studies. [4 9 11 12] Fear of falling was also associated with an increased risk of falls, as found in other studies [8 9] and may result in avoidance of activities and reduction of physical ability which could

therefore increase the risk of future falls. Exercise may improve fear of falling, the functional status of the HAQ scores and disease activity scores such as the DAS28, however further studies are needed to investigate these hypotheses.[38]

In this study, the odds of falling were not significantly related to rising age or female gender, which suggests that the symptoms and risk factors associated with RA override the risk factors usually associated with age and gender. This was surprising as in the general population, adults over the age of 65, in particular females have significantly more falls than younger adults and there is an increased trend to fall in more advanced ages.[31 39 40] Hayashibara and colleagues also report that age was not associated with falls in their small prospective study of 80 women with RA. [2] Older people in general are more prone to muscle weakness due to inactivity and poor gait.[31] Adults of all ages with RA appear to have muscle weakness and this may result in the similar fall rates.

Strengths of the study include its prospective, longitudinal design, high response rate, low attrition rate and the use of validated measurement tools to collect data on fall risk factors. Attempts were made to recruit a representative sample of patients by attending a variety of outpatient clinics that included nurse-led blood monitoring sessions, primary care out of hours clinics as well as rheumatology clinics. However it is likely that patients in this study had more moderate to severe RA or more progressive disease than those generally found in primary care and some caution should be given in applying these results to other settings. It would also have been useful to have included the foot joints in the RA disease activity assessment to have investigated the contribution of swollen/tender joints within the lower limb

assessment. This may be of particular importance given that foot pain is a risk factor for falls in older people, [41 42] however a single question on whether the participant currently experienced foot pain was included in the baseline assessment due to the length of time required to assess the foot joints within limited resources. In addition, the HAQ, Short FES-I, Falls Risk Assessment Tool, VAS pain, VAS fatigue and data on eyesight were self-reported by the participants and may be subject to errors of recall.

Conclusions

Adults with RA are at high risk of falls. Health professionals can identify patients of particular risk of falls by asking whether they have fallen in the past year. Patients with RA would benefit from a falls risk screening tool that utilises the most clinically relevant and significant risk factors associated with falling. We recommend for a screening tool a 12 month history of falls, an assessment of lower limb swollen and tender joints, an assessment of psychotropic medicines, VAS fatigue and VAS pain score, the Four Test Balance Scale to measure postural stability, the Chair Stand Test to measure lower limb strength, the Short FES-I to measure fear of falling, and the HAQ to measure functional ability. Future research should consider a falls prevention programme that incorporates exercises that specifically target lower limb muscle strength and challenge balance alongside a review of medication, in particular the use of psychotropic drugs.

Funding

This study was funded by an Arthritis Research UK Allied Health Professional Fellowship (18010) and a small grant from the Wellcome Trust Clinical Research

Facility, Manchester (06834). The authors of this report are responsible for its content. Statements in the report should not be construed as endorsement by Arthritis Research UK, or the Wellcome Trust Clinical Research Facility, Manchester.

Ethical approval

This study was conducted with the approval of the National Research Ethics Committee, reference 08/H1009/41.

Acknowledgements

Special thanks to all the participants involved in the research and also the nursing and administration staff who supported the data collection phase of the study at Manchester Academic Health Science Centre (MAHSC) and the Wellcome Trust Clinical Research Facility. The authors would also like to thank Professor I. Bruce, Dr A. Hassell, Dr S. Ryan, Mr P. New for their assistance in accessing patients. Thanks to Dr M. Campbell for initial statistical support and Associate Professor M. Clare Robertson for her advice throughout the study.

Conflict of interest

The authors have declared no conflict of interest.

Contributors: ES conceived the study. ES, CT (study guarantor), JO, DS and TO were responsible for the design of the study and obtaining funding, analysis and interpretation of the data and preparation of the manuscript. ES and MP conducted data analyses. All authors reviewed the manuscript.

References

1. Stanmore EK, Oldham J, Skelton DA, O'Neill T, Pilling M, Todd C. Fall incidence and outcomes of falls in a prospective study of adults with rheumatoid arthritis. *Arthritis Care Res* 2012. Nov 8. [Epub ahead of print].

2. Hayashibara M, Hagino H, Katagiri H, Okano T, Okada J, Teshima R. Incidence and risk factors of falling in ambulatory patients with RA: A prospective 1-year study. *Osteoporo Int.* 2010; 21:(11)1825-1833.

3. Armstrong C, Swarbrick CM, Pye SR, O'Neil TW. Occurrence and risk factors for falls in rheumatoid arthritis. *Ann Rheum Dis* 2005; 64: 1602-1604.

4. Oswald AE, Pye SR, O'Neill TW, Bunn D, Gaffney K, Marshall T, Silman A, Symmons DPM. Prevalence and Associated Factors for Falls in Women with Established Inflammatory Polyarthritis. *J Rheum* 2006; 33:4, 690-694.

5. Huusko TM, Korpela M, Karppi P, Avikainen V, Kautianen H, Sulkava R. Threefold increased risk of hip fractures with rheumatoid arthritis in Central Finland. *Ann Rheum Dis.* 2001; 60: 521-2.

6. Cooper C, Coupland C, Mitchell M. Rheumatoid arthritis, corticosteroid therapy and hip fracture. *Ann Rheum Dis*. 1995; 54, (1), 49-52.

7. Smulders E, Schreven C, Weerdesteyn V, Van Den Hoogen F H J, Laan R, Van Lankveld W. Fall incidence and fall risk factors in people with rheumatoid arthritis: *Ann Rheum Dis* 2009; 68(11):1795-1796.

8. Jamison M, Neuberger GB, Miller PA. Correlates of falls and fear of falling among adults with rheumatoid arthritis. *Arthritis Rheum* 2003; 49(5):673-680.

9. Fessel KD, Nevitt MC. Correlates of fear of falling and activity limitation among persons with rheumatoid arthritis. *Arthritis Care Res* 1997; 10: 222-8.

10. Çakit BD, Nacir B, Erdem HR, Karagoz A, Saracoglu M. Fear of falling, fall risk and disability in patients with rheumatoid arthritis. *Turk J Rheumatol* 2011; 26 (3):217-225.

11. Kaz Kaz H. Johnson D. Kerry S. Chinappen U. Tweed K, Patel S. Fall-related risk factors and osteoporosis in women with rheumatoid arthritis. *Rheumatology* 2004; 42:1267-1271.

12. Furuya T, Yamagiwa K, Ikai T, Inoue E, Taniguchi A, Momohara S, Yamanaka H. Associated factors for falls and fear of falling in Japanese patients with rheumatoid arthritis. *Clin Rheum* 2009; 28 (11): 1325-1330.

13. Gillespie LD, Robertson MC, Gillespie WJ, Lamb SE, Gates S, Cumming RG, Rowe BH. (2009) Interventions for preventing falls in older people living in the community. *Cochrane Database Syst Rev* 2009; 2: CD007146.

14. Aletaha D, Neogi T. Silman AJ, Funovits J, Felson DT, Bingham CO. et al. 2010 Rheumatoid arthritis classification criteria: an American College of Rheumatology/European League Against Rheumatism collaborative initiative. *Arthritis Rheum* 2011; 62(9): 2569-81.

15. Van Riel PLCM, Schumacher HR. How does one assess early rheumatoid arthritis in daily clinical practice? *Best Pract Res Clin Rheum* 2001;15(1):67-76.

16. Ramey DR, Fries JF, Singh G. The Health Assessment Questionnaire 1995 – status and review, in B. Spilker (ed.) *Pharmacoeconomics and Quality of Life in Clinical Trials*, 2nd edn. Philadelphia, PA: Lippincott-Raven; 1996.

17. Kempen GI, Yardley L, van Haastregt JC, Zijlstra GA, Beyer N, Hauer K, Todd C. The Short FES-I: a shortened version of the falls efficacy scale-international to assess fear of falling. *Age Ageing* 2008; 37(1):44-50.

18. Nandy S, Parsons S, Cryer C, Underwood M, Rashbrook E, Carter Y, Eldridge S, Close J, Skelton D, Taylor S, Feder G. on behalf of the falls prevention pilot steering group. Development and preliminary examination of the predictive validity of the falls risk assessment tool (FRAT) for use in primary care. *J Pub Health* 2004; 26(2):138-43.

19. Mangione CM, Lee PP, Gutierrez PR, Spritzer K, Berry S, Hays RD. Development of the 25-item National Eye Institute Visual Function Questionnaire. *Arch Ophthalmol* 2001; 119:1050-1058.

20. Murphy DF, McDonald A, Power C, Unwin A, Macsullivan R. Measurement of pain: a comparison of the visual analogue scale with a non-visual analogue scale. *Clin J Pain* 1988; 3: 197-199.

21. Pollard LC, Choy EH, Gonzalez B, Scott DL. Fatigue in rheumatoid arthritis reflects pain not disease activity. *Rheumatology* 2006; 45: 885-889.

22. Guralnik JM, Simonsick EM, Ferrucci L, Glynn RJ, Berkman LF, Blazer DG, Scherr PA, Wallace RB. A short physical performance battery assessing lower extremity function: association with self reported disability and prediction of mortality and nursing home admission. *J Gerontol* 1994; 49:M85-94.

23. Rossiter-Fornoff JE, Wolf SL, Wolfson LI, Buchner DM, and the FICSIT Group. A cross-sectional validation study of the FCSIT common database static balance measures. *J Gerontol* 1995; 50A:M291-297.

24. Lamb SE, Jorstad-Stein EC, Hauer K, Becker C. Development of a Common Outcome Data Set for Fall Injury Prevention Trials: The Prevention of Falls Network Europe Consensus. *J Am Geriatr Soc* 2005; 53:1618-1622.

25. Campbell AJ, Robertson MC, Gardner MM, Norton RN, Tilyard MW, Buchner DM. Randomised controlled trial of a general practice programme of home based exercise toprevent falls in elderly women. *BMJ* 1997; 315 (7115):1065-1069.

26. Schwenk M, Lauenroth A, Stock C, Moreno R R, Oster P, McHugh G, Todd, C, Hauer K. Definitions and methods of measuring and reporting on injurious falls in randomised controlled fall prevention trials: a systematic review. *BMC Medical Research Methodology* 2012; 12 (50).

27. Field A. *Discovering Statistics Using SPSS* (3rd Edn) 2005, London. SAGE.

28. Hosmer DW. Lemeshow S. *Applied Logistic Regression* (2nd Edn) 2000, 2nd edn. John Wiley & Sons, New York

29. SPSS Inc (2008). *SPSS 16.0 for Windows*, Release 16.0.2. SPSS Inc, Chicago, IL.

30. Campbell AJ, Borrie MJ, Spears GF. Risk factors for falls in a community-based prospective study of people 70 years and older. *J Gerontol* 1989; *44*: M112.

31. World Health Organization. *WHO Global report on falls prevention in older age.* World Health Organization, Geneva; 2007.

32. Dickens D, McGowan L, Clark-Carter D, Creed F. Depression in Rheumatoid Arthritis: A Systematic Review of the Literature with Meta-Analysis. *Psychosom Med* 2002; 64:52–60.

33. .Rupp I, Boshuizen HC, Jacobi C E, Dinant HJ, van den Bos GAM. Impact of fatigue on health-related quality of life in rheumatoid arthritis: *Arthritis Rheum* 2005; 51(4): 578-85

34. Weinblatt ME, Keystone EC, Furst DE, Moreland LW, Weisman MH, Birbara CA, Teoh LA, Fischkoff SA, Chartash EK. Adalimumab, a fully human anti-tumor necrosis factor alpha monoclonal antibody, for the treatment of rheumatoid arthritis in patients taking concomitant methotrexate: The ARMADA trial. *Arthritis Rheum* 2003; 48 (1):35-45.

35. Strand V, Scott DL, Emery P, Kalden JR, Smolen JS, Cannon GW, Tugwell P, Crawford B. Leflunomide Rheumatoid Arthritis Investigators Groups Physical function and health related quality of life: analysis of 2-year data from randomized, controlled studies of leflunomide, sulfasalazine, or methotrexate in patients with active rheumatoid arthritis. *J Rheum*. 2005; 32 (4): 590-601.

36. Sherrington C, Whitney JC, Lord SR, Herbert RD, Cumming RD, Close JC. Effective exercise for the prevention of falls: a systematic review and meta-analysis. *J Am Geriatr Soc* 2008. 56(12):2234-43.

37. Neuberger GB, Press AN, Lindsley HB, Hinton R, Cagle PE, Carlson K, Scott S, Dahl J, Kramer B. Effects of Exercise on Fatigue, Aerobic Fitness, and Disease Activity Measures in Persons with Rheumatoid Arthritis. *Res Nurs Health,* 1997; 20, 195–204.

38. Williams SB, Brand CA, Hill KD, Hunt SB, Moran H. Feasibility and outcomes of a home-based exercise program on improving balance and gait stability in women with lower-limb osteoarthritis or rheumatoid arthritis: a pilot study. *Arch Phys Med Rehabil* 2010; 91(1): 106-14.

39. Rubenstein LZ, Josephson KR. (2002). The epidemiology of falls and syncope. *Clin Geriatr Med* 2002; 18(2): 141-58.

40. Peden M, McGee K, Sharma G. *The injury chart book: a graphical overview of the global burden of injuries.* World Health Organisation, Geneva; 2002.

41. Mickle KJ, Munro BJ, Lord SR, Menz HB, Steele JR. Foot pain, plantar pressures, and falls in older people: a prospective study. *J Am Geriatr Soc* J. Oct;58(10):1936-40

42. Menz HB, Morris ME, Lord SR. Foot and ankle risk factors for falls in older people: a prospective study. *J Gerontol A Biol Sci Med Sci*. 2006 Aug;61(8):866-70.

Table 1.Baseline demographics and 1-year pre-study characteristics

	Total (n=535)	*Non-faller group (n=340)*	*Single faller group (n=94)*	Multiple faller group (n=101)	Overall *P* value
Variable	**Mean (SD)/n (%)**				
Age	62 (13.6)	62 (12.7)	66 (11.7)	61 (12.7)	0.12
Women	386 (69.1)	235 (30.9)	68 (72.3)	70 (69.3)	[a]0.83
Number of swollen joints {0-28}	4.7 (6.3)	4.5 (6.1)	3.8 (5.0)	5.8 (7.0)	0.09
Number of tender joints {0-28}	5.3 (6.9)	5.0 (6.6)	4.2 (5.5)	7.0 (8.0)	0.02
DAS28 score {0 -10}	4.1 (1.6)	3.9 (1.6)	4.1 (1.3)	4.5 (1.5)	0.002
Use of psychotropic medication	105 (18.8)	47 (13.8)	20 (21.3)	34 (33.7)	[a]<0.001
Taking four or more types of medicines each day	431 (77.1)	247 (72.4)	83 (88.3)	82 (81.2)	[a]0.003
Taking steroids at baseline	117 (20.9)	61 (17.9)	21 (22.3)	28 (27.7)	[a]0.03
History of stroke or Parkinson's disease	38 (6.8)	18 (5.3)	5 (5.3)	13 (12.9)	[a]0.02
VAS pain score {0-10}	3.85 (2.7)	3.5 (2.6)	3.8 (2.6)	5.0 (2.4)	<0.001
VAS fatigue score {0-10}	4.7 (2.8)	4.2 (2.7)	5.2 (2.9)	5.8 (2.2)	<0.001
History of fall in previous 12 months	232 (43.4)	108 (31.8)	53 (56.4)	71 (70.3)	[a]<0.001
History of no falls in previous 12 months	303 (56.6)	232 (68.2)	41 (43.6)	30 (29.7)	_
History of single fall in previous 12 Months	116 (21.7)	58 (17.1)	36 (38.3)	22 (21.8)	_
History of multiple falls in previous 12 months	116 (21.7)	50 (14.7)	17 (18.1)	49 (48.5)	_
History of fractures	228 (40.8)	127 (37.4)	39 (41.5)	53 (52.5)	[a]0.008
History of injuries from previous falls {0-6}	1.6 (1.5)	_	1.8 (1.1)	2.5 (1.4)	<0.001
Poor vision {registered blind, very poor or poor}	46 (8.6)	26 (7.6)	8 (8.5)	12 (11.9)	[a]0.87
Number of co-morbidities {0-10}	2.0 (1.9)	1.9 (1.9)	2.1 (1.9)	2.2 (2.3)	0.36

Previous surgery	408 (73.1)	246 (72.4)	66 (71.0)	79 (78.2)	[a]0.63
Painful feet	432 (77.3)	260 (76.5)	72 (76.6)	84 (83.2)	[a]0.17
Number of joint replacements {0-4}	125 (22.5)	76 (22.5)	22 (23.4)	24 (24.0)	[a]0.74
Complaints of feeling dizzy or unsteady	370 (66.2)	209 (61.5)	64 (68.1)	80 (79.2)	[a]0.01
Fear of falling Short FES-I score {7-28}	15.3 (6.5)	14.4 (6.4)	15.6 (17.8)	17.8 (5.6)	>0.01
HAQ score {1-4}	2.4 (0.9)	2.3 (0.8)	2.5 (0.8)	2.8 (0.8)	<0.001
Four test balance scale					
Fail at each level					
Unsuccessful {0}	39 (7.0)	19 (5.6)	6 (6.4)	11 (10.9)	….._
Feet together stand {1}	13 (2.2)	5 (1.5)	2 (2.1)	3 (3.0)	….._
Semi-tandem stand {2}	216 (38.6)	127 (37.4)	42 (44.7)	38 (37.6)	….._
Tandem stand {3}	116 (20.8)	67 (19.7)	20 (21.3)	25 (24.8)	….._
One leg stand {4}	175 (31.3)	122 (35.9)	24 (25.5)	24 (23.8)	[a]0.008
Ability to complete 5 chair stands	484 (86.6)	307 (90.3)	83 (88.3)	76 (75.2)	[a]<0.001
Time taken to perform 5 chair stands {Seconds}	20.9 (12.2)	19.8 (11.2)	22.8 (14.1)	24.2 (13.7)	0.02

{}denotes range for variable

NS = non significance at 0.5% level

Significant differences were evaluated by one-way ANOVA or [a] chi-square test

Table 2 Associations between fall risk factors and fallers using bivariate binary logistic regression (all fallers n = 195/non-fallers n = 340).

Risk factor	Score	Odds ratio (OR)	OR 95% Confidence Intervals
Demographic risk factors			
Gender	Male (referent)		
	Female	1.1	0.7, 1.6
Age	18 - 88	1.0	0.99, 1.02
Medical risk factors			
Number of tender joints	0 - 28	1.0	0.98, 1.04
Swollen or tender lower limb	No(referent)		
joints	Yes	2.0	1.3, 2.8
DAS28 Score	0.1 – 8.	1.2	1.1, 1.3
Use of psychotropic medicines	No (referent)		
	Yes	2.4	1.5, 3.7
Taking four or more types of	No (referent)		
medicines	Yes	2.1	1.3, 3.3
Taking steroids at baseline	No (referent)		
	Yes	1.5	1.0, 2.4
History of stroke or Parkinson's	No (referent)		
disease	Yes	1.8	0.9, 3.6
Number of co-morbidities	0-10	1.0	0.97,1.2
VAS pain score	0 - 10	1.2	1.1, 1.2
VAS fatigue score	0 - 10	1.2	1.1, 1.3

History of falls in previous 12	0 fall (referent)		
months	1 fall	3.3	2.1, 5.1
	2 or more falls	4.3	2.7, 6.8
History of fracture	No (referent)		
	Yes	1.5	1.04, 2.1
History of injuries from	0 - 6	1.3	1.1, 1.6
previous falls			
Self-report/functional ability			
risk factors			
Short FES-I score	7 - 28	1.1	1.03, 1.1
HAQ score	1.00 – 4.00	1.7	1.4, 2.1
Postural risk factors			
Four test balance scale:			
Unsuccessful	0	2.3	1.1, 4.7
Feet together stand	1	2.5	0.7, 9.1
Semi- tandem stand	2	1.6	1.0, 2.5
Tandem stand	3	1.7	1.0, 2.8
One – leg stand	4 (referent)		
Complaints of feeling dizzy or	No (referent)		
unsteady	Yes	1.8	1.2, 2.6
Ability to complete chair stand	No (referent)		
test	Yes	0.48	0.29, 0.8
Time taken for chair stand test	4 – 104 secs	1.02	1.01, 1.04
(n = 484)			

Table 3.Results from a multivariate analysis based on 16 predictive risk factors of all fallers (195) versus non-fallers (340).

Variable	Odds ratio (95% confidence intervals)
Swollen or tender lower limb joints	**1.7 (1.1, 2.8)**
DAS28 score (0.1-8)	0.9 (0.8, 1.1)
Use of psychotropic medicines (Yes/No)	1.6 (0.9, 2.9)
Taking four or more types of medicine (Yes/No)	1.8 (1.5, 3.1)
Taking steroids at baseline (Yes/No)	1.3 (0.8, 2.3)
VAS pain score (0-10)	1.02 (0.9, 1.1)
VAS fatigue score (0-10)	**1.11 (1.0, 1.3)**
12 month history of a single fall (Yes/No)	**3.6 (1.8, 7.3)**
12 month history of multiple falls (Yes/No)	**5.3 (2.3, 12.3)**
A history of fracture (Yes/No)	1.3 (0.8, 1.9)
A history of injuries from	0.8 (0.6, 1.1)

previous falls (Yes/No)	
Short FES-I score (7 -28)	1.0 (0.9, 1.0)
HAQ score (1.00 -4.00)	1.2 (0.7, 2.0)
Four test balance scale (0-4)	1.0 (0.8, 1.3)
Complaints of feeling dizzy or unsteady (Yes/No)	0.9 (0.5, 1.5)
Time taken to complete the chair stand test (Secs)	0.99 (0.98, 1.02)

Table 4. Results from a multivariate analysis based on 12 explanatory risk factors of all fallers (195) versus non-fallers (340) excluding history of falls.

Variable	Odds ratio (95% confidence intervals)
Swollen or tender lower limb joints	**1.7 (1.1, 2.7)**
DAS28 score	0.9 (0.8, 1.1)
Use of psychotropic medicines	**1.8 (1.1, 3.1)**
Taking four or more types of medicines	1.6 (0.96, 2.8)
Taking steroids at baseline	1.2 (0.7, 2.1)
VAS pain score	1.02 (0.92, 1.1)
VAS fatigue score	**1.13 (1.02, 1.2)**
Fear of falling Short FES-I score	1.004 (0.95, 1.06)
HAQ score	1.11 (0.7, 1.8)
Four test balance scale	1.0 (0.8, 1.3)
Complaints of feeling dizzy or unsteady	1.1(0.7, 1.7)
Time taken for Chair Stand Test	1.002 (0.08, 1.02)