Older adults with chronic musculoskeletal pain are at increased risk of recurrent falls and the brief pain inventory may help identify those most at risk

Abstract

Objective

Chronic musculoskeletal pain (CMP) and falls are common among community dwelling older adults. Study aims were 1) investigate the relationship between CMP and any (≥1), single and recurrent falls (≥2) in community dwelling older adults. 2) Determine the discriminative validity of the Brief Pain inventory (BPI) to differentiate between non- and a) any and b) recurrent fallers.

Method

Cross sectional study involving 295 community dwelling participants (mean 77.5±8.1 years, 66.4% female). CMP was assessed and classified as none (=comparison group), single and multisite (≥2). The BPI severity and interference subscales were used and falls were recorded over 12 months. Data were analysed with logistic regression and receiver operator curves (ROC).

Results

Over half of participants (154/295, 52.2%) had CMP (41.6% single and 58.4% multisite pain). Participants with CMP were at increased risk of recurrent falls (odds ratio (OR) 2.25, 95% CI: 1.03-4.88) and this risk was highest in those with multisite CMP (OR 3.43, CI: 1.34-8.65). The BPI severity subscale demonstrated good discriminative ability to differentiate between recurrent and non-

fallers with an area under the curve (AUC) of 0.731, (CI: 0.635-0.826); a mean score of 5.1 had a sensitivity of 93.3% and specificity of 56.7%. The AUC for the BPI interference subscale was 0.724 (CI: 0.630-0.818) and a cut off score of 4.6 had a sensitivity of 84.4% and specificity of 57.8%

Conclusion

Older adults with multisite CMP are at greatest risk of recurrent falls. In clinical settings, the BPI may prove useful to discriminate between recurrent and non-fallers.

Key words: Falls, recurrent falls, musculoskeletal pain, falls screening tool, community dwelling older adults

Introduction

Falls are devastating in older age and are associated with reduced function, premature admission to long term care facilities and considerable morbidity and mortality [1, 2]. The financial impact of falls are also extraordinary [1-3] and around a third of older adults over the age of 65 fall each year [4-6]. With an ageing global population the international emphasis on preventing falls is increasing [5].

In order to prevent falls, it is important that contributing risk factors are identified and ultimately interventions developed to negate their risk [4]. Recently, research has begun to consider if older adults with pain and in particular chronic musculoskeletal pain (CMP) are at an increased risk of falls [7-10]. Chronic pain is defined as pain which has persisted beyond normal tissue healing time [11] lasting for at least the last month and for 3 of the previous 12 months [8, 12]. The relationship between CMP and falls is of great clinical relevance as CMP is highly prevalent affecting approximately 50% of community dwelling older adults [13, 14]. Recent meta-analyses found that chronic pain is associated with an increased risk of falls ($\geq$1; [15]) and in particular recurrent falls [16]. However, these meta-analyses have identified a number of limitations in the literature to date. For instance, relatively few authors have defined a fall and secondly, most studies have not clearly assessed CMP in line with recommended pain assessment guidelines and not noted considered the influence of pain severity and interference [14, 17]. This questions if we have an accurate indication of the relationship between CMP and falls. To date, only one study [8] has clearly assessed CMP and investigated the relationship with falls but the authors did not investigate the association with recurrent falls [8]. Recurrent fallers (those who fall two or more times over 12 months, [18]) are at greatest risk of experiencing the plethora of adverse consequences of falling and are therefore a clinical and research priority [4, 19, 20]. Given the fact that CMP and falls are common and highly problematic in community dwelling older adults, it is essential that this association is accurately explored with particular emphasis on recurrent falls.

A key strategy to prevent falls in clinical practice is the use of falls screening tools to discriminate between fallers and non-fallers [21]. With the mounting evidence that pain is associated with falls [8, 10, 22], it seems possible that a pain assessment tool could prove useful and discriminate between fallers and non-fallers. To date, no study has investigated the discriminative validity of a widely-used pain assessment tool. We therefore investigated whether the brief pain inventory (BPI, [23, 24]) a simple, validated and commonly used tool in older adults [8, 25], can differentiate between fallers ($\geq$1) and non-fallers and secondly, recurrent fallers ($\geq$2) and non-fallers.

The aims of this study were to 1) establish if older adults with CMP are more likely to experience a) any ($\geq$1), b) single and c) recurrent falls than a comparison group without CMP. 2) To establish if the odds of a) any ($\geq$1), b) single and c) recurrent falls differs between those with single and multisite pain compared to the comparison group. 3) Investigate the discriminative validity of the BPI to differentiate between non-fallers and a) any falls ($\geq$1) and b) recurrent fallers in older adults with CMP.

Materials and Method

Study design and Participants

In this cross sectional study, data were collected over an 8 month period (May to December 2013) across 10 participating centres in England (5 day centres, 2 sheltered housing schemes and three community 'clubs' for older adults). Permission to conduct the study was obtained from the scheme manager who determined which participants may be eligible and interested in taking part. Inclusion criteria were 1) community dwelling older adults (≥60 years), 2) mobile over 10 meters with or without a walking aid and 3) able to understand written and verbal English. Exclusion criteria included those who a) had dementia or mild cognitive impairment (including those demonstrating any signs of cognitive impairment as advised by the scheme manager/ medical records) b) had a recent self-reported history of stroke or major surgery (in the past 6 months), c) were terminally ill, d) had a serious mental illness. Data were collected over one session by the principal investigator (BS) following a standardised format lasting up to 60 minutes. All questionnaires were administered by the primary investigator to maximise understanding and participation.

Written informed consent was obtained from each participant and the study was approved by the University research and ethics committee.

Demographic information, medical history, medication use and Quality of life

Demographic details including age (years), sex and living arrangements (live alone yes/ no) were recorded. In accordance with previous research details of participant's physician diagnosed comorbidities were recorded and an overall number calculated [25] Details of all medication over the past 2 weeks were recorded [8]. All participants completed the European Quality of Life Instrument (EuroQoL EQ-5D [26]) in which participants rate their overall perceived health state from 0 to 100.

Chronic musculoskeletal pain assessment and classification

Chronic musculoskeletal pain was assessed in line with recognised pain assessment guidelines [14, 17]. CMP was confirmed when participants reported that their musculoskeletal pain was present over the past month and for at least 3 months of the previous year [8, 12]. Participants were then categorised as 1) no CMP (=comparison group), 2) single site and 3) multisite CMP (pain at ≥two sites;[8]).

Brief Pain Inventory

All participants completed the BPI severity (4 items) and interference subscales (7 items; [23, 24]). The BPI is validated for use in older adults [24]. Whilst the BPI assesses general pain rather than a particular site or type of pain, in accordance with previous research we enquired about each participants CMP over the previous two weeks [25]. We calculated the mean score across the severity and interference subscales thus providing a measure of CMP severity and interference upon activities of daily living.

The definition and ascertainment of falls

A fall was defined as '*an unexpected event in which the participants come to rest on the ground, floor, or lower level*' [27]. The total number of falls over the past 12 months was recorded and respondents classified as non-, single or recurrent fallers [28]. In order to negate the risk of reverse causality, all participants that had CMP were asked '*did your current pain arise following from a fall?*'. Participants answering yes were excluded from the analysis.

Functional mobility assessment

All participants underwent the timed up and go test [29]. The test requires the participant to stand up from a chair, walk 3 meters, turn around, walk back and sit down again. The time taken was measured in seconds and scores represent functional mobility [30].

Falls efficacy and fear of falling

All participants completed the short form falls efficacy scale international (Short FES-I, [31]). The Short FES-I scores range from 7 (no fear of falling) to 28 (very fearful of falling) and its psychometric properties have been established [31, 32].

Sedentary Behaviour

All participants were asked for the amount of time they spent sitting each day (hours and minutes per day) over the past week using the International Physical Activity Questionnaire-short form (IPAQ-SF; [33]). Previous research [34] has demonstrated that the IPAQ-SF is a valid and useful tool to assess physical activity/ sedentary behaviour in older adults.

Sample size calculation

An a priori sample size calculation was conducted using G* power software. Using a Z test to compare the proportion of fallers for those with CMP (0.5 [15]) and without (0.3 [5]), an a priori alpha of 0.05 was set with power at 0.8 and the two tailed calculation demonstrated that 93 people were needed in each group.

Statistical analysis

Data were analysed using SPSS version 20 (SPSS inc Chicago, USA). The Shapiro-Wilks and Levene's tests were used to assess normality and homogeneity of variance of the data [35]. When satisfied; an independent t-test was used to analyse differences in continuous data between groups. When these assumptions were not met, non-parametric equivalents were used. A Chi-square test was used to analyses categorical data between groups.

In order to establish if compared to the comparison group, older adults with CMP were more likely to experience a) any (≥1), b) single and c) recurrent falls, we calculated the odds ratio (OR) adjusting for age and gender (Aim 1). Next, we investigated the adjusted OR for a) any (≥1), b) single and c) recurrent falls comparing those with chronic single and multisite CMP separately against the

comparison group (Aim 2). In order to establish if medication (mean number), comorbidities (mean number), self-rated HRQOL (0-100; EQ 5D) and mobility limitations (TUG scores) influenced the association; we subsequently adjusted for these factors (in addition to age and gender) for all logistic regression analysis (adjustment 2). Finally, we adjusted for IPAQ-SF and short FES-I scores in addition to the factors adjusted for previously (adjustment 3).

For aim 3, a receiver–operator curve (ROC) analysis using the area under the curve (AUC) was utilised to determine an optimal cut-point in BPI to discriminate between a) non-fallers and any fallers and b) recurrent fallers and non- and single fallers and c) recurrent fallers and non-fallers only. Sensitivity was defined as the percentage of recurrent fallers who were correctly identified and specificity was defined as the percentage of non-recurrent fallers that were correctly identified [19]. In line with previous research investigating the discriminative ability of different falls measures [36] we established cut off points for the BPI subscales based on the optimal trade-off between sensitivity and specificity.

Results

Participant demographics

Out of a total of 401 eligible participants that were invited, 295 older adults agreed to take part (response rate 73.5%). Of those that did not take part, seventy five (18.7%) were not interested in participating for a range of reasons (e.g. belief that research does not apply to them, do not have time today) and 31 (7.7%) met one or more of the exclusion criteria.

Chronic musculoskeletal pain and comparison group

154 participants (52.2%) were categorised as having CMP and 141 (47.8%) did not and formed the comparison group. There was no significant difference in the mean age or proportion of females between the CMP and comparison group (see table 1). The mean duration of CMP was 6.6 years (range 0.4-50 years), 64 (41.6%) persons had single site pain whilst 90 (58.4%) reported multisite CMP. Full details of the CMP and comparison groups are presented in table 1.

Table 1 here

Falls in older adults with chronic musculoskeletal pain compared to the comparison group – Aim 1

The adjusted OR investigating the association between those with CMP and any ($\geq$1), single and recurrent falls are presented in table 2. In summary, the odds of any fall ($\geq$1) in the CMP group were higher than the comparison group when adjusted for age and gender (adjustment 1, OR 2.60, 95% confidence interval (CI) 1.60-4.24)), at the second adjustment for medical and mobility factors (OR 1.88, CI 1.05-3.36) but not when we adjusted further for sedentary behaviour and short FES-I scores (adjustment 3; OR 1.49, CI: 0.80-2.75). The odds of single falls were not increased in those with CMP. The odds of recurrent falls were higher in the CMP group at each adjustment and remained elevated in the fully adjusted model (OR 2.25, CI 1.03-4.88).

The odds of falling according to the number of sites of pain – Aim 2

Next we analysed those with single and multisite CMP separately. The odds of any (≥1), single or recurrent falls was not increased for those with single site pain. The odds of those with multisite CMP experiencing recurrent falls was consistently increased in each model and in the fully adjusted model the was OR 3.43 (CI: 1.34-8.65) (see table 2).

Table 2 here

The Brief Pain Inventory discriminative ability to differentiate between fallers and non-fallers-Aim 3a

The participants with CMP (n=154) mean scores on the BPI pain severity and BPI interference subscales were 5.6 (±1.8) and 4.7 (±1.9) respectively. The AUC for the BPI severity subscale to discriminate any falls and non-fallers was 0.665 (95% CI: 0.576- 0.753, n=154) and a BPI score of 5.1 had a sensitivity of 71.0% and a specificity of 56.7%. The AUC for the BPI interference subscale was 0.663 (95% CI 0.575-0.751) and a score of 4.5 on the BPI had a sensitivity of 71.1% and specificity of 55.1%.

The Brief Pain Inventory discriminative ability to differentiate between recurrent fallers and non-fallers-Aim 3b

Next, we compared the ability of the BPI to discriminate between recurrent fallers vs. non-fallers and single fallers together (n=154). The AUC for the BPI severity subscale was 0.679 (CI: 0.594-0.763) and a score of 5.3 had a sensitivity of 86.7% and specificity of 56.0%. The AUC for the BPI interference subscale was 0.684 (CI: 0.600-0.769) and a score of 4.7 had a sensitivity 82.2% and specificity of 55.0%.

Finally, we compared the discriminative ability of the BPI comparing recurrent fallers versus non-fallers only (n=109) (figure 1). The AUC was for the BPI severity subscale was 0.731, (CI: 0.635-0.826) and a score of 5.1 had a sensitivity of 93.3% and specificity of 56.7%. The AUC for the BPI

interference subscale was 0.724 (CI: 0.630-0.818) and a cut off score of 4.6 had a sensitivity of 84.4% and specificity of 57.8%.

Figure 1 here

Discussion

To our knowledge, this is the first study to investigate the association between clearly assessed CMP and recurrent falls. We found that after multiple adjustments, the odds of recurrent falls were significantly increased in older adults with CMP (OR 2.25, CI: 1.03-4.88). However, this risk was greatest in those with multisite CMP (OR 3.43, CI: 1.34-8.65). We did not find that the odds of falling (any, single or recurrent) was increased in older adults with single site CMP. The results support previous research that has clearly investigated falls in older adults with CMP [8]. In addition, our results concur with previous research that chronic pain (although assessed through a single question; [37]) is more strongly associated with recurrent falls compared to single or any falls. This relationship has also been demonstrated in non-chronic pain (i.e. < 3 months) by other authors previously [22, 38] although none assessed pain in accordance with pain assessment guidelines [12, 15]. For instance, Kitayuguchi et al [38] found that multisite musculoskeletal pain was particularly associated with recurrent falls but the authors relied upon a single question assessing pain over the last week.

The prevalence of CMP in our study (52%) is in line with recent research [8, 14]. Our analysis demonstrated that over half of those with CMP were affected by multisite pain (58.4%) and this group were more likely to have any ($\geq$1) and recurrent falls. Reasons for the particularly increased risk of recurrent falls in older adults with CMP are likely to be complex since falls are typically multifactorial [5, 39]. However, it may be that pain increases the risk of falls in the long term by accelerating the process of functional decline [13] thus impairing balance and increasing an older person's propensity to fall. Both balance and functional mobility are strongly related to falls [4, 40] and these are likely to contribute. In addition, previous research has clearly linked increasing pain severity to the risk of falls the following month [8] thus suggesting that in the shorter term pain severity may have a more imminent effect on increasing falls risk. Factors potentially underlying the pain-falls relationship may include local joint pathology (e.g. osteoarthritis, [41]), the neuromuscular effects of pain and more central mechanisms whereby pain interferes with cognition [8]. The current

study shows that in those with CMP, recurrent falls were experienced by 29.2% which is higher than previously reported in other chronic pain samples (e.g. [37]). However, no previous study has clearly assessed CMP and recurrent fall rates have been reported to be as high as 25% in people of a comparable age (aged 80 years) and above in the general population [39, 42].

In our results, we found that the BPI severity and interference subscales had a moderate ability to discriminate between fallers and non-fallers with an AUC of 0.665 (95% CI: 0.576- 0.753) and 0.663 (95% CI 0.575-0.751) respectively. This is higher than previous research investigating more traditional falls screening tools including the TUG (AUC 0.61, [43]), the Berg Balance Scale (AUC 0.59, [44]) and Tinnetti balance scale (AUC 0.56, [43]) but lower than a functional gait assessment (FGA; AUC 0.87, [45]). The BPI severity and interference subscales may be more useful to discriminate between non and recurrent fallers since the AUC for the BPI severity and interference subscale was higher than previously reported tools for recurrent falls in the literature including the LASA (Longitudinal Aging Study Amsterdam falls risk tool) instrument (AUC: 0.71, CI: 0.67–0.74; [20]), lower limb strength (AUC 0.58, CI: 0.51–0.64, [19]) and mediolateral sway (AUC 0.67, CI: 0.57–0.77, [19]). This is of great interest as preventing recurrent fallers is an International priority [4]. With this in mind, the BPI severity (4 items) or interference (7 items) could be considered in clinical practice as a falls screening measure for older adults identified as having CMP as it is quick and may prove useful in identifying those at greatest risk of recurrent falls.

Limitations

A number of limitations should be considered with the results of this paper. First, we relied upon retrospective recall of falls from our sample. Although numerous authors [7, 9, 22, 37, 38] have used this approach, there are concerns about the accuracy of this method and in particular recall bias [27]. *Whilst recall bias may cast some doubt about the accuracy of the overall number of falls in the sample, there is no reason to believe that any potential recall bias would be different for those with CMP and the comparison group.* Second, it is not possible to completely rule out reverse causality in

the relationship between pain and falls. Third, despite excluding participants with dementia and MCI, it is possible that some participants had some form of cognitive impairment. Fourth, the study was cross sectional. Fifth, the principal investigator (BS) collected all data and may have introduced bias.

Future Research

Future research is needed to establish if screening with the BPI can help identify and reduce the risk of falls and in particular recurrent falls in community dwelling adults. Future research should prioritise the measurement of falls prospectively [27] and should consider not only the influence of the number of pain sites but also the influence of CMP location. A randomised control trial is warranted to establish if pain management interventions can reduce the occurrence of falls in older adults with CMP.

In conclusion, older adults with multisite CMP appear to be at significantly increased risk of recurrent falls compared to people of similar age and gender. The BPI severity and interference subscale scale may prove useful to discriminate between non and recurrent fallers. CMP should no longer be ignored as a risk factor for falls and future research is required to establish if pain management interventions can reduce this risk with a particular emphasis on those with multisite CMP.

Acknowledgements

We thank the participants and centre managers who kindly gave up their time to take part in this research.

Disclosure statement

No conflict of interest to declare by any author. However, BS is supported by a Vice Chancellors scholarship at the University of Greenwich but this has no influence on the research at any stage or decision to publish.

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Figure legends

Figure 1 The Receiver operating characteristic (ROC) and area under the curve (AUC) for the BPI Severity (AUC=0.731, 95% CI: 0.635-0.826) and Interference subscales (AUC=0.724, 95% CI: 0.630-0.818) to discriminate between recurrent fallers and non-fallers only (n=109).

Table 1 Comparison of the baseline characteristics of those with chronic musculoskeletal pain and comparison group

Table 2 The Adjusted Odds of falling according to pain category