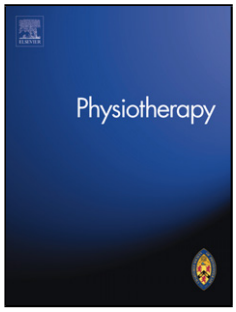


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# Musculoskeletal pain characteristics associated with lower balance confidence in community-dwelling older adults

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**Abstract**

**Objective** To determine whether musculoskeletal pain (pain severity and number of chronic pain sites; single or multisite) is associated with balance confidence over and above previously established risk factors.

**Design** Cross-sectional study.

**Setting** Ten community sites (five day centres, two sheltered housing schemes and three community 'clubs') in the UK.

**Participants** Two hundred and eighty-nine community-dwelling older adults [response rate 72%, mean age 78 (standard deviation 8) years, 67% female] completed the study assessment. Eligibility criteria were as follows: living in the community; aged ≥60 years; able to walk ≥10 m; able to communicate in English; and no cognitive (e.g. dementia), neurological or mental health conditions.

**Interventions** Not applicable.

**Main outcome measure** Balance confidence as measured by the 16-item Activities Balance Confidence (ABC) scale (lower scores indicate less confidence).

**Results** One hundred and fifty participants had at least one site of chronic musculoskeletal pain (52%), and the remaining 139 (48%) participants did not report chronic musculoskeletal pain. Older people with chronic musculoskeletal pain had significantly lower scores on the ABC scale compared with those without chronic musculoskeletal pain (mean 48.3 vs 71.3, $P<0.001$). After adjustment for established risk factors, two separate hierarchical regression models demonstrated that both pain severity (β=-0.106, $P=0.029$) and number of chronic musculoskeletal pain sites (β=-0.98, $P=0.023$) were significantly associated with lower balance confidence.

**Conclusion** Both pain severity and number of chronic pain sites (particularly multisite pain) are associated with lower balance confidence in community-dwelling older adults. Further

research is needed to target pain symptoms and balance confidence in relation to fall risk in older adults with chronic musculoskeletal pain.

*Keywords:* Balance confidence; Chronic musculoskeletal pain; Pain; Falls; Older adults

**<A>Introduction**

Chronic musculoskeletal pain affects approximately 50% of community-dwelling older adults [1] and is a leading cause of disability in old age, associated with mobility and activities of daily living (ADL) difficulties [2,3]. Research has also demonstrated that both chronic musculoskeletal pain (particularly multisite) and pain severity are important risk factors for falls [4,5]. Recently, interest has risen about the possible impact of chronic musculoskeletal pain on 'psychological concerns related to falls' such as balance confidence [6]. However, research in this area is lacking [6,7].

Balance confidence refers to an individual's confidence to maintain their balance and avoid falling over when undertaking their ADL [8,9]. Loss of balance confidence is a cause for concern as it may result in activity restriction, which can consequently increase sensorimotor deconditioning and subsequently increase the older person's risk of falls [8–11]. Furthermore, reduced balance confidence is, in its own right, disabling and detrimental to the wellbeing of older adults [7,12]. Among the few measures of balance confidence, one measure, the Activities and Balance Confidence (ABC) scale [13], is favoured among clinicians and has excellent test–retest reliability ($r$=0.92, $P$<0.001) [13] and internal consistency (Cronbach's alpha=0.96) [14]. The ABC scale is a 16-item questionnaire that assesses a person's confidence to perform various functional tasks without losing their balance [13], and is able to identify those at risk of falls [9,15].

In a recent systematic review, Stubbs *et al.* [6] were unable to identify any publications describing research with the primary aim of investigating the relationship between chronic musculoskeletal pain and balance confidence. This is despite the fact that both are common and pervasive phenomena among older adults, and that musculoskeletal pain is associated with risk factors for low balance confidence (e.g. poor mobility, history of falls [7,9]). Stubbs *et al.* [6] only identified one small study [16] that compared balance

confidence in older adults with back pain (*n*=15) with those without pain (*n*=15). The study found that older adults with back pain scored lower on the ABC scale than those without pain. To the present authors' knowledge, no other studies have addressed this issue. However, as high numbers of community-dwelling older adults are affected by chronic musculoskeletal pain and reduced balance confidence, research is required to disentangle this relationship. Specifically, research is required to investigate the impact of the severity of musculoskeletal pain, and also to see if the number of chronic pain sites (particularly multisite pain) is an important factor for balance confidence. Moreover, if musculoskeletal pain does contribute to balance confidence, this association could be influential in the impact that pain has on mobility and falls risk [3,5,17,18].

The aim of this study was to determine whether the severity of chronic musculoskeletal pain and number of pain sites is associated with balance confidence. It was hypothesised that both pain severity and multisite pain contribute to loss of balance confidence after accounting for other common risk factors for lower balance confidence, including demographic, medical and mobility factors.

## <A>Methods

### <B>*Design*

A cross-sectional study was conducted in 10 participating sites across the UK, including five day centres, three community activity 'clubs' for older adults and two sheltered housing schemes. Ten separate sites were picked to ensure some diversity among the type of participants recruited across different settings and locations.

### <B>*Recruitment and participants*

The principal investigator (BS) met with a manager at each participating centre who advised on potential participants who were likely to meet the eligibility criteria. The eligibility criteria were: community-dwelling older adults (≥60 years); mobile over 10 m with or without a walking aid; and able to understand written and verbal English. Exclusion criteria were: dementia or mild cognitive impairment (as advised by the manager at each centre); self-reported history of stroke or major surgery in the past 6 months; terminally ill; or serious mental illness (self-reported or reported by the centre manager). Data were collected by the principal investigator using a standardised format, lasting approximately 1 hour, on site at each facility. Ethical approval was obtained from the Research and Ethics Committee at the University of Greenwich, and written informed consent was obtained from each participant.

*<B>Demographic and background variables*

The interview included participants' demographic characteristics [age, sex, currently live alone (yes/no)] and medical history (self-reported physician-diagnosed comorbidities and number of prescribed and over-the-counter medications taken in the previous 2 weeks). All participants completed the European Quality of Life Instrument (EQ-5D) [19], in which participants rated their overall health state from 0 to 100 (higher scores = better health-related quality of life). The EQ-5D includes questions regarding symptoms of anxiety and depression, and difficulties undertaking ADL ranging from 1 (no symptoms of depression/no difficulties undertaking ADL) to 5 (severely depressed/unable to undertake ADL). Participants scoring >1 were classified as having depressive symptoms and difficulties undertaking ADL, respectively.

*<B>Mobility assessments*

Details of participants' use of walking aids either inside or outside (yes/no) were obtained, and all participants completed the timed up and go (TUG) test [20]. History of falls in the past year was assessed; a fall was defined as 'an unexpected event in which the participants come to rest on the ground, floor, or lower level' [21]. Sedentary behaviour were ascertained using the International Physical Activity Questionnaire [22].

*<B>Chronic musculoskeletal pain assessment*

In accordance with previous research, participants were asked if they had experienced musculoskeletal pain over the past month, and for at least 3 of the past 12 months, across seven bodily locations (hands and wrists, shoulders, hips, knees, back, neck and feet [4]). Participants who met these criteria were classified as having chronic musculoskeletal pain [either single site or multisite (at least two sites)], and those who did not meet these criteria were classified as not having chronic musculoskeletal pain [4].

*<B>Brief Pain Inventory*

All participants completed subscales of the Brief Pain Inventory (BPI) [23] which has been validated for use in older adults with non-malignant pain [24]. The BPI contains a subscale measuring the severity of pain (four items), in which the participant rates their pain on an 11-point scale (0=no pain, 10= worst pain) at its (a) worst, (b) least, (c) on average and (d) right now. Participants were asked to refer to their pain over the past 2 weeks, and the mean score was calculated across the four items [4,23].

*<B>Balance confidence assessment*

The ABC scale [13] is a 16-item instrument in which participants rate their confidence in maintaining their balance when undertaking 16 functional ADL. Each question begins with

'How confident are you that you will not lose your balance or become unsteady when you…?' For each question, the participant rates their confidence in their balance from 0% (no confidence) to 100% (complete confidence). The mean score was calculated across the 16 items, with higher scores indicating greater confidence. A range of different functional activities are covered ranging from low-level activities such as 'walking around the house' to much more challenging activities such as 'walking on an icy pavement' and 'walking on an escalator without holding on to the handrail'.

*<B>Data analysis*

Data were analysed using Statistical Package for the Social Sciences Version 20 (IBM Corp., Armonk, NY, USA). Continuous data were assessed for normality with a visual inspection of PP plots in addition to the calculation of skew and kurtosis [25]. The BPI severity score and time to perform the TUG test were consequently log-transformed. The ABC scores were divided into tertiles (cut-off points to create three groups: 0 to 33.3%, 33.4 to 66.6% and >66.6% of ABC scores) to enable comparisons between groups. In addition, participants were grouped into tertiles according to BPI pain severity scores. Secondly, participants were grouped according to the number of chronic musculoskeletal pain sites: none, single site and multisite. Analysis of variance and Chi-squared tests were used to compare continuous and categorical variables between those with low, moderate and high balance confidence. In order to determine the influence of pain severity and number of pain sites (none, single and multisite), separate hierarchical regression models were run with balance confidence (ABC scores) as the dependent variable. In the first step (Model 1), either the mean BPI severity score or number of pain site (none, single or multisite) categories were entered, together with age and sex. In the second step (Model 2), Model 1 and medical and health-related quality of life (HRQOL) factors (number of comorbidities, number of medications, vision, self-care,

anxiety and depression, and overall HRQOL) were included. In the third step (Model 3), Models 1 and 2 and mobility factors (use of a walking aid, history of falls, sedentary behaviour) were included. Finally, in the fourth step (Model 4), variables in Models 1 to 3 were included in addition to TUG test results. At each step of the modelling, the standardised beta-coefficients for mean BPI severity score and number of pain site categories are reported. Multicollinearity was assessed by calculation of the variation inflation factor (VIF) and tolerance for each model, ensuring that they were within satisfactory ranges (VIF <10 and not much higher than 1; tolerance > 0.2 [25]). Significance was set at $P \leq 0.05$.

*<B>Sample size calculation*

A sample size calculation was conducted using G power software before commencement of the study. Using alpha of 0.05, power of 0.95, a model with 13 predictors and a medium effect size ($F^2$=0.15), a total sample size of 189 was required.

**<A>Results**

*<B>Participant characteristics*

Out of 401 participants invited to take part, 295 agreed and enrolled in the study. Of those who did not take part, 75 (19%) were not interested and 31 (8%) met one or more of the exclusion criteria. ABC questionnaires were incomplete for six participants, so 289 (response rate 72%) older adults had complete information for this study. The average age of the sample was 78 years [standard deviation (SD) 8 years] and 195 were female (67%). Across the sample, the mean ABC score was 59% (SD 24%). The ABC score were categorised into tertiles as low balance confidence (*n*=98, ABC score 0 to 45%), moderate balance confidence (*n*=94, ABC score 45.1 to 71.3%) and high balance confidence (*n*=97, ABC score 71.4 to 100%).

In total, 150 participants had chronic musculoskeletal pain (52%) and 139 (48%) did not. Of those with chronic musculoskeletal pain, 61 had single site pain (41%) and 89 had multisite pain (59%). The mean score on the BPI severity subscale among the chronic musculoskeletal pain group was 5.6 (SD 1.8, *n*=150). Nineteen participants without chronic musculoskeletal pain reported some mild pain over the past 2 weeks on the BPI severity scale (mean BPI severity score 0.29). Pain severity tertiles were classified as no pain (*n*=120), moderate pain (*n*=77, mean BPI score 3.3, range 0.9 to 5.0) and high pain (*n*=92, mean BPI score 6.8, range 5.3 to 10.0).

*<B>Characteristics of participants according to balance confidence*

A summary of the key sociodemographic, medical and mobility factors according to balance confidence tertiles is presented in Table 1. Participants with low balance confidence tended to be older, reported more comorbidities, took more medications and had lower HRQOL than participants with high balance confidence. In addition, there were significant trends for those with lower balance confidence to be more sedentary and have poorer mobility (slower times on TUG test) and a history of falls.

**<Insert Table 1 here>**

*<B>Relationship between chronic musculoskeletal pain, pain severity and balance confidence*

Overall, participants with chronic musculoskeletal pain (*n*=150) had significantly lower ABC scores (48%) compared with those without chronic musculoskeletal pain (*n*=139; 71%), equating to a mean difference of 23 (*P*<0.001). Table 1 shows a strong and significant trend between chronic musculoskeletal pain and balance confidence, with higher proportions of

participants with low balance confidence having chronic musculoskeletal pain (78%), compared with those with moderate (52%) and high balance confidence (26%).

As shown in Fig. 1a, participants with the most severe pain according to the BPI severity subscale were much more likely to have low balance confidence compared with participants with no pain. Similar findings were observed according to the number of pain sites (Fig. 1b), where the greatest proportion of people with low balance confidence was found among participants with multisite chronic musculoskeletal pain.

**<insert Figure 1a and b here>**

*<B>Predictors of balance confidence among older adults with musculoskeletal pain*

*<C>Pain severity*

In Model 1, pain severity (mean BPI scores), age and sex significantly explained 39% of the variance in ABC scores ($F_{[3,287]}$=60.2, $P$<0.001, $R^2$=0.386, adjusted $R^2$=0.380). After adjusting for sociodemographic, medical, mobility and HRQOL factors, pain severity continued to be inversely associated with balance confidence in Model 4 (β=-0.106, $P$=0.029).

*<C>Number of chronic musculoskeletal pain sites*

In Model 1, the number of pain sites (none, single, multisite), age and sex explained 34% of the variance in ABC scores ($F_{[3,287]}$= 48.8, $P$<0.001, $R^2$=0.338, adjusted $R^2$=0.331). After adjusting for demographic, health and mobility factors, the number of pain sites continued to be independently associated with poorer balance confidence in Model 4 (β=-0.98, $P$=0.023). Full details on the influence of pain severity and the number of pain sites on balance

confidence at each stage of modelling are summarised in Table A (see online supplementary material).

**<A>Discussion**

The results of this study support the notion that greater pain severity and multisite chronic musculoskeletal pain are associated with reduced balance confidence in community-dwelling older adults. Older adults with chronic musculoskeletal pain scored much lower on the ABC scale than those without chronic pain. The study findings show that after adjustment for multiple established risk factors for lower balance confidence (number of comorbidities, mobility difficulty, history of falls, sedentary behaviour), pain severity and multisite pain are associated with lower balance confidence.

The average ABC score of older adults with chronic musculoskeletal pain in this study was 48%; this low score is comparable to other populations such as patients with vestibular disorders (50%) [26], patients following a hip fracture (58%) [27], and adults with multiple sclerosis (66%) [28]. Whilst these latter populations have traditionally been considered to be 'at risk' for both lower balance confidence and falls, attention has only recently started to consider these important outcomes in people with chronic musculoskeletal pain. When one considers that those with chronic musculoskeletal pain have profound mobility limitations [3,29], which is a consistent risk factor for reduced balance confidence [7], this result may come of little surprise. However, the associations between pain characteristics and balance confidence remained evident after adjusting for multiple risk factors. These data demonstrate for the first time that the deficits in balance confidence seem most profound in those with multisite pain and those with the most severe pain. Previous research has highlighted that those with multisite and severe pain are most likely to fall [4,5,30]. Thus, this study supports the idea that clinicians should pay particular attention to

older adults who have chronic musculoskeletal pain for fall prevention efforts. The exact reasons for reduced balance confidence cannot be deduced with certainty, but may include a sense of instability leading to loss of confidence, or similar factors proposed for the pain and falls relationship including local joint pathology, neuromuscular effects of pain, and central mechanisms, within which pain possibly interferes with cognition or executive function and therefore perceived confidence [4].

With these results in mind, clinicians could consider the available options to improve both pain and balance confidence. A recent systematic review [31] established that tai chi offered a medium effect size improvement in balance confidence [standardised mean difference (SMD) 0.48], and appeared to have more favourable effects than exercise and multifactorial interventions (SMD range 0.22 to 0.31). Tai chi has also demonstrated a beneficial effect on balance and falls [32], and may reduce pain and disability in people with chronic musculoskeletal conditions [33]. Taken together, in clinical practice, tai chi may offer favourable outcomes in several of these important domains that are commonly affected in older adults with chronic musculoskeletal pain. In addition, exercise including balance and strength training can also improve balance confidence [31], and a recent umbrella review of meta-analyses of randomised control trials established that exercise is the most consistently reported effective single intervention to reduce falls in older adults [34]. Physiotherapists may prove to be highly valuable for assessing the risk of falls in individuals, and advising on appropriate adaptive strategies for those with more profound mobility limitations and high falls risk. Other forms of structured physical activity may also have beneficial effects on pain symptoms [35], and possibly on falls [36] and injurious falls [37]. However, to the authors' knowledge, no authors have specifically investigated the influence of physical activity on both pain symptoms and falls in a sample of community-dwelling older adults with chronic musculoskeletal pain.

*<B>Limitations and future research*

Whilst this study introduces new findings on the psychological impact of pain in older adults, there are a number of limitations that should be considered. First, this study was cross-sectional and one can only refer to correlation and not causation. Second, despite the fact that the authors attempted to exclude for cognitive impairment and/or dementia, it is possible that some people with a degree of cognitive impairment entered the study, although all participants enrolled were able to complete the interview and assessment. Third, the participants within this study were self-selected and not a random sample; as such, the results are not generalisable to the older UK population, although the participants were drawn from several areas around the UK. Finally, a small number (13%) of participants who did not meet the definition of chronic musculoskeletal pain reported some very mild pain over the past 2 weeks (mean BPI 0.29 vs 5.6 in those with chronic pain).

Future prospective population-based research is needed to determine whether there is a temporal relationship whereby pain leads to lower balance confidence in older adults, and should seek to identify contributing factors. Of equal importance is consideration of future interventional strategies that may not only improve balance confidence, but also improve physiological balance, reduce fall risk and improve pain symptoms among older adults living with chronic musculoskeletal pain. Tai chi does show promise when various domains are considered separately (e.g. balance confidence, physiological balance, pain and falls) but this has not yet been tested collectively in a sample of older adults with chronic musculoskeletal pain.

**<A>Conclusion**

This study demonstrated that both pain severity and number of chronic musculoskeletal pain sites are associated with lower balance confidence in a sample of community-dwelling older adults. The associations between pain severity and multisite pain with balance confidence remained evident after adjustment for several well-established risk factors. There is a need for future prospective research to better understand these relationships, and, in particular, to develop and test interventions to improve pain symptoms, balance confidence and mobility limitations in older adults with chronic musculoskeletal pain.

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*Conflicts of interest:* None declared.

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Table 1
Sociodemographic and health characteristics according to balance confidence groups.

| Variable | Low balance confidence (*n*=98) | Moderate balance confidence (*n*=94) | High balance confidence (*n*=97) | *P*-value trend |
|---|---|---|---|---|
| Age in years, mean (SD) | 80 (8) | 78 (7) | 74 (8) | <0.001 |
| Female, *n* (%) | 72 (74) | 60 (64) | 63 (65) | 0.29 |
| Live alone, *n* (%) | 70 (71) | 63 (67) | 59 (61) | 0.28 |
| Vision OK or better, *n* (%) | 59 (60) | 70 (74.4) | 83 (85.5) | <0.001 |
| Number of comorbidities, mean (SD) | 4.2 (1.2) | 3.3 (1.2) | 2.6 (1.4) | <0.001 |
| Number of medications, mean (SD) | 5.3 (1.8) | 3.6 (1.9) | 2.4 (1.8) | <0.001 |
| Number with symptoms of depression and anxiety (scores of >1 to 5), *n* (%) | 50 (51) | 31 (33) | 9 (9) | <0.001 |
| Uses walking aid, *n* (%) | 85 (87) | 38 (40) | 8 (8) | <0.001 |
| Fallen in past year, *n* (%) | 56 (57) | 53 (56) | 24 (25) | <0.001 |
| Sedentary behaviour in hours/day, mean (SD) | 12.7 (2.5) | 9.6 (3.2) | 6.3 (2.8) | <0.001 |
| Timed get up and go scores in seconds, mean (SD) | 17.7 (6.9) | 11.8 (2.9) | 9.0 (2.0) | <0.001 |
| Number with difficulties in self-care (scores of >1 to 5), *n* (%) | 71 (72) | 24 (26) | 7 (7) | <0.001 |
| Chronic musculoskeletal pain, *n* (%) | 76 (78) | 49 (52) | 25 (26) | <0.001 |
| How good or bad is | 56.7 (21.8) | 68.1 (18.7) | 80.6 (15.7) | <0.001 |

| | |
|---|---|
| your health? (0 to 100), mean (SD) | |

SD, standard deviation.

Low balance confidence, Activities Balance Confidence (ABC) scale score 0 to 45%; moderate balance confidence, ABC scale score 45.1 to 71.3%; high balance confidence, ABC scale score 71.4 to 100%.

Figure 1. (a) Balance confidence categories according to (a) Brief Pain Inventory pain severity categories and (b) number of chronic musculoskeletal pain sites. Blue bars indicate low balance confidence, red bars indicate moderate balance confidence and green bars indicate high balance confidence.