Article:
Smith, RD, McHugh, GA orcid.org/0000-0002-5766-5885, Quicke, JG et al. (4 more authors) (2022) The relationship between multisite peripheral joint pain and physical activity levels in older adults: A cross-sectional survey. Musculoskeletal Care, 20 (2). pp. 341-348. ISSN 1478-2189

https://doi.org/10.1002/msc.1593

Title: The relationship between multisite peripheral joint pain and physical activity levels in older adults: a cross-sectional survey

Running title: Relationship between multisite joint pain and physical activity

Authors: Smith RD[1], McHugh GA[2], Quicke JG[3], Finney A[3], Lewis M[3], Dziedzic KS[3] & Healey EL[3]

[1] School of Nursing, The University of Hong Kong, Hong Kong, China.
[2]School of Healthcare, University of Leeds, Leeds, United Kingdom, LS2 9JT.
[3]School of Medicine, Primary Care Centre Versus Arthritis, Keele University, Keele, Staffordshire, United Kingdom, ST5 5BG.

Acknowledgments:

The lead author (RS) was funded by a Keele University ACORN studentship. The funder had no involvement in the design, collection, analysis, writing or publishing of this paper. This work was supported by a National Institute for Health Research (NIHR) Programme Grant (RP-PG-0407-10386). This research was also funded by the Arthritis Research UK Centre in Primary Care grant (Grant Number 18139). KD and ELH are part funded by the National Institute for Health Research (NIHR) Applied Research Centre (ARC) West Midlands. KD was also part funded by an NIHR Knowledge Mobilisation Research Fellowship (KMRF-2014-03-002) and is an NIHR Senior Investigator. ELH is part funded by the National Institute for Health Research (NIHR) Applied Research Centre (ARC) West Midlands. JQ is part funded by a NIHR Clinical Research Network West Midlands, Research Scholar Fellowship. The views expressed in this publication are those of the author(s) and not necessarily those of the NHS, the NIHR, HEE or the Department of Health and Social Care.

Conflict of interest:

All the authors have no conflict of interest to report.

Author contribution:

The study's research question, study design and analysis plan were conceived by as part of RDS PhD thesis with ELH, KSD and GMH. Data cleaning and analysis were conducted equally by ML, RDS and JGQ. Interpretation of findings were contributed by all authors, all authors also contributed to the preparation of this manuscript.

Abstract

Introduction

Research on levels of physical activity (PA) in those with peripheral joint pain have only focused on single sites, in the knee or hips. This study investigated the levels of PA in adults with single-site and multisite peripheral joint pain compared to adults with no joint pain.

Methods

Analysis of a cross-sectional population survey mailed to adults aged ≥45 years (n=28,443) was conducted. Respondents reported any peripheral joint pain in the last 12 months in either the hands, hips, knees or feet; PA levels were self-reported using the short telephone activity rating scale. The association between PA levels, peripheral joint pain and outcomes of health status (physical and mental component scores, PCS and MCS, using SF-12) pain intensity (10-point scale) and health-related quality of life (HRQoL) (EQ-5D) were investigated using analysis of variance and ordinal regressions.

Results

Compared to those with no joint pain, all pain groups reported lower levels of PA: joint pain in one site (OR=0.91, 0.83-0.99 95%CI); two sites (0.74, 0.67-0.81), three sites (0.65, 0.59-0.72) and four sites (0.47, 0.42-0.53). Across all joint pain groups, levels of PA were associated with pain intensity, physical health status, mental health status and HRQoL.

Discussion

Adults with more sites of peripheral joint pain were more likely to report lower levels of PA. Those with more sites of pain and lower levels of PA reported poorer outcomes. Health care providers should be aware that those with multisite joint pain are most likely to have low levels of PA.

Keywords: Physical activity, multisite peripheral joint pain, cross-sectional survey.

Background

Peripheral joint pain is common among adults aged 45 years and over within the UK with around 79% of all adults experiencing some joint pain in the hands, hips, knees and feet (Finney, Dziedzic, Lewis, & Healey, 2017). In adults aged 45 years and over, osteoarthritis (OA) is the most common cause of peripheral joint pain (Felson, 2009). OA is a clinical syndrome of joint pain causing varying degrees of limitation in physical function and reduced quality of life (National Insitute of Health and Care Excellence (NICE), 2014). Physical activity (PA) is recommended as a core treatment for all adults with OA in the hands, hips, knees and feet, regardless of age, other co-existing health conditions, level of pain or disability (NICE, 2014). To date, research on levels of PA in those with peripheral joint pain have only focused on single joint sites such as the knee (Daugaard et al., 2018; Glaviano, Baellow, & Saliba, 2017; Herbolsheimer et al., 2016; Sliepen, Mauricio, Lipperts, Grimm, & Rosenbaum, 2018; Thoma et al., 2018; White et al., 2013) or the hip (De Groot, Bussmann, Stam, & Verhaar, 2008; Holsgaard-Larsen & Roos, 2012) which were associated with lower levels of physical activity compared to similar aged general populations adults. In addition to the clinical benefits that therapeutic exercise has on outcomes for adults with OA (Uthman et al., 2013), levels of PA during daily living are important as low levels of PA are associated with higher levels of pain intensity symptoms and poorer physical functioning (Shim, Park, Kim, Kyung, & Shin, 2018; Stubbs, Hurley, & Smith, 2015; Thoma et al., 2018; Timmermans et al., 2019).

Pain in multiple sites across all the body is common, a survey of Swedish adults aged 65 years and over showed 38% reported two or more areas of pain on their body compared to only 12% that reported pain in only one area (Dragioti, Larsson, Bernfort, Levin, & Gerdle, 2017). Adults with a

higher number of painful sites commonly report lower general well-being, lower self-reported physical and mental health, more pain frequency, pain severity and increase risk of falls (Dragioti et al., 2017; Finney, Dziedzic, Lewis, & Healey, 2017; Lacey et al., 2014; Welsh, Clarson, Mallen, & McBeth, 2019). Despite over half of adults aged 45 years and over reporting multisite peripheral joint pain in the hands, hips, knees and feet (Finney et al., 2017), there has been limited investigation into PA levels in adults with multisite peripheral joint pain. Despite the emphasis on the importance of regular PA in the management of joint pain, uptake of exercise as a treatment for their pain appears to be underutilised, with predominate reliance on pharmacological treatment (Healey et al. 2018). In adults with at least two sites of joint pain, only 30% participate in exercise as treatment compared to 95% that report regular use of at least one analgesic medications (Raja et al., 2016). There has been no study to date investigating the levels of PA in those with multisite joint pain and the relationships between multisite peripheral joint pain, levels of PA and joint pain symptoms or health outcomes.

The clinical guidelines that recommend PA as a core treatment for OA acknowledged many adults will have OA in multiple sites (NICE, 2014). Currently, it is unclear what the uptake of PA is in UK adults with multisite peripheral joint pain. The aim of this study was to determine levels of PA in those with single-site and multisite peripheral joint pain (pain in two or more sites of the hands, hips, knees or feet) compared to similar aged adults with no reported joint pain.

Methods

Design and participants

Secondary analysis was conducted of the cross-sectional population postal survey which was part of the 'Managing Osteoarthritis in Consultations' MOSAICS study (Dziedzic et al., 2014). This study was

reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for cross-sectional studies (Von Elm et al., 2007). The survey was mailed to 28,443 adults aged 45 years and over, registered at eight participating general practices in the West Midlands and North West of England between May 2011 and April 2012. General practice characteristics varied in terms of: number of registered patients; number of clinical staff; practice location (which included both urban and rural settings); and levels of local area deprivation. General practitioners had an opportunity to screen and exclude ineligible participants for example those unable to provide informed consent or had a recent family bereavement (Dziedzic et al., 2014). Those flagged as excluded from research in that practice were excluded and those contacting the research team indicating they did not wish to take part in the study were not contacted again. The postal survey was mailed in a two-stage mailing process. The first stage included a letter of invitation sent to participants and information about the MOSAICS study, and the survey. After two weeks, non-responders were sent a reminder survey and letter. The study was approved by the North West Midlands 1 Research Ethics Committee, Cheshire, UK, as part of the MOSAICS study (ISRCTN number: ISRCTN06984617) (Dziedzic et al., 2014).

Data collection

The population survey collected participants' demographic information (age, gender, self-reported height and weight), area deprivation for participants' postcode was measured in quintiles using the Index of Multiple Deprivation (IMD) (Noble, Wright, Smith, & Dibben, 2006). The survey included items asking participants if they experienced '*any pain in the last year in or around the hands, hips, knees or feet?*' Participants were asked to score the average level of pain intensity on a 0-10 numerical rating scale in correspondence to each painful peripheral joint. Level of PA was measured using the Short Telephone Activity Rating (STAR) scale (Matthews et al., 2005). The STAR questionnaire is a short 3-item questionnaire, which measures frequency and duration of moderate and vigorous activity. The STAR questionnaire categorises respondents into three levels of PA;

inactive (no moderate- or vigorous- intensity activity in a normal week), somewhat active (some moderate- or vigorous- intensity, but insufficient amounts to recommended levels) and active to recommended levels (moderate intensity for 5 $d \cdot wk^{-1}$ and 30 $min \cdot d^{-1}$ (5 30) or vigorous intensity for 3 $d \cdot wk^{-1}$ and 20 $min \cdot d^{-1}$) (Haskell et al., 2007). The STAR has demonstrated test-retest reliability and construct validity in relation to objective activity monitoring in general adult populations (Matthews et al., 2005). Those that did not complete the STAR in the population survey were excluded from this analysis. Other measures in the survey included general health status measured using the SF-12 in the physical component scale (PCS) and mental component scale (MCS)(Ware Jr, Kosinski, & Keller, 1996) and health-related quality of life (HRQoL) using the EQ-5D 3L (EuroQol, 1990).

Statistical analysis

Descriptive statistics were used in stratified data by the number of joint pain sites; those with no joint pain, single site joint pain, joint pain in any two sites, any three sites or all four sites, displaying participants' demographic data and reported outcomes. Proportions or means and standard deviations (SD) were calculated for each participants' demographic data or reported outcome. In participants with more than one pain site, average pain intensity was calculated as a mean score across the different sites of joint pain (Finney et al., 2015). Mean difference in demographics and reported outcomes between groups were tested using an unadjusted one-way ANOVA, and linear trends were tested using linear contrasts. The association between the number of joint pain sites (those with no reported joint pain taken as the reference group) and levels of PA was investigated using proportional odds ordinal regression model. Adjustments for potential confounding were made in covariates: age, gender, deprivation score and BMI were used in the ordinal regression models that compared levels of PA between joint pain groups.

In those with self-reported joint pain, we compared the general health status (PCS and MCS), HRQoL and average pain intensity across the levels of PA within each number of joint pain sites using unadjusted one-way ANOVA. Linear trends between levels of PA within each joint pain group were

tested using linear contrasts. All analyses were conducted using STATA v14.1. An alpha level of 5% was used.

Results

The MOSAICS population survey was sent to 28,443 eligible adults, 15,083 (53%) returned the survey, of those 14,796 (98%) completed the STAR questionnaire and were included in this study. There were 11,777 (79%) responders that reported peripheral joint pain (**figure 1**). **Table 1** shows the characteristics and self-reported levels of PA of the responders that returned the survey and completed the STAR questionnaire. Single site peripheral joint pain was most commonly reported (31%), followed by two-site (30%), three-site (21%), and four-site peripheral joint pain being reported the least (18%). In those reporting any peripheral joint pain; 8,101 (69%) reported multisite peripheral joint pain. Overall, as the number of reported sites of peripheral joint pain increased so did age, BMI and average pain intensity. Physical and mental health status and HRQoL worsened as the number of reported site peripheral joint pain increased. Participants who reported peripheral joint pain in three or four sites were more likely to live in areas of higher deprivation compared to those who reported no peripheral joint pain.

Self-reported levels of physical activity

Responders with no peripheral joint pain reported being the most active compared to those reporting peripheral joint pain. Those with more sites of joint pain were less likely to be categorized as “active” with odd ratios ranging from OR=0.91 (0.83-0.99, 95%CI) for one site of joint pain to OR=0.47 (0.42-0.53, 95%CI) for those with all four sites of joint pain (**table 1**). When examining levels of PA in those with single site joint pain, only those with pain in the hips reported a significantly lower levels of PA compared to those with no reported joint pain (OR=0.82, 0.70-0.96 95%CI) (**table 2**).

Average joint pain intensity was lower in those reporting higher levels of PA for each of the joint pain groups (**table 3**). Those with four-sites of joint pain and scored as inactive reported the highest average pain intensity across all joint pain groups (6.4±2.1) and those with one-site of joint pain scored as active reported the lowest average pain intensity (3.2±2.1). Linear trends for average pain intensity and PA levels were observed within all groups of joint pain (**table 3**). The same patterns were shown for PCS, MCS and HRQoL with higher scores for those that reported higher levels of PA across all single and multisite joint pain groups (**table 3**).

Discussion

Main findings

This study investigated the self-report levels of PA in those with and without multisite peripheral joint pain. Overall, levels of PA tended to be highest among those who reported no peripheral joint pain. Those with fewer sites of joint pain were more likely to be categorised as "active" compared to those with more sites of joint pain. Self-report levels of physical inactivity ranged from 10.2% in those with no joint pain to 22.9% in joint pain with all four sites. When comparing location of pain in those with single-site peripheral joint pain to those with no joint pain, only those experiencing hip pain were significantly less likely to be more physically active, although non-significant trends towards lower levels of PA were observed among the other pain sites. This suggests that while hip pain could be associated with lower levels of PA, location of different sites of joint pain were not significantly related to different levels of PA. Although only a subgroup of the study' responders were used to explore the relation between levels of PA and different locations of single site joint pain. There were associations between pain intensity and levels of PA within those reporting one, two, three and four sites of peripheral joint pain. Adults with more pain sites were less active and had poorer physical health, mental health, HRQoL and higher average pain intensity. For example, those with four sites of joint pain that reported as physically active had lower average pain intensity scores compared to those with three sites scoring somewhat active and inactive.

Comparison with other studies

While this is the only study to-date that has explored different levels of PA in multisite joint pain, some of the findings from this study show similarities with other studies exploring multisite pain and clinical outcomes. Similar to our findings, other studies have shown multisite joint pain to be associated with more pain intensity, lower well-being and poorer health status (Dragioti et al., 2017; Finney et al., 2017).

Self-report levels of PA in our study showed a similar pattern with other studies comparing those with joint pain or OA to general populations; those with peripheral joint pain reporting lower overall levels of PA compared to those with no reported pain. However, the sample in this study appeared to have reported higher levels of PA compared to other studies measuring PA in adults with knee or hip OA (Herbolsheimer et al., 2016; Shim et al., 2018; Thoma et al., 2018; Timmermans et al., 2019). Within those with one to four sites of peripheral joint pain; 10-23% reported as inactive, and 36-53% reported as active compared to other studies in knee OA where objectively measured levels of inactivity were 61% and 25% were active (Sliepen et al., 2018).

Strengths and limitations of the study

There are a number of strengths and limitations of this study. The strengths included the large survey sample size allowing for adequate precision in reporting estimates across multiple groups (for example measuring the association between levels of PA and number of joint pain sites). When measuring for possible relationships between PA, different levels of single-multisite peripheral joint pain and health-related outcomes, the risk of confounding was reduced by adjusting for age, gender and BMI; and the general practices participating in this survey were selected to be generally representative of the UK adult population as a whole (Dziedzic et al., 2014).

Limitations included the use of the STAR questionnaire, which had been closely related to objective measures of PA in adults (Matthew et al., 2005), had not been validated in older adults with joint

pain and so may have overestimated true levels of PA in this study sample. This is likely, as other self-report measures have been shown to overestimate levels of PA in adults with peripheral joint pain when compared to objective measures. This could be the case for the STAR questionnaire and any self-report measures of PA in OA may also be influenced by social desirability bias, recall bias or over- and underestimation of activities (Casartelli, Bolszak, Impellizzeri, & Maffiuletti, 2015; Healey et al., 2020). As our study measured multisite peripheral joint pain, pain intensity for multiple sites were measured for each individual site, we approached this with mean values as the most representative of an individuals' global experience of joint pain, compared to taking the highest value of pain intensity (Finney et al., 2017). Finally, we are unable to infer causation from this cross-sectional study due to a lack of temporal data. Despite these limitations, the main findings of this study are supported by other related studies and remain relevant (Dragioti et al., 2017; Finney et al., 2017; Sliepen et al., 2018).

Implications for research and clinical practice

The findings from this study suggest that multisite joint pain is common and those with it are at high risk of having lower levels of PA. People with multisite joint pain attributed to OA are an important group to target to increase PA levels and improve general health. However, the presence of multisite pain may also be an important barrier to regular PA and further studies could investigate this relationship over time and explore how best to tailor future PA interventions to increase PA levels for multisite peripheral joint pain. This is important given the lack of evidence around the management of multisite peripheral joint pain (Finney et al., 2016). A positive clinical message that emerges from our study is that despite high levels of pain intensity and multisite pain many adults did remain active and qualitative research learning *how* this sub-group does so may provide insight to help tailor interventions for others with multisite joint pain.

Conclusion

Peripheral joint pain is common among adults aged 45 years and over, with the majority of those having pain in more than one site. Those with peripheral joint pain are more likely to be less physically active compared to adults with no reported joint pain and those with more sites of joint pain the most likely to be less physically active. Health providers need to be aware of the clinical benefits of PA for those with peripheral joint pain in outcomes such as pain intensity, physical health, mental health and HRQoL, but adults with multisite joint pain would potentially benefit more given observed inequality for health related outcomes given their low PA levels.

References

Casartelli, N. C., Bolszak, S., Impellizzeri, F. M., & Maffiuletti, N. A. (2015). Reproducibility and validity of the physical activity scale for the elderly (PASE) questionnaire in patients after total hip arthroplasty. *Physical therapy, 95*(1), 86-94.

Daugaard, R., Tjur, M., Sliepen, M., Lipperts, M., Grimm, B., & Mechlenburg, I. (2018). Are patients with knee osteoarthritis and patients with knee joint replacement as physically active as healthy persons? *Journal of Orthopaedic Translation, 14*, 8-15.

De Groot, I., Bussmann, J., Stam, H., & Verhaar, J. (2008). Actual everyday physical activity in patients with end-stage hip or knee osteoarthritis compared with healthy controls. *Osteoarthritis and Cartilage, 16*(4), 436-442.

Dragioti, E., Larsson, B., Bernfort, L., Levin, L.-Å., & Gerdle, B. (2017). A cross-sectional study of factors associated with the number of anatomical pain sites in an actual elderly general population: results from the PainS65+ cohort. *Journal of pain research, 10*, 2009.

Dziedzic, K. S., Healey, E. L., Porcheret, M., Ong, B. N., Main, C. J., Jordan, K. P., . . . Morden, A. (2014). Implementing the NICE osteoarthritis guidelines: a mixed methods study and cluster randomised trial of a model osteoarthritis consultation in primary care-the Management of OsteoArthritis In Consultations (MOSAICS) study protocol. *Implementation Science, 9*(1), 1-15.

EuroQol, G. (1990). EuroQol--a new facility for the measurement of health-related quality of life. *Health policy (Amsterdam, Netherlands), 16*(3), 199.

Felson, D. T. (2009). Developments in the clinical understanding of osteoarthritis. *Arthritis research & therapy, 11*(1), 203.

Finney, A., Dziedzic, K. S., Lewis, M., & Healey, E. (2017). Multisite peripheral joint pain: a cross-sectional study of prevalence and impact on general health, quality of life, pain intensity and consultation behaviour. *BMC musculoskeletal disorders, 18*(1), 535.

Finney, A., Dziedzic, K. S., Lewis, M., Ryan, S., & Healey, E. (2015) Measuring pain intensity in older adults with 'Multisite' peripheral joint pain using a composite pain score. *Annals of Rheumatic Disease,* (suppl2):549. *European League Against Rheumatism (EULAR) conference (Rome).*

Finney, A., Healey, E., Jordan, J.L., Ryan, S., & Dziedzic, K.S. (2016) Multidisciplinary approaches to managing osteoarthritis in multiple joint sites: a systematic review. *BMC Musculoskeletal Disorders,* 17: 266

Glaviano, N. R., Baellow, A., & Saliba, S. (2017). Physical activity levels in individuals with and without patellofemoral pain. *Physical Therapy in Sport, 27*, 12-16.

Haskell, W. L., Lee, I.-M., Pate, R. R., Powell, K. E., Blair, S. N., Franklin, B. A., . . . Bauman, A. (2007). Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Circulation, 116*(9), 1081.

Healey, E.L., Afolabi, E.K., Lewis, M., Edwards, J.J., Jordan, K.P., Finney, A., . . . Dziedzic, K.S. (2018). Uptake of the NICE osteoarthritis guidelines in primary care: a survey of older adults with joint pain. *BMC Musculoskeletal Disorders. 19:* 295-304.

Healey, E. L., Allen, K. D., Bennell, K., Bowden, J. L., Quicke, J. G., & Smith, R. (2020). Self-report measures of physical activity. *Arthritis Care & Research, 72*, 717-730.

Herbolsheimer, F., Schaap, L. A., Edwards, M. H., Maggi, S., Otero, Á., Timmermans, E. J., . . . Cooper, C. (2016). Physical Activity Patterns Among Older Adults With and Without Knee Osteoarthritis in Six European Countries. *Arthritis Care & Research, 68*(2), 228-236.

Holsgaard-Larsen, A., & Roos, E. (2012). Objectively measured physical activity in patients with end stage knee or hip osteoarthritis. *Eur J Phys Rehabil Med, 48*(4), 577-585.

Lacey, R. J., Belcher, J., Rathod, T., Wilkie, R., Thomas, E., & McBeth, J. (2014). Pain at multiple body sites and health-related quality of life in older adults: results from the North Staffordshire Osteoarthritis Project. *Rheumatology, 53*(11), 2071-2079.

Matthews, C. E., Ainsworth, B. E., Hanby, C., Pate, R. R., Addy, C., Freedson, P. S., . . . Macera, C. A. (2005). Development and testing of a short physical activity recall questionnaire. *Medicine and science in sports and exercise, 37*(6), 986-994.

Noble, M., Wright, G., Smith, G., & Dibben, C. (2006). Measuring multiple deprivation at the small-area level. *Environment and planning A, 38*(1), 169-185.

Raja, R., Dube, B., Hensor, E. M., Hogg, S. F., Conaghan, P. G., & Kingsbury, S. R. (2016). The clinical characteristics of older people with chronic multiple-site joint pains and their utilisation of therapeutic interventions: data from a prospective cohort study. *BMC musculoskeletal disorders, 17*(1), 1-9.

Shim, H.-Y., Park, M., Kim, H.-J., Kyung, H.-S., & Shin, J.-Y. (2018). Physical activity status by pain severity in patients with knee osteoarthritis: a nationwide study in Korea. *BMC musculoskeletal disorders, 19*(1), 1-9.

Sliepen, M., Mauricio, E., Lipperts, M., Grimm, B., & Rosenbaum, D. (2018). Objective assessment of physical activity and sedentary behaviour in knee osteoarthritis patients–beyond daily steps and total sedentary time. *BMC musculoskeletal disorders, 19*(1), 1-10.

Stubbs, B., Hurley, M., & Smith, T. (2015). What are the factors that influence physical activity participation in adults with knee and hip osteoarthritis? A systematic review of physical activity correlates. *Clinical rehabilitation, 29*(1), 80-94.

The National Institute for Health and Care Excellence (NICE) (2014). Osteoarthritis: care and management.

Thoma, L. M., Dunlop, D., Song, J., Lee, J., Tudor-Locke, C., Aguiar, E. J., . . . White, D. K. (2018). Are older adults with symptomatic knee osteoarthritis less active than the general population? Analysis from the Osteoarthritis Initiative and the National Health and Nutrition Examination Survey. *Arthritis Care & Research, 70*(10), 1448-1454.

Timmermans, E. J., De Koning, E. J., Van Schoor, N. M., Van Der Pas, S., Denkinger, M. D., Dennison, E. M., . . . Peter, R. (2019). Within-person pain variability and physical activity in older adults with osteoarthritis from six European countries. *BMC musculoskeletal disorders, 20*(1), 1-9.

Uthman, O. A., van der Windt, D. A., Jordan, J. L., Dziedzic, K. S., Healey, E. L., Peat, G. M., & Foster, N. E. (2013). Exercise for lower limb osteoarthritis: systematic review incorporating trial sequential analysis and network meta-analysis. *Bmj, 347*.

Von Elm, E., Altman, D. G., Egger, M., Pocock, S. J., Gøtzsche, P. C., & Vandenbroucke, J. P. (2007). The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Bulletin of the World Health Organization, 85*, 867-872.

Ware Jr, J. E., Kosinski, M., & Keller, S. D. (1996). A 12-Item Short-Form Health Survey: construction of scales and preliminary tests of reliability and validity. *Medical care, 34*(3), 220-233.

Welsh, V. K., Clarson, L. E., Mallen, C. D., & McBeth, J. (2019). Multisite pain and self-reported falls in older people: systematic review and meta-analysis. *Arthritis research & therapy, 21*(1), 1-8.

White, D. K., Tudor-Locke, C., Felson, D. T., Gross, K. D., Niu, J., Nevitt, M., . . . Neogi, T. (2013). Do radiographic disease and pain account for why people with or at high risk of knee osteoarthritis do not meet physical activity guidelines? *Arthritis & Rheumatism, 65*(1), 139-147.

Table 1. Descriptive statistics of demographic and reported outcomes across different joint pain groups

	No joint pain (n=3019)	**Joint pain in one site (n=3676)**	**Joint pain in two sites (n=3522)**	**Joint pain in three sites (n=2656)**	**Joint pain in four sites (n=1923)**	**Difference between group**	**Linear trend**
Age, mean (SD)	62.3 (11.2)	63.0 (11.1)	63.7 (11.0)	64.7 (11.1)	66.2 (10.9)	***F*=45.3 *p*=<0.001**	***F*=175.4 *p*=<0.001**
BMI Kg.m^2, mean (SD)	24.5 (7.5)	25.3 (7.2)	25.9 (8.0)	26.1 (9.0)	26.5 (9.9)	***F*=26.0 *p*=<0.001**	***F*=98.1 *p*=<0.001**
IMD quintile, n (%)							
1 (most affluent)	969 (32.1)	1230 (33.5)	1099 (31.2)	726 (27.3)	451 (23.5)		
2	882 (29.2)	1029 (28.0)	1003 (28.5)	805 (30.3)	520 (27.0)		
3	623 (20.6)	763 (20.8)	710 (20.2)	533 (20.1)	442 (23.0)		
4	333 (11.0)	416 (11.3)	418 (11.9)	341 (12.8)	279 (14.5)		
5 (most deprived)	212 (7.0)	238 (6.5)	292 (8.3)	251 (9.5)	231 (12.0)		
Adjusted OR (95%CI)		0.96 (0.88-1.05)	1.07 (0.99-1.17)	**1.23 (1.12-1.36)**	**1.58 (1.43-1.76)**		
Average pain intensity, mean (SD)	NA	3.5 (2.3)	3.9 (2.1)	4.4 (2.1)	5.2 (2.2)	***F*=280.0 *p*=<0.001**	***F*=821.8 *p*=<0.001**
Health status, mean (SD)							
PCS	50.8 (12.6)	47.6 (13.3)	43.9 (13.6)	39.3 (14.5)	33.7 (14.3)	***F*=606.8 *p*=<0.001**	***F*=292.1 *p*=<0.001**
MCS	51.3 (12.8)	50.4 (12.9)	49.0 (13.0)	46.9 (14.0)	43.9 (14.9)	***F*=117.7 *p*=<0.001**	***F*=442.9 *p*=<0.001**
EQ-5D, mean (SD)	0.91 (0.16)	0.83 (0.19)	0.74 (0.22)	0.65 (0.28)	0.52 (0.33)	***F*=150.5 *p*=<0.001**	***F*=469.3 *p*=<0.001**
Level of PA, n (%)							
Inactive	307 (10.2)	356 (9.7)	437 (12.4)	400 (15.1)	440 (22.9)		
Somewhat active	1100 (36.4)	1501 (40.8)	1552 (44.0)	1190 (44.8)	838 (43.6)		
Active	1612 (53.4)	1819 (49.5)	1533 (43.5)	1066 (40.1)	645 (33.5)		
Adjusted OR (95%CI)		**0.91 (0.83-0.99)**	**0.74 (0.67-0.81)**	**0.65 (0.59-0.72)**	**0.47 (0.42-0.53)**		

Key: Values in **bold** represent statistical significance *p*<0.05. SD=standard deviation, BMI= body mass index, IMD=indices of multiple deprivation, OR=odd ratio, PCS=physical component score, MCS=mental component score, EQ-5D= EuroQol 5-diemensions, PA= physical activity.

Table 2. Levels of self-reported physical activity in participants that reported no peripheral joint pain or a single peripheral joint pain by site.

	Inactive, n (%)	**Somewhat active, n (%)**	**Active, n (%)**	**Adjusted OR (95%CI)**
No peripheral joint pain (n=3019)	307 (10.2)	1100 (36.4)	1612 (53.4)	
Hip pain only (n=724)	94 (13.0)	283 (39.1)	347 (47.9)	**0.82 (0.70-0.96)**
Knee pain only (n=1471)	130 (8.8)	610 (41.5)	731 (49.7)	0.91 (0.81-1.02)
Hand pain only (n=798)	63 (7.9)	334 (41.9)	401 (50.3)	0.97 (0.84-1.12)
Foot pain only (n=683)	69 (10.1)	274 (40.1)	340 (49.8)	0.89 (0.77-1.06)

Key: Values in **bold** represent statistical significance *p*<0.05. OR=odd ratio.

Table 3. Pain intensity, health status and quality of life across levels of physical activity within different joint pain groups.

	Inactive	Somewhat active	Active	Difference between group	Linear trend
Pain intensity, mean (SD)					
One site	4.4 (2.7)	3.6 (2.3)	3.2 (2.1)	***F*=41.4, *p*=<0.001**	***F*=415.6, *p*=<0.001**
Two sites	4.7 (2.3)	4.1 (2.1)	3.6 (1.9)	***F*=54.4, *p*=<0.001**	***F*=448.8, *p*=<0.001**
Three sites	5.5 (2.3)	4.5 (2.0)	3.9 (1.9)	***F*=93.7, *p*=<0.001**	***F*=722.1, *p*=<0.001**
Four sites	6.4 (2.1)	5.1 (2.0)	4.4 (2.0)	***F*=131.9, *p*=<0.001**	***F*=252.9, *p*=<0.001**
Health status PCS, mean (SD)					
No joint pain	41.6 (16.9)	49.8 (13.1)	53.3 (10.1)	***F*=127.3, *p*=<0.001**	***F*=235.2, *p*=<0.001**
One site	37.4 (16.2)	46.4 (13.2)	50.5 (11.5)	***F*=169.3, *p*=<0.001**	***F*=313.1, *p*=<0.001**
Two sites	33.6 (15.7)	42.5 (13.2)	48.3 (11.3)	***F*=240.9, *p*=<0.001**	***F*=471.0, *p*=<0.001**
Three sites	27.7 (14.2)	38.4 (13.6)	44.8 (12.5)	***F*=243.3, *p*=<0.001**	***F*=471.2, *p*=<0.001**
Four sites	24.4 (11.7)	33.6 (12.9)	40.2 (14.2)	***F*=190.1, *p*=<0.001**	***F*=375.1, *p*=<0.001**
Health status MCS, mean (SD)					
No joint pain	46.2 (16.2)	50.2 (13.5)	52.9 (11.2)	***F*=42.8, *p*=<0.001**	***F*=84.5, *p*=<0.001**
One site	46.0 (15.8)	49.5 (12.8)	51.9 (12.1)	***F*=37.1, *p*=<0.001**	***F*=73.0, *p*=<0.001**
Two sites	43.4 (13.1)	48.4 (13.1)	51.3 (11.5)	***F*=66.3, *p*=<0.001**	***F*=128.4, *p*=<0.001**
Three sites	39.8 (16.4)	46.0 (13.8)	50.4 (12.1)	***F*=93.0, *p*=<0.001**	***F*=183.4, *p*=<0.001**
Four sites	37.4 (15.2)	44.4 (13.9)	47.6 (14.6)	***F*=66.7, *p*=<0.001**	***F*=125.7, *p*=<0.001**
EQ-5D, mean (SD)					
No joint pain	0.79 (0.27)	0.90 (0.14)	0.94 (0.11)	***F*=127.5, *p*=<0.001**	***F*=246.3, *p*=<0.001**
One site	0.69 (0.27)	0.81 (0.19)	0.87 (0.15)	***F*=140.9, *p*=<0.001**	***F*=263.6, *p*=<0.001**
Two sites	0.57 (0.30)	0.73 (0.22)	0.81 (0.17)	***F*=213.5, *p*=<0.001**	***F*=408.6, *p*=<0.001**
Three sites	0.38 (0.35)	0.64 (0.25)	0.75 (0.19)	***F*=298.7, *p*=<0.001**	***F*=596.6, *p*=<0.001**
Four sites	0.25 (0.34)	0.54 (0.30)	0.67 (0.22)	***F*=267.2, *p*=<0.001**	***F*=526.8, *p*=<0.001**

Key: Values in **bold** represent statistical significance $p<0.05$. SD=standard deviation, PCS=physical component score, MCS=mental component score, EQ-5D=

EuroQol 5-diemensions.

Figure 1. Flowchart of responses to the MOSAICS population survey