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UNDERSTANDING THE BIOMECHANICAL "SPREAD" OF JOINT PAIN: KNEE PAIN PREDICTS SUBSEQUENT SHOULDER PAIN AND THIS IS MEDIATED BY LEG WEAKNESS. DATA FROM THE OSTEOARTHRITIS INITIATIVE

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Purpose: Joint pain is common in older adults; typically multiple joints are involved. A greater number of painful sites is associated with higher levels of pain intensity in affected joints, more functional impairment and poorer quality of life. However little is known about the pattern of multi-site joint pain development. We aimed to assess whether the number of painful joints increases over time, whether pain in certain joints precedes pain in others, and to assess whether the association is mediated by weakness in a cohort of older adults with painful knee osteoarthritis or at risk of knee osteoarthritis in the NIH Osteoarthritis Initiative (OAI).

Methods: Participants in the Incidence or Progression cohorts of the OAI without baseline knee replacements were categorised as having no knee pain (neither knee painful at baseline and years 1-3), or persistent pain in one or two knees (pain at baseline and on two or more occasions in the same knee over years 1-3). Number of painful joints (neck, back, shoulders, elbows, wrists, hands, hips, knees, ankles, feet) was calculated at each visit. Changes in the number of joints were assessed using mixed effects Poisson regression. Associations between persistent knee pain and incident shoulder pain at year 4 were assessed using log multinomial modelling, adjusted for age, sex, BMI, and CES-D depression score (baseline and change at 4 years) (models 1-3), other lower limb pain (models 2 & 3) and leg weakness, defined as difficulty standing from a sitting position at baseline (WOMAC function subscale 3) (model 3).

Results: Number of painful joints increased by 2.4% (95% CI -0.5%, 5.5%), 1.6% (-1.4%, 4.5%), 3.5% (0.6%, 6.6%) and 5.2% (2.2%, 8.3%) at years 1-4 compared to baseline. In participants with persistent pain in knees only at baseline, who later developed pain in another single joint (n=70), this did not occur randomly across joint types ($p<0.001$) with incidence greatest in shoulders (28.5%). Participants with persistent knee pain in 0, 1 or 2 knees and no baseline shoulder pain (n=1555) were aged 61±9.0, years (range 45-79), 56% female, mean BMI 28±5 (range 18 - 49). Participants reporting weakness, higher depression scores and pain in additional lower limb joints at baseline were more likely to develop shoulder pain at year 4 (all $p<0.001$).

Persistent pain in 1 or 2 knees increased risk of bilateral shoulder pain at year 4 after adjustment for demographic factors (model 1: Table 1). Associations attenuated slightly after further adjustment for lower limb pain (model 2). The association between knee pain and the development of shoulder pain was partially mediated by leg weakness (model 3), as knee pain was associated with weakness (1 knee: β=1.16; 95% CI 1.08, 1.24; 2 knees: β=1.21; 95% CI 1.11, 1.30) and weakness with incident shoulder pain (1 shoulder: relative risk (RR) 1.21; 95% CI 1.06, 1.36; 2 shoulders: RR 1.46, 95% CI 1.25, 1.71).

Conclusions: Spread of joint pain over time is not random, with shoulders the most common painful joint following knees. The association between persistent pain in 1 or 2 knees and incident bilateral shoulder pain is partially mediated by leg weakness, suggesting biomechanical factors influence the spread of pain.

Table 1: Associations between knee pain and incident shoulder pain at year 4 in OAI participants with no baseline shoulder pain

	Model 1: Adjusted for demographic factors		Model 2: Additionally adjusted for lower limb pain		Model 3: Additionally adjusted for leg weakness	
	RR (95% CI) n=1521	p	RR (95% CI) n=1521	p	RR (95% CI) n=1520	p
Incident unilateral shoulder pain						
1 knee	1.24 (0.87, 1.76)	0.23	1.21 (0.85, 1.72)	0.29	0.89 (0.57, 1.38)	0.59
2 knees	1.33 (0.89, 1.99)	0.16	1.28 (0.85, 1.93)	0.24	0.92 (0.56, 1.5)	0.73
Incident bilateral shoulder pain						
1 knee	1.65 (1.01, 2.72)	**0.046**	1.59 (0.97, 2.61)	0.066	1.13 (0.6, 2.11)	0.71
2 knees	2.27 (1.34, 3.85)	**0.002**	2.02 (1.17, 3.49)	**0.01**	1.44 (0.75, 2.77)	0.27

Reference category: Pain in neither knee, no incident shoulder pain