A diagnosis of knee osteoarthritis does not predict physical activity two years later in older adults: findings from the Hertfordshire Cohort Study

Abstract

Introduction

Osteoarthritis (OA) can negatively impact levels of physical activity (PA), although current clinical advice promotes the benefits of staying active in preventing joint degeneration. In this study we examine how knee OA, assessed by self-report, clinical assessment and radiographic assessment, impacts upon objectively measured PA 2 years later.

Methods

The study population comprised 114 subjects from the Hertfordshire Cohort Study. Presence of OA at the knee was determined from self-report, clinical and radiological examination, defined according to American College of Rheumatology (ACR) criteria and Kellgren and Lawrence grading system. Two years later Gulf Coast Data Concepts (GCDC) tri-axial accelerometers were used to measure day-to-day levels of PA. Vertical acceleration peaks over 7 days, expressed in g units, were categorised into low ($0.5 \leq g < 1.0$), medium ($1.0 \leq g < 1.5$) and high ($\geq 1.5g$) impacts.

Results

The study comprise 69 men and 45 women. The mean (SD) age was 78.5 (2.6) for men and 78.6 (2.7) for women. Low count numbers were recorded in the medium and high impact bands. We found no significant reduction in low, medium or high impacts in individuals who had been previously diagnosed with self-reported, radiographic or clinical knee OA in this sample after adjustment for age, sex and BMI.

Conclusion

In our cohort, participants with knee OA were no less likely to partake in objectively measured weight-bearing activity 2 years after assessment than counterparts without a diagnosis of knee OA.

Key Words: Osteoarthritis, physical activity, accelerometer, knee

Introduction

Of the joint disorders affecting older people, osteoarthritis (OA) is the most common. Indeed, in England and Wales it is estimated that 1.6-3.4 million people are afflicted with OA and the societal burden is significant with up to 1.9 million disabled by their symptoms [1]. In OA there is degeneration of the joint involving the articular cartilage in addition to many of the surrounding tissues [2]. This occurs when there is a disruption of the balance between the breakdown and repair of joint tissue, which precipitates the loss of articular cartilage, remodelling of subchondral bone, osteophyte formation, ligament laxity, periarticular muscle weakening, and occasionally synovitis [3]. Individuals with OA may suffer joint pain, which in turn leads to stiffness and restricted movement. The most commonly affected joints in OA are the hands, feet, facet joints and large weight-bearing joints such as the knees and hips [2].

OA can negatively impact levels of physical activity (PA), although current advice promotes the benefits of staying active in preventing joint degeneration [4]. Epidemiological studies have traditionally relied upon the use of health questionnaires, thus not providing an objective measure of PA as brief, non-volitional periods of activity will likely be excluded [5]. Accelerometer based PA readings have been developed as part of the Vertical Impacts on Bone in the Elderly (VIBE) study (a novel method for evaluating day-to-day vertical impacts from weight-bearing PA, subsequently classified according to impact magnitude) [6]. Vertical accelerations reflect impacts resulting from weight bearing activity to which the skeleton preferentially responds. These methods have previously been used to demonstrate a positive association between levels of higher-, but not medium- or low-, impact PA and lower limb bone strength in adolescents and older women [7,8]. Applying this approach to older individuals is, however, challenging as high-impact activities such as running and jumping are rarely undertaken in this age group. The objective of this study was to assess the feasibility of the methodology in older adults, and explore if PA may be reduced in those with a clinical, self-reported or radiological diagnosis of knee OA. We hypothesised that pain associated with self-reported or clinical knee OA may be associated with a greater effect on PA levels then radiographic knee OA which can be asymptomatic.

Methods

The participants in this study were from the Hertfordshire Cohort Study (HCS). The HCS was originally incepted to study the relationship between early life factors and risk of common adult diseases later in life. The study population for this study comprised 69 men and 45 women from the Hertfordshire Cohort Study, who were also part of the VIBE study. The methods of this study and cohort construction are described in detail elsewhere [9], but in brief we traced men and women born between 1931 and 1939 in Hertfordshire and who still lived there in 1998–2004 when a nurse-administered questionnaire and clinic visit were carried out. Participants were not selected on the basis of musculoskeletal pathology, but represented individuals born in a geographic region who continued to live there. In 2011-2012, 592 men and women from the geographical area of East Hertfordshire were invited to take part in a study that was designed to consider the personal burden of OA (European Project on Osteoarthritis (EPOSA) study [10]). In the HCS cohort, only participants who were previously included in the UK arm of the EPOSA study were invited to participate, as this group had available information relating to knee OA status. The cohort included individuals with and without a diagnosis of knee OA. 222 men and 222 women were approached and those that agreed to participate had their PA levels monitored through the use of accelerometers at follow-up. At baseline, subjects were visited at home by a trained research nurse where questionnaires were administered and clinical examinations were performed. Anterior-posterior (AP) and lateral knee radiographs were taken of both knees at a local hospital after the home visit. A self-reported diagnosis of knee OA was obtained by asking study participants “Do you have knee osteoarthritis?” and if the response was “yes” the joint affected by OA was ascertained. A total of 69 men and 45 women completed home visits and attended for x-rays.

Clinical knee OA was defined based on algorithms developed by the American College of Rheumatology [11]. A clinical diagnosis of knee OA was made if a study participant reported pain in the knee (as evaluated by the Western Ontario and McMaster Universities Arthritis Index (WOMAC) pain subscale), plus any 3 of: 1) bony tenderness in at least one side on examination; 2) crepitus on active motion in at least one side on examination; 3) less than 30 minutes of morning stiffness, evaluated by the WOMAC stiffness subscale; 4) no palpable warmth of synovium in both knees on examination; 5) age over 50 years; or 6) bony enlargement in at least one side on examination. The WOMAC is a 24-item questionnaire with three subscales measuring pain (five items), stiffness (two items), and physical function (17 items) [12].

Radiographs were graded according to Kellgren and Lawrence (KL) by 2 experienced rheumatologists. The KL grading system is briefly described as follows: grade 1 – unlikely narrowing of the joint space and possible osteophytes on the radiograph; grade 2 – small osteophytes and possible narrowing of the joint space; grade 3 – multiple, moderately sized osteophytes, definite joint space narrowing, some sclerotic areas and possible deformation of bone ends; and grade 4 – multiple large osteophytes, severe joint space narrowing, marked sclerosis and definite bony end deformity [13]. Here a positive definition of radiological patellofemoral OA reflected a KL score of 2 or above in the patellofemoral joint; radiological tibiofemoral OA a KL score of 2 or above in the tibiofemoral joint; and radiological knee OA a KL score of 2 or above in either the tibiofemoral joint or the patellofemoral joint. If either knee was affected, the subject was classified as having knee OA.

Approximately 2 years after radiographs were taken Gulf Coast Data Concepts (GCDC) X15-1c triaxial accelerometers (Gulf Coast Data Concepts, Waveland, Mississippi) with custom designed size specific elasticated belts, worn at the hip site for seven days, were used to measure day-to-day levels of PA as part of the VIBE study in participants who consented. Whilst wearing the accelerometer individuals also completed a daily time log, detailing when the accelerometer was worn. Participants were instructed to position the accelerometer over their right hip pointing centrally and to remove it only for washing, swimming or sleeping. Accelerometers had a sampling frequency of 50 Hz. The process of analysing the data retrieved from the accelerometers used a custom code and is described in detail by Deere and colleagues [14]. In summary, the raw data from the accelerometers was imported into Stata 13 (StataCorp, College Station, TX). The data was cleaned to remove non-wear time and any movement artefacts. A day of recording was excluded if it comprised less than 10 hours of valid recording time. Only those with ≥3 valid recording days were included in the analysis. Data was normalised based on 7 valid days (≥10 hours recording time) of 14 hours. Vertical acceleration peaks over 7 days, expressed in g units, were categorised into low (0.5≤g<1.0), medium (1.0≤g<1.5) and high (≥1.5g) impacts. Acceleration peaks were calculated based on accelerations higher than the preceding and subsequent reading. All g values represent g over and above 1g from earth's gravitational force.

The UK component of EPOSA had ethical approval from the Hertfordshire Research Ethics Committee, reference number 10/h0311/59 on the 21/01/2014, and all participants gave written, informed consent.

Statistical analysis

Participant demographic data and questionnaire responses were presented using means and standard deviations for continuous variables and the number and percentages for categorical variables. All continuous variables were visually inspected for normality. Median and inter-quartile range (IQR) were used to summarise PA intensity counts due to the skewed nature of the counts. Comparison in counts between lower limb OA status was made using Wilcoxon rank-sum. Associations between lower limb OA and PA intensity was assessed using linear regression after the accelerometry data were log transformed, and a count of 1 was added to medium and high activity counts to enable a log transformation to be completed and allow adjustment for confounders (age, sex and BMI).

Results

A diagnosis of OA and useable PA activity data were available for 114 participants (69 men and 45 women). The mean (SD) age was 78.5 (2.6) for men and 78.6 (2.7) for women. Men were taller and heavier than women ($p<0.01$) although BMI (body mass index) was comparable. Thirteen men (18.8%) and 8 women (17.8%) self-reported knee OA. Similar proportions of men and women had a clinical diagnosis of knee OA, 7 (10.5%) and 5 (11.4%) respectively. Radiographic OA was more common than self-report or clinical OA with 41.0% of men and 34.9% of women having radiographic OA (KL$\geq$2) at the tibiofemoral joint, 32.8% of men and 37.2% of women having radiographic OA at the patellofemoral joint and 52.5% of men and 48.8% of women having radiographic knee OA (OA at either the patellofemoral joint or tibiofemoral joint).. Only one participant had a score of KL grade 4 at the tibiofemoral joint (none at the patellofemoral joint).

Many more activity counts were recorded in the low than the medium intensity range regardless of OA status (the median number of counts in these brackets ranged between 5033 – 7286 in the low intensity range and 119 – 269 in the medium intensity range) and very few counts were recorded in the high intensity band (median number of counts in this bracket ranged between 23 – 46) (table 1).

Table 1 and figure 1 show relationships between PA and OA by the definitions used. Study participants with OA at the knee did not record significant differences in the median number of low, medium and high counts recorded regardless of which definition of OA used except for a significant negative association between radiographic patellofemoral OA and the number of high intensity counts ((Median (IQR) patellofemoral OA present: 23 (6-58), patellofemoral OA not present: 46 (13-122) $p=0.04$) (table 1). We then performed linear regression between OA and activity with adjustment for age, sex and BMI and the association between radiographic patellofemoral OA and the number of high intensity counts was attenuated (figure 2).

Discussion

We have examined the relationship between self-reported, clinical and radiographic diagnoses of knee OA and subsequent objectively assessed PA in a cohort of older adults through the use of accelerometers which recorded vertical movements and classified them based on level of impact. This study proved the methodology is acceptable to older adults who were able to wear an accelerometer for the required period of time and observed no significant relationships between any structural or symptomatic assessment of knee OA and subsequent PA after adjustment for confounders. Radiographic knee OA was more common than self-report or clinical knee OA which is consistent with previous studies [15,16].

Since radiographic changes are known to predict symptoms poorly [17], it could be expected that a difference in PA may be observed in the subgroup with clinical OA. There did appear to be lower activity counts in the middle impact band in those participants with clinical OA but this did not reach statistical significance. Our sample was, however, too small to test this reliably and further studies on larger cohorts where clinical OA is more prevalent are warranted.

Current management of knee OA highlights the need to remain physically active despite the diagnosis. Indeed, non-surgical and non-pharmacological interventions are considered first-line treatments for knee OA as they are safe, low cost, low tech, incorporate self-management performed at home or in the community and have a substantial public health impact [18-20]. The uptake of guidance for individuals with knee OA to remain physically active and adherence to this has been reported in few studies. A recent questionnaire-based study by Zhou and colleagues showed that in a population of 1,069 individuals in China with knee OA 93.6% of the patients thought that they could adhere to the exercise treatment if they received professional advice [21]. Other studies have shown, however, that despite exercise providing immediate and short-term clinically worthwhile benefits, adherence to exercise declines significantly over time [22]. Our data suggest that the clinical guidelines encouraging maintenance of PA is possibly being heeded but further studies with a larger number of participants with clinical OA are needed. This study is novel because it is a longitudinal follow-up that includes an objective measure of physical activity that might be adopted in other epidemiology studies as the methodology has been shown to be feasible in an older, unselected age-group.

This study has limitations and strengths. There were only a moderate number of participants (114), limiting our power to detect statistically significant relationships and these findings would therefore warrant confirmation in other larger datasets. This is especially true for clinical OA as only 12 participants met the criteria for this and this exploratory analysis needs to be confirmed in larger data sets. Since all the participants recruited were born in the county of Hertfordshire and had continued to reside there until they were 75, the results may not be entirely representative of the wider UK population [23]. It is also conceivable that there may be an element of selection bias, whereby healthier and more physically active individuals are more likely to partake in studies such as this one. The HCS has, however, been previously demonstrated to be a good representation of the general population with regard to body build and lifestyle factors, such as smoking and alcohol intake, therefore suggesting that any selection bias would be small [24]. Two experienced rheumatologists were used to grade the radiographs, with high inter-observer concordance and have previously shown good levels of agreement exists between- and within-observer variation [25]. In this analysis we considered someone to have clinical/radiological knee OA if at least one knee was affected but due to low numbers were unable to consider a dose effect if both knees or other joints were affected and since only one subject had KL grade 4 our analysis included individuals with only moderate radiographic change. We do not have data on whether a participant underwent joint replacement surgery between their baseline assessments and follow up which could increase their ability to perform weight-bearing activity.

In conclusion our results suggest that individuals with evidence of knee OA, however classified (structural or symptomatic), were no less likely to partake in habitual weight-bearing activity 2 years after assessment than counterparts without a diagnosis of knee OA. Our study shows that objective measurement of PA in individuals with OA was feasible in this age-group and further studies in larger cohorts are now indicated.

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent: Informed consent was obtained from all individual participants included in the study.

Author contributions: Contributors: MC wrote and revised the paper and together with CP interpreted the data and formulated conclusions. CP also wrote the statistical analysis plan, cleaned and analysed the data, and revised each draft. ME was involved with study design and recruitment. JT and KD were involved with study design and reviewed the drafted manuscript. CC and ED provided supervision for the whole project, were involved with study design and recruitment, data interpretation, and revision of the drafted manuscript. All authors approved the final version.

Congress abstract publications: This work was presented as a poster at Rheumatology 2017, Birmingham, UK

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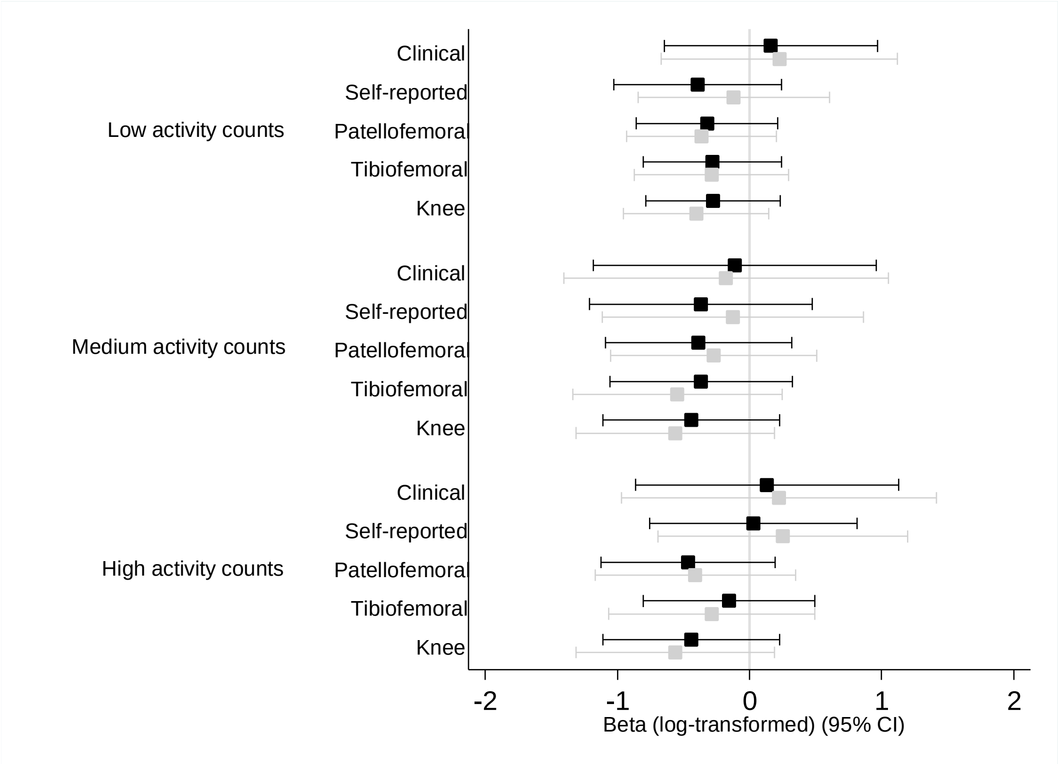
Table 1. Intensity count of activity peaks by OA status

	Yes		N	No		p-value
	Median	IQR [a]		Median	IQR [a]	
Low intensity (>=0.5g to 1.0g)						
Clinical knee OA	7009	3916 - 10887		5880	2373 - 13278	0.77
Self-reported knee OA	5033	1849 - 8820		6407	2712 - 13964	0.16
KL tibiofemoral OA	5035	2159 - 11363		6599	2880 - 12852	0.30
KL patellofemoral OA	5044	1300 - 9543		6812	2756 - 14802	0.16
KL knee OA	5037	2401 - 10230		7826	2712 - 14142	0.18
Medium intensity (>=1.0g to 1.5g)						
Clinical knee OA	168	87 - 291		213	64 - 763	0.68
Self-reported knee OA	166	64 - 263		227	65 - 763	0.27
KL tibiofemoral OA	141	53 - 476		232	68 - 612	0.26
KL patellofemoral OA	119	53 - 318		232	76 - 802	0.09
KL knee OA	136	55 - 437		269	70 - 816	0.09
High intensity (>=1.5g)						
Clinical knee OA	37	22 - 107		38	13 - 112	0.77
Self-reported knee OA	38	22 - 65		38	11 - 122	0.97
KL tibiofemoral OA	29	10 - 99		39	13 - 105	0.69
KL patellofemoral OA	23	6 - 58		46	13 - 122	0.04
KL knee OA	26	9 - 86		45	13 - 121	0.19

[a] IQR inter-quartile range

Figure 1: Relationships between log-transformed activity counts and OA status, according to linear regression



Black = unadjusted

Grey = adjusted for age, sex and BMI