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# What impact does osteoarthritis have on ability to self-care and receipt of care in older adults? Findings from the Hertfordshire Cohort Study

Gregorio Bevilacqua [a], Faidra Laskou [a], Harnish P. Patel [a,b,c,d], Leo D. Westbury [a], Nicholas R. Fuggle [a,e], Cyrus Cooper [a,b,f], Elaine M. Dennison [a,g,*]

[a] MRC Lifecourse Epidemiology Centre, University of Southampton, Southampton, UK
[b] NIHR Southampton Biomedical Research Centre, University of Southampton and University Hospital Southampton NHS Foundation Trust, Southampton, UK
[c] Academic Geriatric Medicine, University of Southampton, Southampton, UK
[d] Medicine for Older People, University Hospital Southampton, Southampton, UK
[e] The Alan Turing Institute, London, UK
[f] NIHR Oxford Biomedical Research Centre, University of Oxford, Oxford, UK
[g] Victoria University of Wellington, Wellington, New Zealand

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ABSTRACT

*Objectives:* Living independently remains the aim of older adults, but musculoskeletal conditions and frailty may hamper this. We examined relationships between osteoarthritis with ability to self-care and access to formal/informal care among community-dwelling older adults, comparing results to relationships between other musculoskeletal conditions of ageing (frailty, sarcopenia, osteoporosis) and these outcomes.

*Design:* Data from the Hertfordshire Cohort Study were used. Osteoarthritis (hand, hip or knee) was defined by clinical examination. Osteoporosis was assessed using dual-energy X-ray absorptiometry and medication use. Sarcopenia was assessed using EWSGOP2 criteria, frailty using Fried criteria. Ability to self-care and access to formal/informal care were self-reported.

*Results:* 443 men and women aged approximately 75 years participated. Osteoarthritis was reported by 26.8% participants; 11.8% had low grip strength; 21.4% had osteoporosis; 8.6% had sarcopenia; 7.6% were identified as frail. Most participants (90.7%) reported no problems with self-care, but more than one-fifth (21.4%) reported having received formal or informal care at home in the previous year. Odds of reporting difficulties with self-care were significantly greater ($p < 0.05$) for participants with osteoarthritis and for those with frailty, but not for those with osteoporosis or sarcopenia. Odds of receiving care at home in the past year were significantly greater among participants with osteoarthritis and among those with frailty, but not among those with osteoporosis or sarcopenia.

*Conclusions:* Frailty and osteoarthritis were associated with both difficulties with self-care and receipt of care; osteoporosis and sarcopenia were not. These results highlight the contribution of clinical osteoarthritis to ability to live independently in later life, and the need to actively manage the condition in older adults.

## 1. Background

An important aim of older adults is to maintain their autonomy, and it has been previously estimated that in northern Europe nine out of ten older adults live independently [1]. Previous studies have reported that most adults in later life prefer to live in a familiar environment (typically their family home) rather than in residential care homes [2,3]. However, an increase in life expectancy and a subsequent ageing population have led to a growth in syndromes such as musculoskeletal diseases, frailty, and falls [4–7], which might hamper older adults' ability to self-care and maintain a coveted independence.

The most common joint disorder in later life is of course osteoarthritis (OA) [8]. Importantly, OA is accompanied by joint pain, tenderness, and limitation of movement, and can occur in all joints although it most commonly affects the hip, knee, and hand [6]. It has been reported that the prevalence of OA increases with age, especially after age 50, resulting in age being one of the stronger risk factors for OA [9]. A recent study comprising data on approximately 17.5 million patients from the UK

* Corresponding author. MRC Lifecourse Epidemiology Centre, University of Southampton, Southampton, UK.
*E-mail address:* emd@mrc.soton.ac.uk (E.M. Dennison).

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reported that the prevalence of any OA in 2017 was 10.7% (95% CI 10.7–10.8%), and that this prevalence in the previous 20 years had been gradually increasing at an annual rate of 1.4% (95% CI 1.3–1.6%) [10].

Other musculoskeletal conditions are common in later life and some, such as sarcopenia, may be linked to OA: for instance, it has been previously reported that lower grip strength, one of the defining components of sarcopenia, is more common among individuals with hand OA [11]. Sarcopenia, the loss of muscle mass and strength with age, is a progressive and generalized musculoskeletal condition that occurs with advancing age and is associated with increased chances of adverse outcomes such as falls, fractures, physical disability and mortality [12]. Sarcopenia has been associated with loss of independence or necessity of care placement and death [13–15]. Importantly, sarcopenia is considered to be one of the major causes of frailty [16]. Frailty is defined as a biological syndrome of decreased reserve and resistance to stressors, resulting from cumulative declines across multiple physiologic systems, and causing vulnerability to adverse outcomes [17,18]; it is considered to be highly prevalent in older adults [19]. Frailty is associated with higher risks of falls, disability, hospitalization and mortality [19]. Finally, older adults are also at particular risk of osteoporosis, and consequently of fractures, as bone mass declines with age [20].

Given the prevalence of OA in older adults, in the current study, we examined relationships between OA and low grip strength with (1) ability to self-care and (2) access to formal/informal care among community-dwelling older adults, contrasting observations with frailty, and other musculoskeletal conditions of ageing (sarcopenia and osteoporosis) and these outcomes.

## 2. Methods

The study participants were recruited from the Hertfordshire Cohort Study (HCS), a population-based sample of men and women born between 1931 and 1939 in Hertfordshire, UK, who were originally recruited in order to examine the relationship between growth in infancy and the subsequent risk of adult diseases [21,22]. In 2004, of the 966 participants from East Hertfordshire who had a dual-energy X-ray absorptiometry (DXA) scan at baseline, 642 were recruited to the HCS Musculoskeletal Follow-Up (MSFU) Study. In 2011–2012, 443/642 HCS participants [222 men and 221 women; mean (SD) age 75.5 (2.5) years for men and 75.8 (2.6) for women] were visited at home by a trained fieldworker, who administered a lifestyle questionnaire. The questionnaire included demographic and lifestyle questions (alcohol intake, smoking status, and physical activity). Registrar General's social class was coded from the 1990 OPCS Standard Occupational Classification (SOC90) unit group for occupation using computer assisted standard occupational coding [23]. Participants were also asked whether they had had any of the following doctor-diagnosed comorbidities: high blood pressure, diabetes, lung disease (e.g. asthma, chronic bronchitis, emphysema or COPD), multiple sclerosis, thyroid disease, vitiligo, depression, Parkinson's disease, heart disease (e.g. heart attack, angina or heart failure), peripheral arterial disease (e.g. claudication), stroke and cancer. Number of comorbidities was calculated to obtain a marker of morbidity burden.

The questionnaire also included information about participants' ability to self-care and receipt of formal/informal care at home. For self-care, participants were asked to declare whether they: i) had no problems with self-care; ii) had some problems washing or dressing themselves; iii) were unable to wash or dress themselves. Respondents were identified as having problems with self-care if they reported options ii) or iii). For access to care at home, participants were asked the following question: 'Have you received formal/informal care at home in the last year?'.

Additionally, the fieldworker performed a clinical assessment, including the examination of the hands, knees and hips to assess the presence of osteoarthritis (OA). Clinical OA was defined based on algorithms developed by the American College of Rheumatology [24]. A clinical diagnosis of hand OA was based on both medical history and physical examination. Pain in the hand was evaluated using the Australian/Canadian OA Hand Index (AUSCAN) pain and stiffness subscale [25]. For a patient to be diagnosed with clinical hand OA they must have pain plus two of the following: 1) hard tissue enlargement of two or more of the 2nd and 3rd distal interphalangeal (DIPs), 2nd and 3rd proximal interphalangeal (PIPs), or 1st carpometacarpal (CMC) joints of at least one hand; 2) hard tissue enlargement of two or more DIPs of at least one hand; or 3) deformity of at least one of the 2nd and 3rd DIPs, 2nd and 3rd PIPs, or 1st CMC joints of at least one hand [26].

A clinical diagnosis of hip OA was made if pain, evaluated by the Western Ontario and McMaster Universities OA Index (WOMAC) pain subscale score, was present in addition to all of the following: 1) pain associated with hip internal rotation in at least one side; 2) morning stiffness lasting <60 min evaluated by the WOMAC stiffness subscale; and 3) age of over 50 years [26,27].

A clinical diagnosis of OA of the knee was made if patients experienced knee pain in addition to any three of the following: 1) bony tenderness in at least one side; 2) crepitus on active motion in at least one side; 3) less than 30 min of morning stiffness, evaluated by the WOMAC stiffness subscale; 4) no palpable warmth of synovium in both knees; 5) age over 50 years; or 6) bony enlargement in at least one side [28]. For all of the above, pain was evaluated using the WOMAC [27].

During home visits, grip strength and walking speed tests were performed. Isometric grip strength (kg) was measured three times in each hand using a Jamar handheld hydraulic dynamometer (Promedics, UK) and the maximum value of six measures was used for analysis. To assess physical performance using the walking speed test, an 8 ft course was marked out on the floor. Participants were asked to walk at their customary pace and the time taken was recorded using a stopwatch. The use of assistive devices, such as canes, was permitted if required. Walking speed was determined by the mean time from two of these 8 ft gait speed tests.

Following this, participants attended a research clinic where a DXA scan (Lunar Prodigy Advanced Scanner, GE Medical Systems, UK) was performed. Appendicular lean mass (ALM) was measured using DXA scans. Sarcopenia status was derived using the EWGSOP2 diagnostic algorithm with the following cut-points: appendicular lean mass <20 kg for men (<15 kg for women); appendicular lean mass index (ALM/height$^2$) < 7.0 kg/m$^2$ for men (<5.5 kg/m$^2$ for women); grip strength <27 kg for men (<16 kg for women); and chair rise time >15 s for 5 chair rises [12]. Participants with low strength (low grip strength or high chair rise time) and low lean mass (low ALM or low ALM index) were classed as having sarcopenia.

DXA scans also allowed us to measure bone mineral content (g) and areal bone mineral density (g/cm$^2$) at the femoral neck; the lowest value from both sides was used for analysis. Positioning for all scans was completed in accordance with the manufacturer's instructions. Osteoporosis was defined as femoral neck bone mineral density values of at least 2.5 standard deviations below the mean bone mineral density of young adult women (bone mineral density T-score $\leq -2.5$) or if participants were on any of the following medications: female hormone replacement therapy, bisphosphonates or raloxifene.

Frailty was defined as the presence of at least three of the following criteria, as described by Fried [19]: unintentional weight loss, weakness, self-reported exhaustion, slow walking speed and low physical activity. Weight loss was assessed by asking the question: 'In the past year, have you lost any weight unintentionally? If yes, how much?'; participants who had lost more than 10 lbs unintentionally were regarded as having experienced weight loss. Weakness was defined as a maximum grip strength of <27 kg for men and <16 kg for women [29]. Exhaustion was assessed by asking the question: 'How often in the last week did you feel this way: "everything I did was an effort" or "I could not get going?"'. Participants who responded to feel as described above for either moderate amounts or most of the time were identified as exhausted. Slow walking speed was defined as a gait speed of <0.8 m/s. Physical activity was assessed via the Longitudinal Aging Study Amsterdam Physical

Activity Questionnaire (LAPAQ) which has been validated for use in older populations [30]. Low physical activity was defined as a physical activity score (mins/day) in the bottom fifth of the HCS sex-specific distribution (≤91 min/day for men and ≤110 min/day for women). Frailty assessed using Fried's criteria has predictive validity for adverse health outcomes, including disability [19,31].

The number of MSC, out of clinical OA (hand, knee or hip), osteoporosis and sarcopenia, was calculated with a score ranging from 0 to 3.

## 3. Statistical analysis

Descriptive statistics for continuous variables were expressed as means and standard deviations (SD) or medians and interquartile ranges (IQR) as appropriate. Categorical variables were expressed as frequencies and percentages. Since no interactions were found between sex and the exposure variables (osteoporosis, clinical OA at any site, sarcopenia, low grip strength, number of MSC, and frailty) in relation to outcomes (difficulty with self-care and receiving formal/informal care), analyses were conducted with men and women pooled and adjusted for sex. Logistic regression analyses were used to examine each exposure variable in relation to each outcome. The regression analyses were undertaken with and without adjusting for the following demographic and lifestyle confounders: sex, age, BMI, social class, smoker status, alcohol consumption, living alone, and number of comorbidities. No musculoskeletal conditions were included in the derivation of number of comorbidities. The analyses were conducted using Stata (version 17).

## 4. Results

Table 1 reports the demographic characteristics of the participants included in the study. A small proportion of these community-dwelling participants (7.6%) were identified as frail according to Fried's criteria. The most common MSC was OA, which affected 26.8% of the participants. Osteoporosis was identified in 21.4% of participants, while 8.6% had sarcopenia. While most participants (90.7%) reported no problems with self-care, 9.3% said they had some problems with washing or dressing. More than one-fifth of our sample population (21.4%) reported having received one form of care (either formal or informal) at home during the previous year. The median (IQR) number of reported comorbidities was 1 (0–2); the median (IQR) number of alcohol units per week was 2.4 (0.1–8.7), and the median (IQR) time spent doing physical activity over two weeks was 190 (121–279) mins/day. Eighty-six (20.5%) participants reported living alone.

Table 2 reports the associations between frailty, individual MSC, having two or three MSC (out of clinical OA, osteoporosis and sarcopenia), and experiencing problems with self-care. Following adjustment for sex, age, BMI, social class, smoker status, alcohol consumption, living alone and number of comorbidities, those identified as frail according to Fried's criteria had the highest odds of having problems with self-care compared to those who were not frail (OR 5.52, 95% CI 2.22–13.74, $p < 0.001$). Notably however, participants with a clinical diagnosis of knee, hip, or hand OA also had higher odds of reporting problems with self-care compared to those without (OR 3.53, 95% CI 1.66–7.52, $p = 0.001$, following adjustment for confounders). By contrast, neither osteoporosis nor sarcopenia alone were associated with difficulties with self-care, and similarly having two or more MSC was not associated with significantly greater odds of this outcome compared to participants with no MSC.

Table 3 reports the associations between frailty, individual MSC, having two or three MSC, and receiving formal/informal care at home in the previous year. After adjustment for confounders, frailty was again associated with the highest odds of receiving care (OR 4.37, 95% CI 1.98–9.63, $p < 0.001$). Likewise, a clinical diagnosis of knee, hip or hand OA was associated with higher odds of having received formal or informal care at home in the past year (OR 2.48, 95% CI 1.43–4.32, $p = 0.001$, following adjustment for confounders). Osteoporosis and sarcopenia alone were not associated with receipt of care in the past 12 months, and similarly, having two or more MSC was not associated with significantly greater odds of this outcome compared to participants with no MSC.

**Table 1**
Participant characteristics.

| | N | Median | IQR |
|---|---|---|---|
| Age (yrs) | 443 | 75.5 | 73.5–77.9 |
| Grip strength (kg) | 442 | 28.0 | 21.0–36.0 |
| Activity time in last 2 weeks (min/day) | 415 | 190 | 121–279 |
| Number of comorbidities[a] | 443 | 1 | 0–2 |
| Alcohol consumption (units/week) | 443 | 2.4 | 0.1–8.7 |
| | **N** | **Mean** | **SD** |
| BMI (kg/m$^2$) | 438 | 28.1 | 4.6 |
| | **Total N** | **N** | **%** |
| Female sex | 443 | 221 | 49.9 |
| Smoker status | 443 | | |
| Never | | 227 | 51.2 |
| Ex | | 199 | 44.9 |
| Current | | 17 | 3.8 |
| Social class | 432 | | |
| I-IIINM | | 189 | 43.8 |
| IIIM-V | | 243 | 56.3 |
| Marital status | 436 | | |
| Single | | 18 | 4.1 |
| Married | | 302 | 69.3 |
| Divorced or separated | | 20 | 4.6 |
| Widowed | | 84 | 19.3 |
| Cohabiting | | 12 | 2.8 |
| Lives alone[b] | 419 | 86 | 20.5 |
| Received formal or informal care at home in last year | 443 | 95 | 21.4 |
| EuroQoL self-care | 443 | | |
| No problems with self-care | | 402 | 90.7 |
| Some problems washing or dressing | | 41 | 9.3 |
| Musculoskeletal conditions | | | |
| Osteoporosis[c] | 346 | 74 | 21.4 |
| Clinical OA (hip, knee or hand) | 429 | 115 | 26.8 |
| Sarcopenia | 349 | 30 | 8.6 |
| Low grip (<27 kg men, <16 kg women) | 442 | 52 | 11.8 |
| Have 2 or 3 (out of: osteoporosis, OA, sarcopenia) | 315 | 29 | 9.2 |
| Fried frailty | 434 | 33 | 7.6 |

[a] Number of co-morbidities out of high blood pressure, diabetes, lung disease (e.g., asthma, chronic bronchitis, emphysema or COPD), multiple sclerosis, thyroid disease, vitiligo, depression, Parkinson's disease, heart disease (e.g., heart attack, angina or heart failure), peripheral arterial disease (e.g., claudication), stroke and cancer.

[b] Does not live with partner, children, other relatives or other people they're not related to.

[c] Osteoporosis: t-score ≤ −2.5 or taking HRT, bisphosphonates or raloxifene.

As low grip strength is a defining component of both sarcopenia and frailty, and may be associated with hand osteoarthritis [11], in our study we also looked at possible associations of low grip strength alone with both reporting problems with self-care (dressing/washing oneself) and receiving formal/informal care (Tables 2 and 3): participants with low grip strength were at higher odds of having problems with self-care (OR 3.07, 95% CI 1.33, 7.08, $p = 0.008$) and having received care at home in the past 12 months (OR 3.26, 95% CI 1.68, 6.33, $p < 0.001$). Both results are adjusted for the following confounders: sex, age, BMI, social class, smoker status, alcohol consumption, living alone, and number of comorbidities.

Finally, because low grip strength is common in patients with hand OA, we also performed a sensitivity analysis to consider relationships in participants without low grip strength. For reporting problems with self-care, fully-adjusted odds ratios (95% CI) were attenuated for OA [3.53 (1.66, 7.52) to 3.18 (1.30, 7.77)] and Fried frailty [5.52 (2.22, 13.74) to 4.10 (1.04, 16.22)] when restricted to participants without low grip strength but remained statistically significant. For receiving care at

**Table 2**
Musculoskeletal conditions (individual and total number) and frailty as explanatory variables for reporting problems with self-care (washing or dressing).

| | Adjusted for sex only | | | | Fully adjusted[a] | | | |
|---|---|---|---|---|---|---|---|---|
| | N | Odds Ratio | 95% CI | p-value | N | Odds Ratio | 95% CI | p-value |
| Osteoporosis | 346 | 0.94 | (0.33, 2.67) | 0.909 | 307 | 0.75 | (0.22, 2.49) | 0.636 |
| Clinical knee, hip or hand OA | 429 | 5.29 | (2.66, 10.53) | <0.001 | 392 | 3.53 | (1.66, 7.52) | 0.001 |
| Sarcopenia | 349 | 1.82 | (0.49, 6.80) | 0.375 | 309 | 1.63 | (0.31, 8.59) | 0.564 |
| Low grip (<27 kg men, <16 kg women) | 442 | 4.86 | (2.34, 10.08) | <0.001 | 404 | 3.07 | (1.33, 7.08) | 0.008 |
| Having 2 or 3 musculoskeletal conditions[b] | 315 | 4.72 | (0.97, 23.00) | 0.055 | 278 | 2.55 | (0.39, 16.48) | 0.326 |
| Fried frailty | 434 | 9.19 | (4.09, 20.65) | <0.001 | 398 | 5.52 | (2.22, 13.74) | <0.001 |

[a] Adjusted for sex, age, BMI, social class, smoker status, alcohol consumption, living alone and number of comorbidities.
[b] Odds ratios are presented for having 2 or 3 musculoskeletal conditions (out of: osteoporosis, clinical OA, and sarcopenia) compared to having none; odds ratios for the other explanatory variables are for the presence versus absence of the condition.

**Table 3**
Musculoskeletal conditions (individual and total number) and frailty as explanatory variables for receiving formal/informal care at home in the past year.

| | Adjusted for sex only | | | | Fully adjusted[a] | | | |
|---|---|---|---|---|---|---|---|---|
| | N | Odds Ratio | 95% CI | p-value | N | Odds Ratio | 95% CI | p-value |
| Osteoporosis | 346 | 1.14 | (0.58, 2.21) | 0.709 | 307 | 1.02 | (0.49, 2.12) | 0.964 |
| Clinical knee, hip or hand OA | 429 | 2.39 | (1.46, 3.92) | 0.001 | 392 | 2.48 | (1.43, 4.32) | 0.001 |
| Sarcopenia | 349 | 1.88 | (0.80, 4.41) | 0.146 | 309 | 1.26 | (0.47, 3.39) | 0.641 |
| Low grip (<27 kg men, <16 kg women) | 442 | 4.18 | (2.27, 7.69) | <0.001 | 404 | 3.26 | (1.68, 6.33) | <0.001 |
| Having 2 or 3 musculoskeletal conditions[b] | 315 | 2.28 | (0.89, 5.85) | 0.088 | 278 | 2.12 | (0.72, 6.21) | 0.172 |
| Fried frailty | 434 | 6.02 | (2.86, 12.69) | <0.001 | 398 | 4.37 | (1.98, 9.63) | <0.001 |

[a] Adjusted for sex, age, BMI, social class, smoker status, alcohol consumption, living alone and number of comorbidities.
[b] Odds ratios are presented for having 2 or 3 musculoskeletal conditions (out of: osteoporosis, clinical OA, and sarcopenia) compared to having none; odds ratios for the other explanatory variables are for the presence versus absence of the condition.

home, fully-adjusted odds ratios were very similar for OA when restricted to participants without low grip strength [2.49 (1.31, 4.74) vs 2.48 (1.43, 4.32) in unrestricted sample] but those for Fried frailty were attenuated [4.37 (1.98, 9.63) to 3.07 (0.91, 10.39)] and were no longer significant.

## 5. Discussion

We have reported problems with self-care among community-dwelling older adults, with slightly less than 10% reporting to have difficulties with washing or dressing. The prevalence of frailty in our study is comparable with both US and European data for frailty defined by the Fried criteria, ranging from 4 to 25% [32]. The observation that frailty was associated with problems with self-care and receipt of care is expected. Our observation that OA was also associated with ability to self-care, and receipt of care was striking but also in accord with previous studies [6,33,34].

Our study population is all community-dwelling and might therefore be expected to be healthier than peers. The prevalence of OA in a given population is affected by the way it is defined and assessed, which makes comparisons with other studies' findings difficult; in general, it has been estimated that OA affects 10% of men and 18% of women over the age of 60 years worldwide [6]. In our population sample, 26.8% of participants had a clinical diagnosis of hip, knee or hand OA, a high prevalence which might be explained by the old age of our cohort. Similarly, the prevalence of sarcopenia in the literature varies broadly, being influenced by the population and the methods used to assess the condition; it has been estimated that in the community it can range between 1% and 33% across different populations, with higher prevalence found among older adults [35]. A previous study within the HCS found that the prevalence of sarcopenia was 4.6% among men and 7.9% among women (mean age 67 years) [36,37], and the slightly higher prevalence we found in our study (8.6%, male and female combined) was unsurprising, as this condition's prevalence increases with age [36]. The prevalence of osteoporosis in our population sample was in line with previously reported estimates in the 27 countries of the European Union (including the UK), with 6.7% of men and 21.9% of women over the age of 50 years having osteoporosis [38].

The fact that frailty was associated with having problems with self-care and receiving care at home is unsurprising, as frailty has been previously linked to disability [19,31,39]. A study conducted in over 300 adults from Brazil, aged 65 years and older, found that, when compared to non-frail participants, frail subjects were more likely to have a caregiver (prevalence ratio: 1.58) and to have been hospitalized (prevalence ratio: 1.65) [40]. Studies conducted in Canada and France among community-dwelling older adults reported that frailty was associated with difficulties in performing various activities of daily living, including bathing and dressing [31,39]. A cross-sectional study conducted with 740 community-dwelling Canadian men and women aged 75 years and over found that frailty, assessed using Fried's criteria, was associated with difficulties in performing activities of daily living (ADL), such as bathing and dressing, and instrumental activities of daily living (IADL), such as housekeeping and taking medications [39]. In this Canadian study, 29.1% of participants classified as frail had disability in ADL and 92.7% had disability in IADL [39]. Analogous results were reported by Ávila-Funes and colleagues in a longitudinal study conducted with more than 6000 French community-dwelling older adults (age range 65–95 years); in this cohort, Fried frailty was again associated with disability in both ADL and IADL [31]. It is thus expected that frailty might lead to difficulties with self-care and necessity to receive care, as we indeed observed in our sample population of UK community-dwelling older adults, and we were interested to compare relationships between different MSC and receipt of care in the same population.

Additionally, low grip strength has been shown to be a better predictor of adverse health outcomes than low muscle mass [41]. In our study we found that low grip strength on its own was associated with both reporting difficulties with dressing/washing oneself and receiving formal/informal care, suggesting that low muscle strength plays a fundamental role as a predictor of difficulties with self-care and receipt of care. It is also worth noting that reduced grip strength is one of the symptoms of hand OA [42], and several studies include grip strength as an outcome measure for hand OA [11,43–45]. We therefore also performed analyses in the subset of patients without low grip strength. Our results were (in general) not substantially changed, except when considering associations between frailty and receiving care at home. This suggests that whilst low muscle strength may play a key role in the

association between frailty and receiving care at home, other associations between OA and frailty in relation to the outcomes examined in this study were independent of low muscle strength.

We found that OA was associated with reporting problems with washing and/or dressing oneself, while no such association emerged with osteoporosis and sarcopenia. It is perhaps unsurprising that, among the MSC considered in the present study (clinical OA, osteoporosis and sarcopenia), OA is the one associated with difficulties with both self-care and receipt of any form of care at home: the main symptoms for OA are pain and stiffness which, especially when affecting weight-bearing joints like hips and knees, often lead to significant disability [6,34,46]. The pain and joint restriction that typically accompany osteoarthritis can therefore substantially undermine the ability to wash and dress oneself, and thus the necessity to receive either formal or informal care in one's home.

The bone fragility that characterizes osteoporosis, on the other hand, can lead to difficulty in self-care only indirectly, as pain, physical disability and impaired quality of life are the consequence of fragility fractures caused by osteoporosis [38,47]. As long as fractures do not occur, osteoporosis might not immediately hamper one's ability to self-care, and consequently one's need to receive care at home.

Our study has limitations. Our study population may not be entirely representative of the wider UK population, since all recruited participants were born in the county of Hertfordshire, were still living in their homes, and were all Caucasian. Nevertheless, it has been previously demonstrated that the HCS is representative of the general population with regard to anthropometric body build and lifestyle factors, such as smoking and alcohol intake, which was in line with data found in the European Investigation into Cancer and Nutrition Cohort (EPIC) [48]. Selection bias was therefore minimal, but a 'healthy' responder bias is evident within the HCS [21]. An additional limitation of this study is the cross-sectional design of its analysis. Lastly, ability to self-care was defined as reporting problems with dressing and washing oneself, which is a crude assessment that does not cover the whole spectrum of a participant's actual difficulties with self-care. Similarly, access to formal/-informal care at home was self-reported and thus recall bias may not be excluded.

However, our study has also several strengths. Firstly, the data were carefully collected according to rigorous protocols by trained researchers and doctors [21]. The AUSCAN pain and stiffness subscale is a validated and reliable tool in assessing hand OA [25]. Similarly, the reliability, validity, and responsiveness of the WOMAC OA Index have been demonstrated in a range of different studies [49,50]. In addition, we assessed frailty using the accepted and objective Fried criteria [51]. Finally, a significant strength of this study is the reasonably large sample size in a population of community-dwelling older adults that have been extensively phenotyped and well characterized with regard to lifestyle and past medical history.

## 6. Conclusions

In a cohort of community-dwelling older adults in the UK, we found that while both OA and frailty were associated with difficulties with self-care and receipt of formal/informal care at home, sarcopenia and osteoporosis were not. These findings highlight the importance of OA in ability to selfcare and live independently in later life, and reinforce the importance of OA when considering care in older adults.

## Author contributions

EMD identified the study question. LDW planned and conducted the statistical analyses. GB and EMD wrote the first draft of the paper. All authors (GB, FL, HPP, LDW, NRF, CC, and EMD) contributed to the writing of subsequent and final drafts of the manuscript. The authors read and approved the final manuscript.

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## Ethics statement

All procedures performed in studies involving human participants were in accordance with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Ethical approval for work conducted in HCS was granted by the East of England—Cambridgeshire and Hertfordshire Research Ethics Committee, reference number 11/EE/0196. The patients/participants provided their written informed consent to participate in this study.

## Declaration of competing interest

Dr. Harnish P. Patel has received lecture fees and honoraria from Health Conferences UK, Abbott and Pfizer outside of the submitted work. Professor Cyrus Cooper has received lecture fees and honoraria from Amgen, Danone, Eli Lilly, GSK, Kyowa Kirin, Medtronic, Merck, Nestlé, Novartis, Pfizer, Roche, Servier, Shire, Takeda and UCB outside of the submitted work. Professor Elaine M. Dennison has received lecture fees and honoraria from UCB, Pfizer, Lilly and Viatris outside of the submitted work. Dr. Nicholas R. Fuggle has received travel and educational bursaries from Pfizer and Lilly. Drs. Gregorio Bevilacqua, Faidra Laskou, and Leo D. Westbury declare no conflicts of interest.

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