TITLE PAGE

Title: Changes in social isolation and loneliness following total hip and knee arthroplasty: longitudinal analysis of the English Longitudinal Study of Ageing (ELSA) cohort.

Running title: Social isolation and loneliness pre- and post-THA and TKA

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ABSTRACT

Objective: To determine the prevalence and change in social isolation and loneliness in people before and after THA and TKA in England.

Design: The English Longitudinal Study of Ageing dataset, a prospective study of community-dwelling older adults, was used to identify people who had undergone primary THA or TKA because of osteoarthritis. Social isolation was assessed using the ELSA Social Isolation Index. Loneliness was evaluated using the Revised University of California, Los Angeles (UCLA) Loneliness Scale. The prevalence of social isolation and loneliness were calculated and multilevel modelling was performed to assess the potential change of these measures before arthroplasty, within a two-year operative-recovery phase and a following two-year follow-up.

Results: The sample consisted of 393 people following THA and TKA. The prevalence of social isolation and loneliness changed from 16.9% and 18.8% pre-operative to 21.8% and 18.9% at the final post-operative follow-up respectively. This was not a statistically significant change for either measure (p=0.15; p=0.74). There was a significant difference in social isolation at the recovery phase compared to the pre-operative phase (p=0.01), where people following arthroplasty reported an increase in social isolation (16.9% to 21.4%). There was no significant difference between the assessment phases in respect to UCLA Loneliness Scale score (p≥0.74).

Conclusions: Given the negative physical and psychological consequences which social isolation and loneliness can have on individuals following THA or TKA, clinicians should be mindful of this health challenge for this population. The reported prevalence of social isolation and loneliness suggests this is an important issue.

Keywords: Joint replacement; social participation; environment; rehabilitation; psychology; multi-morbidity

INTRODUCTION

Social isolation is the lack of meaningful and sustained communication or interaction with friends, family and the wider community [1]. Loneliness refers to the subjective feeling of being alone or apart from other people [2]. It is a balance between desired and actual social contact [2]. Whilst social isolation and loneliness are inter-related, each reflect a different concept [3]. Examples of social participation can include charity/volunteer work, and attending sports/social clubs, educational/training courses or joining political/community organisations. It has been estimated that approximately five percent of older people in England are categorised as 'completely' isolated [4].

Social isolation and loneliness are associated with a negative self-assessment of health and well-being in older people [5-7]. This can result in adverse health outcomes including poor physical and mental health, maladaptive behaviors and an increased likelihood of institutionalization [8,9]. It is associated with increased emergency department admissions, and greater length of hospital stay [6,10]. People who report being socially isolated or lonely also report less exercise participation, greater tobacco use and have a greater number of long-term medical conditions compared to those with greater social participation behaviors.

Total hip (THA) and knee (TKA) arthroplasty are two of the most common orthopedic surgery procedures undertaken worldwide [11]. These procedures are projected to increase annually to an estimated 95,877 THAs and 118,666 TKAs by 2035 in the United Kingdom alone [12]. Whilst a proportion of these procedures are performed for younger people, the mean patient age ranges from 68 to 74 years within the literature [11,13]. The aim of both THA and TKA is to reduce the pain

and disability associated with degenerative joint disease, to facilitate greater quality of life and increased physical activity engagement [14,15].

Previous evidence has reported the link between pain and reduced function with increased social isolation [16,17]. Social participation and isolation have been shown to increase through a reduction in symptoms such as pain and stiffness and increased function for people with chronic pain [18]. However, this has not been assessed for those following lower limb arthroplasty. There exists some qualitative evidence to suggest that individuals may have considerable reluctance to increase physical activity engagement in social activities following lower limb arthroplasty because of: (a) uncertainty about what they can and cannot do; (b) fear avoidance regarding damaging the 'new' joint; or (c) a reluctance to engage in activities due to psychological or emotional barriers after a long-period living in chronic pain which may have impacted on their confidence and motivation to engage within society [19,20]. It remains unknown whether these patient perceptions are reflective of behaviours and quantifiable measures of social isolation or loneliness.

The purpose of this research was therefore to determine the prevalence of social isolation and loneliness in people following THA and TKA in an English cohort, and secondly to explore the potential natural change of social isolation and isolation before and after a THA or TKA.

METHODS

ELSA Cohort

Data were drawn from the ELSA cohort. The methods, sampling and data collection procedures for this study have been fully reported elsewhere [21]. ELSA is an ongoing, national cohort study of

community-dwelling adults born on or before 29th February 1952. It aims to examine the relationship between health with economic activity, social participation, physical activity and lifestyle behaviors, productivity, networks and sport [22]. It is a nationally representative sample of the non-institutionalized population living in England, aged 50 years or older on enrollment [21]. From the 2002/2003 inception, participants are contacted every two years for a follow-up interview. Participants are also contacted every four years for a medical examination. A total of 11,391 participants were recruited at the first data collection phase (Wave 1).

Ethical approval was gained from the London Multi-Centre Research Ethics Service (Reference number: MREC/01/2/91) and written informed consent obtained from all participants. Anonymized unlinked data for this study was provided by the UK Data Service.

Participant Identification

In this present analysis, we identified all people who self-reported that they had undergone a primary THA or TKA within a 10-year follow-up interval (2004/2005 to 2014/2015). This ensured that it was possible to ascertain social isolation: (a) in the follow-up wave prior to their arthroplasty (within two years) termed 'pre-operative phase'; (b) in the wave when the arthroplasty and recovery occurred, termed 'recovery phase'; and (c) in the subsequent wave (minimum of two years post-arthroplasty), termed 'follow-up phase'. We only included unilateral THA or TKA, and where the indication for surgery was non-trauma.

Measurements

The primary outcome was social isolation. This was measured using the validated and previously reported ELSA Social Isolation Index [23,24]. This index is based on respondents being unmarried/not cohabiting, less than monthly contact (including face-to-face, telephone, or

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written/e-mail contact) with children, other family members, and friends, and if they did not participate in organizations such as social clubs or residents groups, religious groups or committees [23,24]. Scores range from zero to five where higher scores indicate greater social isolation.

Loneliness was measured using the validated three-item short form of the Revised University of California, Los Angeles (UCLA) Loneliness Scale [25]. This is based on responses to: how frequently participants 'felt left out', 'isolated from others' and 'felt lonely'. Response options are: hardly ever or never, some of the time, and often. Ratings were summed to produce the loneliness score, with scores ranging from three to nine [25]. Higher scores indicate greater loneliness [25].

Based on the ELSA Wave 2, data were gathered on age, gender, ethnic classification (white/non-white), occupational class (current or most recent occupation) was measured using the National Statistics-Socio-Economic Classification scheme (NS-SEC) which is a validated measure of an individual's social position determined using the nature of their employment [26]. Data on timed walk as assessed with an eight feet (2.4m) walking test performed at normal walking pace, and self-reported depression, pain and health were also identified.

Data Analysis

Demographic characteristics for this cohort were reported using mean and standard deviation values and frequencies. The frequency of responses for social isolation and loneliness were calculated at each of the assessment time-points. Prevalence of social isolation and loneliness with 95% confidence intervals were calculated for baseline (pre-operative phase) and the follow-up phase (defined as at a time period at least two years post-arthroplasty). Cut-off for the prevalence of social isolation was defined as a score of two (or above) and the loneliness cut-off was defined as a score of six (or above). Both cut-offs were based on the median (or close to) for the scale on which they were measured.

Change of social isolation and loneliness over time was assessed by the three consecutive time periods (Time=base (pre-operative phase), Time=during (recovery phase), Time=post (minimum of two years post-operatively)). Multilevel modelling was used to examine if there was a significant contribution from 'Time' (levels=base, during, post) between any two of the levels (pairwise comparison). Random intercept models (where each participant's data was fitted with the same slope but different intercept) were compared to random intercept and slope models (where each participant's data was fitted with a different slope and intercept). In all cases, the random intercept models were preferred due to model parsimony/best fit tests.

'Age' (continuous), 'Gender' (factor: male/female), 'Type' (factor: THA/TKA), 'Depressed' (factor: self-reported yes/no), 'Walking time' (continuous), 'Pain' (factor: yes/no), 'Self-reported health' (factor: excellent/very good/good/fair/poor) and 'Occupational status' (factor: Managerial and professional occupations/Intermediate occupations/routine and manual occupations) were included as explanatory variables (in addition to the factor variable, 'Time') to explain some of the other variation in social isolation and loneliness. We performed an age stratification analysis where the dataset was stratified to 60 to 70 years and 71 to 88 years by reference to the median age (70 years).

In all analyses, statistical significance was deemed when $p<0.05$. All analyses were performed in the R Statistics program (R Core Team (2015). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.) using the 'lmer' function in the 'lme4' package.

RESULTS

As summarised in **Figure 1**, of the 11,391 participants in the ELSA dataset, 393 were identified as having had a THA or TKA with complete data (**Figure 1**).

In total 126 participants were not analysed due to insufficient data across the three follow-up assessments. A comparison of the characteristics of these two groups (participants versus non-participants due to missing data) demonstrated that gender (male/female) was similar (38%/62% in non-participants versus 37%/63% in participants) and mean age was similar (72.2 years versus 70.2 years). Similarly at baseline, the UCLA Loneliness Scale mean score was 3.8 (non-participants) versus 4.0 (participants) and the ELSA Social Isolation Index mean score was 1.0 (non-participants) versus 0.8 (participants), suggesting that non-participants was similar in baseline characteristics to the participant group.

The demographic characteristics of the participants are presented in **Table 1**. **Table 2** illustrates the frequency of social isolation/participation and loneliness between the three assessment points. The results of the multilevel models are presented in **Table 3**.

Social Isolation

There was no statistically significant difference in social isolation pre-operative compared to the later (minimum of two years) follow-up phase (p=0.15). The prevalence for social isolation pre-operatively was 16.9% (95% CI: 13.1 to 20.6) and 21.8% (95% CI: 18.3 to 25.3) at final follow-up. There was no difference in social isolation between the pre-arthroplasty to the final follow-up phase when assessed for participants aged 60 to 70 years (p=0.23) or those aged 71 to 88 years (p=0.61).

There was a significant difference in social isolation at the recovery phase compared to the pre-operative phase (p=0.01), where people following arthroplasty reported an increase in social isolation between these time-points. The prevalence of social isolation increased from 16.9% (95% CI: 13.1 to 20.6) to 21.4% (95% CI: 17.4 to 25.5). There was however no statistically significant change in social isolation between the recovery phase and the final follow-up phase (p=0.39), where the prevalence was 21.4% (95% CI: 17.4 to 25.5) compared 21.8% (95% CI: 18.3 to 25.3). None of the explanatory variables (age (p=0.17); gender (p=0.36); depression (p=0.09); type of arthroplasty procedure (p=0.49), timed walk (p=0.15), pain (p=0.06), self-reported health (p=0.18) or occupational status (p=0.20)), were significantly associated with a change in social isolation.

Loneliness

There was no statistically significant difference in loneliness pre-operative compared to the (minimum of two years) final follow-up phase (p=0.74). The prevalence of loneliness pre-operative was 18.8% (95% CI: 14.6 to 22.9) and 18.9% (95% CI: 15.5 to 22.2) at the final follow-up phase. There was no difference in loneliness between the pre-operative to the final follow-up phase when assessed for participants aged 60 to 70 years (p=0.74) or those aged 71 to 88 years (p=0.96).

There was no difference in loneliness from pre-operative compared to the recovery phase (p=0.88). The prevalence of loneliness pre-operatively changed from 18.8% (95% CI: 14.6 to 22.9) to 20.4% (95% CI: 16.4 to 24.4) at the recovery phase. Similarly, there was no statistically significant change in loneliness between the recovery phase and the final follow-up phase (p=0.83), where the prevalence changed from 20.4% (95% CI: 16.4 to 24.4) to 18.9% (95% CI: 15.5 to 22.2).

The explanatory valuables of age (p=0.06), gender (p=0.41), type of arthroplasty (p=0.63), timed walk (p=0.18), pain (p=0.66), self-reported health (p=0.11) and occupational status (p=0.54) were not significant explanatory variables. However self-reported depression was a statistically significant

explanatory variable (p<0.001), where those with self-reported depression were associated with increased loneliness compared to those without.

DISCUSSION

The community-based, prospectively-collected data which ELSA offers provided a rigorous dataset on-which to answer this research question. Based on this, the prevalence of social isolation and loneliness is approximately 20% before and after THA and TKA. Although social isolation and loneliness may fluctuate around the operative period, this does not significantly change over time from pre-operatively to a minimum of two years post-arthroplasty. This population therefore has a potential health gain from the introduction of an intervention to address this either pre- or post-arthroplasty. This may have a significant impact on improving their physical and mental well-being.

The prevalence of social isolation and loneliness for people pre- and post-THA or TKA was approximately 20%. The analyses suggest that this was maintained throughout the first two years post-arthroplasty. Accordingly, interventions are required to address this health and social challenge. As Smith et al [19] highlighted, there are a number of specific barriers which people post-arthroplasty face in relation to physical activity engagement. These include fear avoidance, barriers surrounding empowerment and not knowing what to do to improve physical activity participation and community engagement [19]. These may originate from pre-arthroplasty chronic pain and disability which people with degenerative joint conditions frequently present [27], and may account for the reported prevalence throughout this period. Furthermore these specific barriers which may foster social isolation and loneliness are a specific consequence of arthroplasty as opposed to being derived from socioeconomic or psychological factors, or due to the presence of specific co-morbidities [19]. Given the health benefits which improving social isolation and loneliness can offer,

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the development, testing and implementation of an intervention to address these barriers with both physical and psychological components, is a recommended research priority. Based on our analysis of potential explanatory variables, only depression was associated with loneliness in this population. Whilst those who experience depressive symptoms may be specifically targeted, such interventions should be considered potentially valuable across the THA/TKA population irrespective of age, gender, type of arthroplasty, functional capability, self-reported health, pain levels or occupational status.

There was a significant change in social isolation between the pre-operative to recovery phase, where this increased. This suggests that this population have the capability to change levels of social participation. This may be seen as a positive, where individuals are capable of returning to their previous status after these orthopedic procedures. However, given that social isolation and loneliness remains prevalent in this population after this period, it may be suggested that these individuals have greater health gains to be made and should be supported further to continue this increase in social participation following their recovery phase. Further exploration as to how this should be undertaken, by whom, in what context and when are therefore key research priorities.

Depression was the one explanatory factor identified from the analysis. Depression has previously been reported as strongly associated with social isolation and loneliness in older people [28-30]. However this relationship is complex with numerous factors such as sedentary time, obesity, self-esteem and self-efficacy are all recognised as potentially mediators to depressive symptoms [31]. Age was not identified as an explanatory variable. The relationship between age and social isolation and loneliness has also been widely reported, where older individuals are at greater risk [5]. This has been attributed, particularly in community-dwelling individuals, to changing social networks through retirement and bereavements, loss of identify and loss of physical capabilities to access community and social events [8,9]. However in this analysis, such a relationship was not identified.

The analysis indicated that the type of arthroplasty (i.e. THA or TKA) was not an explanatory factor for social isolation or loneliness. This may be viewed with surprise since the difference in clinical outcomes between these procedures, where TKA provide poorer outcomes compared to THA [32]. Given than approximately 20% of people following TKA report persistent pain and disability [33], it may be expected that this could impact on social isolation and loneliness. It was not possible to ascertain this from the ELSA data. Further exploratory analyses to determine how post-operative joint symptoms may relate to social isolation and physical activity would be valuable. This could improve understanding on this relationship and whether further rehabilitation needs should be addressed to maximise social participation post-arthroplasty.

This study presented with several limitations. First, due to insufficient data on the cohort from the ELSA dataset, it was not possible to determine the relationship between medical morbidities and social participation. This may be important given previous literature has suggested an association between social participation and hypertension [34]. This may be a result of physical activity being a causal pathway [34]. Whilst it has been reported that social isolation is associated with functional disability in older people [35,36], further exploration of the specific effects of social isolation and loneliness on diseases would provide a further rationale for developing strategies to increase social participation in people post-arthroplasty. Second, it was not possible to ascertain the actual date of surgery for these participants. Whilst the ELSA cohort design meant that it was possible to analyse the pre-operative, recovery and follow-up phases, each of the three intervals were two years in duration. Accordingly, it was not possible to determine whether social isolation or loneliness changed to a greater degree than those reported in this analysis due to the wide intervals between assessment points. Analysing by 'phase' negated this as meant that the interval between operation to final follow-up would be sufficient to ensure all participants would have recovered from their operation given that functional trajectories plateau between six and 12 months post-arthroplasty [32]. Third, although the ELSA Social Isolation Index [23,24] has demonstrated construct validity, its

reliability has not been evaluated, and validity testing has only occurred within the ELSA study and not an independent sample. Four, the assessment of potential confounders such as depression and pain, in addition to confirmation of arthroplasty were self-reported. Accordingly there was a potential risk of under-reporting or false reporting of this data. Finally, no power calculation was undertaken since all potentially eligible participants were analysed (**Figure 1**). There is therefore a potential risk of the study being underpowered to detect change over time.

In conclusion, social isolation and loneliness is prevalent in people who undergo THA and TKA. There appears little change in social isolation or loneliness over time comparing pre-operative to a minimum of two years post-arthroplasty. Given the negative physical and psychological consequences of social isolation and loneliness, clinicians should be mindful of this in this, and appropriate interventions should be made available to patients to address this major health challenge post-arthroplasty.

AUTHOR CONTRIBUTION

• Conception and design: TS, AMc

• Analysis and interpretation of the data: JD, TS, AMc

• Drafting of the article: JD, TS, AMc

• Critical revision of the article for important intellectual content: JD, TS, AMc

• Final approval of the article: JD, TS, AMc

• Provision of study materials or patients: TS

• Statistical expertise: JD, AMc

• Obtaining of funding: None received

• Administrative, technical, or logistic support: JD, AMc

• Collection and assembly of data: TS, JD

Guarantor: TS

REFERENCES

1.   Wenger GC, Davies R, Shatahmasebi S, Scott A. Social isolation and loneliness in old age: review and model refinement. Ageing and Society 1996;16:333-358.

2.   Ernst JM, Cacioppo JT. Lonely hearts: psychological perspectives on loneliness. Applied and Preventive Psychology 1999;8:1-22

3.   Routasalo PE, Savikko N, Tilvis RS, Strandberg TE, Pitkälä KH. Social contacts and their relationship to loneliness among aged people - a population-based study. Gerontology. 2006;52:181-7.

4.   Shankar A, Harner M, McMunn A, Steptoe A. Social isolation and loneliness: relationships with cognitive function during 4 years of follow-up in the English Longitudinal Study of Ageing. Psychometric Medicine 2013;75:161-170.

5.   Golden J, Conroy RM, Bruce I, Denihan A, Greene E, Kirby M et al. Loneliness, social supports, mood and wellbeing in community-dwelling elderly. International Journal of Geriatric Psychiatry 2009;24:694-700

6.   Landeiro F, Leal J, Gray AM. The impact of social isolation on delayed hospital discharges of older hip fracture patients and associated costs. Osteoporosis International. 2016;27:737-745.

7.   Tivis RS, Laitala V, Routasalo PE, Pitkälä KH. Suffering from loneliness indicates significant mortality risk of older people. Journal of Aging Research 2011: In Press.

8.   Luanaigh CO, Lawlor BA. Loneliness and the health of older people. International Journal of Geriatric Psychiatry 2008;23:1213-1221.

9.   Courtin E, Knapp M. Social isolation, loneliness and health in old age: a scoping review. Health and Social Care in the Community. 2015: In Press.

10.   Lim SC, Doshi V, Castasus B. Lim JK, Mamun K. Factors causing delay in discharge of elderly patients in an acute care hospital. Annals of the Academy of Medicine Singapore 2006;35:27-32.

11.   Hooper G, Lee AJ, Rothwell A, Frampton C. Current trends and projections in the utilisation rates of hip and knee replacement in New Zealand from 2001 to 2026. New Zealand Medical Journal 2014;127:82-93.

12.   Culliford D, Maskell J, Judge A, Cooper C, Prieto-Alhambra D, Arden NK et al. Future projections of total hip and knee arthroplasty in the UK: results from the UK Clinical Practice Research Datalink. Osteoarthritis and Cartilage 2015;23:594-600.

13. Ravi B, Croxford R, Reichmann WM, Losina E, Katz JN, Hawker GA. The changing demographics of total joint arthroplasty recipients in the United States and Ontario from 2001 to 2007. Best Practice Research Clinical Rheumatology 2012;26:637-47.

14. Frankel L, Sanmartin C, Conner-Spady B, Marshall DA, Freeman-Collins L, Wall A, et al. Osteoarthritis patients' perceptions of "appropriateness" for total joint replacement surgery. Osteoarthritis and Cartilage 2012;20:967-73.

15. Frankel L, Sanmartin C, Hawker G, De Coster C, Dunbar M, Bohm E, et al. Perspectives of orthopaedic surgeons on patients' appropriateness for total joint arthroplasty: a qualitative study. Journal of Evaluations in Clinical Practice 2015:In Press.

16. Ravesloot C, Ward B, Hargrove T, Wong J, Livingston N, Torma L, Ipsen C. Why stay home? Temporal association of pain, fatigue and depression with being at home. Disability and Health Journal 2016;9:218-25.

17. Docking RE, Beasley M, Steinerowski A, Jones EA, Farmer J, Macfarlane GJ, Jones GT. The epidemiology of regional and widespread musculoskeletal pain in rural versus urban settings in those ≥55 years. British Journal of Pain 2015;9:86-95.

18. Lützner C, Kirschner S, Lützner J. Patient activity after TKA depends on patient-specific parameters. Clinical Orthopaedics and Related Research 2014;472:3933-40.

19.   Smith TO, Latham SK, Maskrey V, Blyth A. What are people's perceptions of physical activity before and after joint replacement? A systematic review and meta-ethnography. Postgraduate Medical Journal 2015;91;483-91.

20.   Wolf LD, Davis MC. Loneliness, daily pain, and perceptions of interpersonal events in adults with fibromyalgia. Health Psychology 2014;33:929-37.

21.   Steptoe A, Breeze A, Banks J, Nazroo J. Cohort profile: The English Longitudinal Study of Ageing. International Journal of Epidemiology 2013;42:1640–1648.

22.   Bowling A, Windsor J. The effects of question order and response-choice on self-rated health status in the English Longitudinal Study of Ageing (ELSA). Journal of Epidemiology and Community Health 2008;62:81-5.

23.   Steptoe A, Shankar A, Demakakos P, Wardle J. Social isolation, loneliness, and all-cause mortality in older men and women. Proceedings of the National Academy of Sciences USA. 2013;110:5797-801.

24.   Shankar A, McMunn A, Banks J, Steptoe A. Loneliness, social isolation, and behavioral and biological health indicators in older adults. Health Psychology 2011;30:377-85.

25.   Hughes ME, Waite LJ, Hawkley LC, Cacioppo JT. A short scale for measuring loneliness in large surveys: results from two population-based studies. Research in Aging 2004;26:655-672.

26.   Rose D, Pevalin D. A researcher's guide to the National Statistics Socio-Economic Classification. London: Sage Publications Ltd; 2003.

27.   Gossec L, Paternotte S, Maillefert JF, Combescure C, Conaghan PG, Davis AM, et al. The role of pain and functional impairment in the decision to recommend total joint replacement in hip and knee osteoarthritis: an international cross-sectional study of 1909 patients. Report of the OARSI-OMERACT Task Force on total joint replacement. Osteoarthritis and Cartilage 2011;19:147-54.

28.   Santini ZI, Fiori KL, Feeney J, Tyrovolas S, Haro JM, Koyanagi A. Social relationships, loneliness, and mental health among older men and women in Ireland: A prospective community-based study. Journal of Affective Disorders 2016;204:59-69.

29.   Health Quality Ontario. Social isolation in community-dwelling seniors: an evidence-based analysis. Ontario Health Technology Assessment Service 2008;8:1-49.

30.   Rico-Uribe LA, Caballero FF, Olaya B, Tobiasz-Adamczyk B, Koskinen S, Leonardi M, et al. Loneliness, Social Networks, and Health: A Cross-Sectional Study in Three Countries. PLoS One 2016;11:e0145264.

31.   Hawkley LC, Thisted RA, Cacioppo JT. Loneliness predicts reduced physical activity: cross-sectional & longitudinal analyses. Health Psychology 2009;28:354-63.

32.   Choi JK, Geller JA, Yoon RS, Wang W, Macaulay W. Comparison of total hip and knee arthroplasty cohorts and short-term outcomes from a single-center joint registry. Journal of Arthroplasty 2012;27:837-41.

33.   Baker PN, van der Meulen JH, Lewsey J, Gregg PJ; National Joint Registry for England and Wales. The role of pain and function in determining patient satisfaction after total knee replacement. Data from the National Joint Registry for England and Wales. Journal of Bone and Joint Surgery (Br) 2007;89:893-900.

34.   Yazawa A, Inoue Y, Fujiwara T, Stickley A, Shirai K, Amemiya A, et al. Association between social participation and hypertension among older people in Japan: the JAGES Study. Hypertension Research 2016: In Press.

35.   Kanamori S, Kai Y, Aida J, Kondo K, Kawachi I, Hirai H, et al. Social participation and the prevention of functional disability in older Japanese: the JAGES cohort study. PLoS One 2014;9:e99638.

36.   Hikichi H, Kondo N, Kondo K, Aida J, Takeda T, Kawachi I. Effect of a community intervention programme promoting social interactions on functional disability prevention for older adults: propensity score matching and instrumental variable analyses, JAGES Taketoyo study. Journal of Epidemiology and Community Health 2015;69:905-10.

FIGURE AND TABLE LEGENDS

Figure 1: Participant flow chart illustrating the composition of the study cohort from the ELSA cohort.

Table 1: Demographic characteristics of the analysed cohort at baseline.

Table 2: Frequency (%) of scores for ELSA Social Isolation Index and UCLA Loneliness Scale based on the total cohort and sub-grouped by age (n=393).

Table 3: Results of the multilevel models for ELSA Social Isolation Index and UCLA Loneliness Scale of the study cohort.

Figure 1: Participant flow chart illustrating the composition of the study cohort from the ELSA cohort.
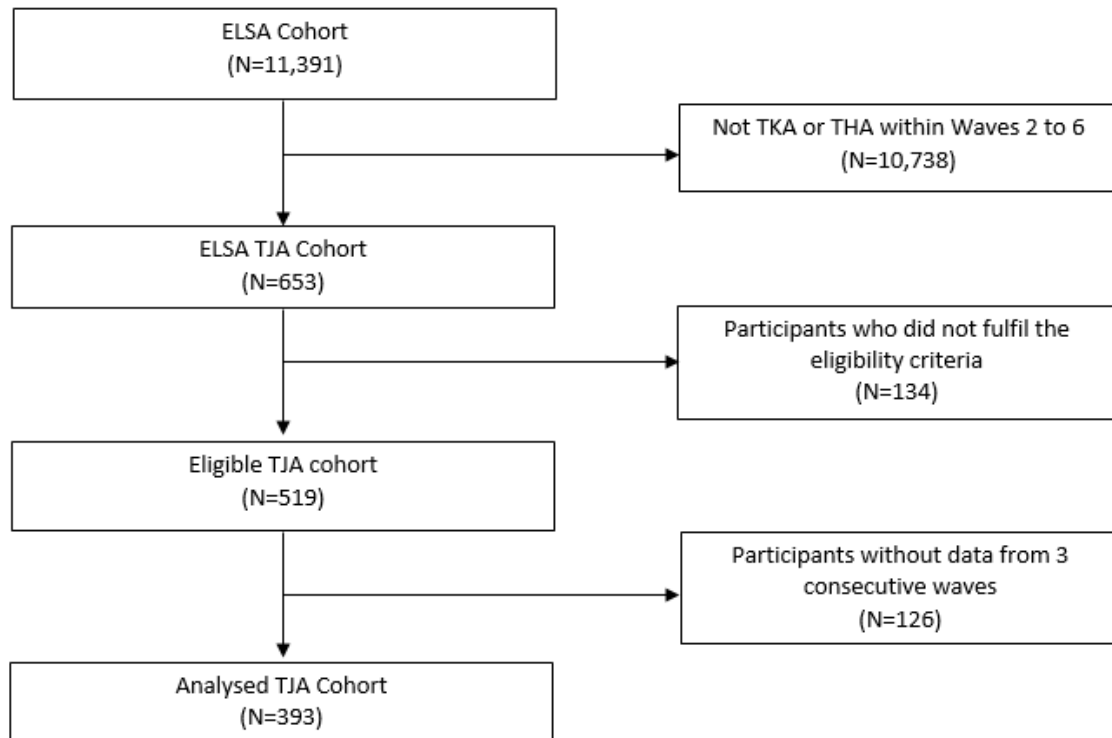
ELSA – English Longitudinal Study of Ageing; THA – Total Hip Arthroplasty; TJA – Total Joint Arthroplasty; TKA – Total Knee Arthroplasty

Table 1: Demographic characteristics of the analysed cohort at baseline.

N	393
THA/TKA/both	218/175
Gender (M/F)	145/248
Mean Age (SD) in years	70.2 (6.7)
Ethnic Group (%)	48.9: White
	13.5: Non-White
	37.7: Not Defined
Pain (%)	65.6: Yes
	34.4: No
Mean (SD) timed walk (seconds)	3.6 (2.7)
Self-reported health (%)	6.4: Excellent
	22.1: Very good
	33.6: Good
	20.9: Fair
	7.1: Poor
	9.9: Missing
Occupational status (%)	21.1: Managerial
	24.7: Intermediate
	34.9: Manual
	19.3: Missing
Self-reported depression (%)	9.4: Yes
	55.7: No
	34.9: Missing

F– female; M – male; N – number of participants; THA – total hip arthroplasty; TKA – total knee arthroplasty; SD – standard deviation

Table 2: Frequency (%) of scores for ELSA Social Isolation Index and UCLA Loneliness Scale based on the total cohort and sub-grouped by age (n=393).

	Pre-Operative Phase	Recovery Phase	Post-Recovery Phase
Social Isolation Index (Total Cohort)			
	0: 42.2 1: 39.1 2: 13.9 3: 2 4: 0.2 5: 0.2	0: 36.1 1: 42.2 2: 17.3 3: 2.7 4: 1.2 5: 0	0: 38.9 1: 40.2 2: 13.7 3: 6.1 4: 0.2 5: 0.2
Social Isolation Index (Age Stratified: 60-70 years)			
	0: 47.8 1: 35.8 2: 11.9 3: 1.9 4: 0 5: 0.4	0: 40.6 1: 36.8 2: 17.7 3: 2.3 4: 2.3 5: 0	0: 42.1 1: 37.3 2: 13.3 3: 5.7 4: 0 5: 0.4
Social Isolation Index (Age Stratified: 71-88 years)			
	0: 35.8 1: 42.9 2: 16.3 3: 2.1 4: 0.5 5: 0	0: 30.9 1: 48.3 2: 16.8 3: 3.2 4: 0 5: 0	0: 35.3 1: 43.4 2: 14.1 3: 6.5 4: 0.5 5: 0
Loneliness (Total Cohort)			
	3: 46 4: 18.8 5: 11.7 6: 9.2 7: 4.2 8: 2.2 9: 1.9	3: 49.3 4: 14.2 5: 15 6: 12.4 7: 3.3 8: 1.7 9: 2.5	3: 48.5 4: 15.1 5: 15.1 6: 10.7 7: 5.9 8: 1.5 9: 1.2
Loneliness (Age Stratified: 60-70 years)			
	3: 49.4 4: 17.5 5: 11.8 6: 8.7 7: 2.5 8: 3.6 9: 1.5	3: 53.1 4: 15.3 5: 17.2 6: 8.1 7: 2.3 8: 1.4 9: 1.9	3: 54.5 4: 14.9 5: 12.5 6: 12 7: 3.8 8: 0.4 9: 0.4
Loneliness (Age Stratified: 71-88 years)			
	3: 41.9 4: 20.3 5: 11.7 6: 9.8 7: 6.1 8: 0.6 9: 2.4	3: 45.1 4: 13 5: 12.5 6: 17.3 7: 4.3 8: 2.1 9: 3.2	3: 41.7 4: 15.3 5: 18.1 6: 9.3 7: 8.2 8: 2.7 9: 2.1

Table 3: Results of the multilevel models for ELSA Social Isolation Index and UCLA Loneliness Scale of the study cohort.

	Social Isolation		Loneliness	
	Mean (se)	**p-value**	**Mean (se)**	**p-value**
Intercept	0.082 (0.465)		3.076 (0.790)	
Age	0.009 (0.006)	0.173	0.020 (0.011)	0.062
Walking time	0.019 (0.013)	0.147	0.028 (0.021)	0.178
Gender				
Male	ref		ref	
Female	0.079 (0.086)	0.357	0.120 (0.147)	0.414
Depression				
Yes	ref		ref	
No	-0.144 (0.085)	0.092	-0.614 (0.128)	2.2E-06
Type of Arthroplasty				
THA	ref		ref	
TKA	0.035 (0.088)	0.693	-0.072 (0.151)	0.634
Pain				
Yes	ref		ref	
No	0.117 (0.061)	0.057	0.040 (0.090)	0.662
Self-reported Health				
Excellent	ref		ref	
Very good	0.045 (0.103)	0.693	-0.128 (0.156)	0.410
Good	-0.097 (0.103)	0.346	0.104 (0.155)	0.501
Fair	0.031 (0.116)	0.786	-0.059 (0.174)	0.736
Poor	0.079 (0.146)	0.587	-0.218 (0.221)	0.323
Occupational Status				
Managerial, Professional	ref		ref	
Intermediate	0.135 (0.104)	0.198	0.177 (0.175)	0.314
Routine, Manual	-0.024 (0.098)	0.804	0.164 (0.166)	0.323
Assessment Phase				
Pre-Operative	ref		ref	
Recovery	0.141 (0.055)	0.011	0.012 (0.079)	0.876
Follow-up Phase	0.091 (0.062)	0.146	0.031 (0.092)	0.736

Ref – Reference; se – standard error; THA – total hip arthroplasty; TKA – total knee arthroplasty