**FEASIBILITY AND SUSTAINABILITY OF WORKING IN DIFFERENT TYPES OF JOBS AFTER TOTAL HIP ARTHROPLASTY: ANALYSIS OF LONGITUDINAL DATA FROM TWO COHORTS**

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**ABSTRACT**

**Objectives**. To investigate the rates of return to work and workability amongst working-age people following total hip arthroplasty (THA).

**Methods**. Participants from the Geneva Arthroplasty Registry and the Clinical Outcomes for Arthroplasty Study aged 18-64 years when they had primary THA and with at least 5 years’ follow-up were mailed a questionnaire 2017-2019. Information was collected about pre-operative and post-THA employment along with exposure to physically-demanding activities at work or in leisure. Patterns of change of job were explored. Survival analyses using Cox proportional hazard models were created to explore risk factors for having to stop work because of difficulties with the replaced hip.

**Results**. In total, 825 returned a questionnaire (response 58%), 392 (48%) men, mean age 58 years, median follow-up 7.5 years post-THA. The majority (93%) of those who worked pre-operatively returned to work, mostly in the same sector but higher rates of non-return (36-41%) were seen amongst process, plant and machine operatives and workers in elementary occupations. 7% reported subsequently leaving work because of their replaced hip and the risk of this was strongly associated with: standing > 4 hours/day (HR: 3.81, 95%CI 1.62-8.96); kneeling/squatting (HR: 3.32, 95%CI 1.46-7.55) and/or carrying/lifting≥ 10 kg (HR: 5.43, 95%CI 2.29-12.88).

**Conclusions.** It may be more difficult to return to some (particularly physically-demanding) jobs post-THA than others. Rehabilitation may need to be targeted to these types of workers or it may be that re-deployment or job change counselling are required.

**KEY WORDS:** Workability, total hip arthroplasty, occupation, physically-demanding occupational activities; leisure activities

**KEY MESSAGES**

**What is already known about this subject**?

From the few studies available, it is known that most of those who are working pre-operatively return to work post-THA. However, there is little information about the types of work to which people return post-THA nor the sustainability of some (particularly physically-demanding) occupational activities.

**What are the new findings?**

Not only is it more difficult to return to some types of physically-demanding jobs post-THA (notably amongst process, plant and machine operatives or those in elementary occupations), but also some jobs are more difficult to sustain post-THA if they involve in an average day: standing prolonged hours; lifting or carrying weights; kneeling/squatting.

**How might this impact on policy or clinical practice in the foreseeable future?**

Physically demanding jobs are more difficult to return to and sustain post-THA. This could mean a risk of widening health inequalities as these types of jobs tend to be performed by those with lesser educational attainment in poorer socio-economic circumstances. There could be a need for targeted post-THA rehabilitation for these types of workers and/or considering opportunities for re-deployment or re-training when a THA is planned.

**INTRODUCTION**

Total hip arthroplasty (THA) is a very successful operation, delivering excellent pain relief and functional improvement for the majority of those with failure of the hip joint for any reason.[1] Traditionally performed amongst adults at older ages,[2] this success has led to increasing demand amongst younger adults aged <65 years.[3] Where projections exist, it is predicted that THA demand will continue to grow, at least in the Organisation for Economic Co-operation and Development countries.[4-6] Simultaneously, with a combination of increasing longevity and declining birth rates, the population is ageing and the old age dependency ratio (proportion of adults who are no longer economically active in relation to those who are) is increasing. This has led governments to make legislative changes (e.g. increasing the age of eligibility for state pension) to encourage adults to work to older ages. Taken together, a growing proportion of people undergoing THA will need to return to work (RTW) post-operatively and remain in paid work for some years.

Historically, orthopaedic surgeons have expressed reservations about THA recipients returning to very physically-demanding activities post-operatively, be they occupational or sports-related. It is unclear whether their concerns relate to the known associations between heavy occupational activities and primary osteoarthritis (OA) (which is the commonest indication for THA),[7-10] personal experiences with patients, or both. Given that arthroplasty failure necessitates revision surgery, which is generally more complicated and less successful than the primary operation,[11, 12] it is perhaps unsurprising that published surveys suggest that surgeons recommend avoidance of a number of high-impact sports post-THA.[13-16] In the absence of much evidence, it appears that orthopaedic surgeons generally suggest that people needing to return to “light work” or “office-based work” post-THA may expect to return within approximately 6 weeks of the operation whilst people returning to a job “involving heavy duties” may need to take “several weeks longer”.[17] Whatever the advice of orthopaedic colleagues, a systematic review showed that high proportions of THA recipients return to both work and sports.[18]

Clearly therefore, there is a need for more evidence about what types of work people return to post-operatively, how feasible occupational physically-demanding activities are post-THA and whether or not they are sustainable, to provide evidence-based advice to patients. We investigated these questions using data from two well-characterised cohorts of arthroplasty recipients in Switzerland and the UK. As a secondary outcome we examined whether post-operative leisure activities affected job retention.

**METHODS**

Data were obtained from two contemporary THA cohorts: the Geneva Hip Arthroplasty Register (GAR), a hospital-based registry which includes all patients with THA performed at the Geneva University Hospitals since March 1996;[19] and the Clinical Outcomes for Arthroplasty Study (COASt), a dual-centre study recruiting THA patients pre-operatively from Southampton and Oxford since 2010.[20]

People were eligible if they underwent elective unilateral THA aged between 18-64 years and a minimum of 5 years had elapsed since their primary THA. Where people had both hips replaced over time, we took the first THA as index surgery. For participants in both studies, information available at baseline included: sex, body mass index (BMI), age at THA, Charnley score, American Society of Anesthesiologists (ASA) score, indication for primary THA (primary and secondary OA) and date of arthroplasty.

Eligible participants were posted a questionnaire between October 2017 and January 2019. The questionnaire enquired about pre-operative employment status and details of jobs in which they had participated post-operatively for a minimum of 1 month (up to a maximum of 3 jobs) with dates of starting/stopping each job. We enquired about physically-demanding activities performed as part of each job (standing >4 hours; walking >3 km; lifting/carrying ≥10kg and/or 25kg; digging/shovelling; kneeling/squatting; climbing >30 flights of stairs per day and climbing up/down ladders), and participation in leisure-time physical activities (LTPA) post-THA in relation to loading the hips either “repeatedly”, “moderately” or “lightly”, each with a range of examples. They were asked to report the type of activity, and the duration over which they participated (in years), frequency (< once a week or ≥ once a week) and intensity (number of hours/week). The questionnaire also asked respondents to recall the time post-operatively at which they felt that they had reached optimum function (< one year, ≥ one year). For the GAR participants, the questionnaire was translated into French and back-translated to English to ensure accuracy of wording and comparability of questions. The questionnaires (French and English) were further tested with a group of 15-20 people and modified based on their feedback.

COASt participants originally consented to receive five annual follow-up questionnaires at baseline and, in many cases, the work questionnaire was sent as part of the expected 5-year follow-up. We obtained an ethics amendment to additionally post this questionnaire to eligible individuals who had passed their 5-year follow-up. GAR participants are routinely followed-up by the Register team and with their support, we obtained ethical approval to send our questionnaire to eligible GAR participants. Non-respondents were sent a reminder questionnaire (after 4 weeks in COASt and after one year in GAR).

All jobs reported were grouped into categories using the Standard Occupational Classification (SOC) 2010 (2 digits).[21] The leisure-time activities were coded as high-, medium- or low-impact based upon information from existing published sources (Supplementary Table 1).[22, 23] For activities reported for which there was no available information, two observers independently coded them as high-, medium- or low-impact based upon other similar activities. Where necessary, disagreements were resolved after discussion. For each individual, we took the self-reported activity involving the highest impact amongst the examples they had provided and then took into account both the duration (in years) of exposure to that level of activity and the frequency (less than once weekly or ≥ once weekly). The type of impact was then combined with the frequency of participation to create three categories: inactive (no high-, medium- or low-impact activity), moderately active (low- or medium- impact leisure activities only, regardless of how often these were performed and high-impact activities < once a week) and highly active (high-impact activities ≥ once a week).

The outcome of the study was hip related job loss (HRJL), this is stopping work post-THA due to problems with their replaced hip. For each post-operative job held for at least one month the survey asked participants to report whether “*they left their job at least partly because of problems with the hip*”.

**Statistical analysis**

Participants’ characteristics were described using counts and prevalence rates for categorical variables, and medians (IQRs) for continuous, not normally distributed variables. We tested for differences between respondents and non-respondents, and respondents from both cohorts, and we constructed a Kaplan-Meier plot to illustrate job retention rates post-THA over follow-up.

To explore factors associated with HRJL, a survival dataset was created. Each line of this dataset represented a period of time during which a participant was working and therefore ‘at risk’ of HRJL. Each participant was considered to be at risk from the day they worked post-THA and remained at risk until the earliest of: a) the date the participant reported leaving a job because of a problem with the replaced hip, b) date of finishing a job for other reasons than HRJL, or c) end of follow-up if they were still working at the time of survey completion. Participants with more than one job post-THA were not at risk from the time they finished a job to the time they started their next one, ending up with multiple records in the survival dataset for the multiple jobs they reported. Time to first event was considered for the current analyses. For participants who were working pre-operatively and returned to the same job, date of returning to work post-THA was imputed as three months after the surgery date, based on data from other studies that suggest the median time to RTW is 3 months post-operation.[18, 24]

Crude Cox proportional hazards (PH) regression models were fitted to examine associations of HRJL with the highest impact LTPA reported, or any exposure to each of the reported physically-demanding occupational activities post-THA. Subsequently, the Cox proportional hazards regression models were repeated, adjusting for: age at operation, sex and BMI (measured at baseline) [25] as well as site of recruitment to the study to account for differences between cohorts; duration of follow-up, and optimal function reached post-arthroplasty, chosen as a measure of fitness after the operation. Finally, the occupational activities significantly associated with HRJL after adjustment for other covariates were further added into a mutually adjusted Cox PH regression model. Statistical analyses were performed using STATA® version 16.0.

**Ethics approval**

Ethics approval was obtainedfrom the NHS Research Ethics Committee, Oxford REC A (ref. 10/H0604/91) in March 2017, Oxford REC C (ref. 09/H606/11) in January 2018, and the Commission Cantonale d’Ethique de la Recherche de Genève (PB\_2017\_00164) in October 2017.

**RESULTS**

Amongst 1,449 people who fulfilled our eligibility criteria, 825 (392 men and 433 women), returned a useable questionnaire (response rate 58%) (Figure 1). The median follow-up time was 7.5 years post-THA [IQR (6.2- 12.1)], with a minimum of 5 years and a maximum of 22 years. COASt participants were more likely to be female (67% vs 45%) (p<0.001), to have a BMI>30 Kg/m2 (28% vs 19%) (p=0.02) and to have had primary OA as the indication for THA (74% vs 68%) (p<0.001) than GAR participants, but pre-operative ASA and Charnley scores were similar in both cohorts.

A comparison of the characteristics of respondents with non-respondents shows that respondents were older by on average two years, more likely to have received their THA for primary OA and differed in terms of ASA score (Supplementary Table 2).

**Working status at time of THA**

Figure 1 shows that a total of 687/825 (83%) had ever worked before THA. However, 195 (28%) of these had stopped working at the time of THA, 60 (31%) of whom stopped working pre-operatively because of their hip.

**Working status post-operatively**

In total 514/825 (62%) held at least one paid job post-THA. Most (93%) of those who worked post-THA were working pre-operatively but 6% unable to work pre-operatively became able to work. Table 1 describes the type of work (2-digit SOC 2010 codes), before and after arthroplasty for 652 participants who reported their job title (35 missing). Most people returned to the same job sector as pre-operatively. However, 26% of those in the caring, leisure and other service occupations changed to a different type of job post-THA. The category of employment to which the highest proportion of workers returned was Associate Professional and Technical Occupations (13% failed to return). However, rates of non-return were higher among process, plant and machine operatives, and elementary occupations: 41% and 36% respectively. The odds of non-RTW were almost 4-fold higher among process, plant and machine operatives (OR: 3.92, 95%CI:1.63-9.47), and 2.8-fold higher among workers in elementary occupations (OR: 2.77, 95%CI: 1.43-5.34) compared with professional workers. Workers in these types of occupation were more likely to be male, younger and had a similar duration of follow-up to those in other occupational sectors (Table 1). We also explored whether they had different pre-operative ASA or Charnley scores, or indication for surgery but found no differences (data not shown).

**Table 1.** **Changes in self-reported occupation pre- and post-THA according to SOC 2010 major groups**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **SOC 2010 codes** | **People in work**  **ever before THA (N)** | **Did not return to work post-THA** | | | | | **Returned to work post-THA** | | | | | | | | |
| **Total**  N (%) | **Men (%)** | **Women**  **(%)** | **Age (yrs)**  **Median (IQR)** | **Duration of FU (yrs),**  **Median (IQR)** | **Total**  **N (%)** | **Men (%)** | **Women**  **(%)** | **Age (yrs)**  **Median (IQR)** | **Duration of FU (yrs),**  **Median (IQR)** | **Same job as pre-op, N (%)** | **Different**  **job post-op N (%)** | **Missing N (%)** | **Non-return as compared with return OR (95% CI)** |
| 1 Managers, Directors and Senior Officials | 46 | 10 (22) | 30 | 70 | 62  (61-64) | 7.0  (6.4-7.5) | 36 (78) | 64 | 36 | 58  (52- 61) | 7.6  (6-13.2) | 25 (54) | 8 (17) | 3 (7) | 0.78  (0.33 – 1.86) |
| 2 Professional Occupations | 163 | 37 (23) | 35 | 65 | 63  (60-64) | 7.1  (6.4-8.7) | 126 (77) | 44 | 56 | 56  (51- 60) | 7.7  (6.6-12.6) | 106 (65) | 10 (6) | 10 (6) | referent |
| 3 Associate Professional and Technical Occupations | 71 | 9  (13) | 56 | 44 | 59  (58-62) | 12.5  (7.7-16.9) | 62 (87) | 40 | 60 | 55  (47- 59) | 7  (5.9-10.7) | 46 (65) | 7 (10) | 9 (13) | 0.59  (0.26 – 1.35) |
| 4 Administrative and Secretarial Occupations | 91 | 25 (27) | 16 | 84 | 61  (58-63) | 8.2  (6.7- 14.7) | 66 (73) | 30 | 70 | 56  (51-59) | 7.6  (6-11.9) | 51 (55) | 7 (7) | 8 (9) | 1.22  (0.65 – 2.30) |
| 5 Skilled Trades Occupations | 95 | 23 (24) | 78 | 22 | 59  (53-63) | 14.2  (8.6- 17.9) | 72 (76) | 93 | 7 | 58  (50-60) | 9  (6.6-13.8) | 56 (59) | 8 (8) | 8 (8) | 1.65  (0.84 - 3.24) |
| 6 Caring, Leisure and Other Service Occupations | 46 | 9  (20) | 0 | 100 | 63  (61-64) | 8.7  (7.2-13.7) | 36 (80) | 33 | 67 | 51  (45-58) | 7.1  (6.1-8.7) | 25 (54) | 12 (26) | 0 (0) | 0.92  (0.37 - 2.29) |
| 7 Sales and Customer Service Occupations | 28 | 7  (25) | 14 | 86 | 61  (57-63) | 8.3  (5.4-20.5) | 21 (75) | 38 | 62 | 60  (56- 62) | 8.8  (6.4-13.4) | 19 (67) | 1 (4) | 1 (4) | 0.84  (0.32 - 2.22) |
| 8 Process, Plant and Machine Operatives | 34 | 14 (41) | 71 | 29 | 61  (53-63) | 11.0  (7.2-18.6) | 20 (59) | 90 | 10 | 57  (49- 60) | 12.1  (6.8-18.5) | 18 (53) | 1 (3) | 1 (3) | 3.92  (1.63 - 9.47) |
| 9 Elementary Occupations | 78 | 28 (36) | 25 | 75 | 59  (55-62) | 11.9  (7.4-18.2) | 47 (64) | 49 | 51 | 53  (45-57) | 9.5  (6.3-15.7) | 42 (54) | 2 (3) | 6 (7) | 2.77  (1.43 - 5.34) |

\*Job with longest duration out of the 3 possible jobs reported post-THA

**Exposure to occupational activities post-THA**

In total, 411 of the 514 people who worked post-operatively provided complete post-THA occupational exposure information: 241 from GAR and 170 from COASt (Table 2). The median age at THA was 56 years [IQR 49-60] with OA as the main indication. 34% of respondents did sedentary work, while among the rest (doing at least one physically-demanding activity) standing >4 hours, lifting/carrying ≥10kg and kneeling/squatting were the most prevalent activities.

**Table 2.** **Characteristics of the 411 participants with complete information about occupational exposures post-THA included in the survival analyses of person years at risk of hip-related job loss (HRJL)**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **All**  N=411 | **Men**  N=206 | **Women**  N=205 |
| **Age at THA**, Median (IQR) | 56 (49,60) | 56 (51, 60) | 55 (47, 59) |
| **Age at follow-up,** Median (IQR) | 64.2 (57.6-68.9) | 65.3 (59.1-70.1) | 63.7 (56.5-67.9) |
| **Time since THA,** Median (IQR) | 7.5 (6.2-12.1) | 7.9 (6.1-13.3) | 7.3 (6.3-10.6) |
| **Body mass index at baseline** (kg/m2), n (%) | |  |  |
| 18.5 - 24.9 | 141 (35) | 49 (24) | 92 (45) |
| 25.0 - 29.9 | 174 (42) | 100 (49) | 74 (36) |
| ≥ 30.0 | 94 (23) | 55 (27) | 39 (19) |
| Missing | 2 (0) | 2 (1) | 0 (0) |
| **American Society of Anesthesiologists score,** n (%) | |  |  |
| ASA I | 140 (34) | 67 (33) | 73 (36) |
| ASA II | 226 (55) | 116 (56) | 110 (54) |
| ASA III | 14 (3) | 9 (4) | 5 (2) |
| Missing | 31 (8) | 14 (7) | 17 (8) |
| **Charnley score,** n (%) |  |  |  |
| A | 180 (44) | 93 (45) | 87(42) |
| B | 110 (27) | 58 (28) | 52 (25) |
| C | 51 (12) | 28 (14) | 23 (11) |
| Missing | 70 (17) | 27 (13) | 43 (21) |
| **Indication for THA,** n (%) |  |  |  |
| Primary OA | 291 (71) | 151 (73) | 140 (68) |
| Secondary OA | 102 (25) | 45 (22) | 57 (28) |
| Missing | 18 (4) | 10 (5) | 8 (4) |
| **Type of impact activity** n (%) |  |  |  |
| None | 15 (4) | 9 (4) | 6 (3) |
| Low | 142 (35) | 62 (30) | 80 (39) |
| Medium | 137 (33) | 68 (33) | 69 (34) |
| High | 105 (26) | 58 (28) | 47 (23) |
| Missing | 12 (3) | 9 (4) | 3 (1) |
| **Frequency of leisure activities,** n (%) |  |  |  |
| No activity | 15 (4) | 9 (4) | 6 (3) |
| <Weekly | 155 (38) | 85 (41) | 70 (34) |
| ≥Weekly | 206 (50) | 91 (44) | 115 (56) |
| Missing | 35 (8) | 21 (10) | 14 (7) |
| **Occupational activities†,** n (%) |  |  |  |
| None reported | 141 (34) | 58 (28) | 83 (40) |
| Standing >4 hours/day | 189 (46) | 104 (50) | 85 (42) |
| Walking >3 km/ day | 141 (34) | 86 (42) | 55 (27) |
| Carrying/Lifting ≥10 kg | 141 (34) | 93 (45) | 48 (24) |
| Carrying/Lifting ≥25 kg | 57 (14) | 49 (24) | 8 (4) |
| Digging/shovelling | 29 (7) | 26 (13) | 3 (1) |
| Kneeling/squatting | 145 (35) | 83 (40) | 62 (31) |
| Climbing >30 stairs | 111 (27) | 80 (39) | 31 (15) |
| Climbing ladders | 76 (19) | 62 (30) | 14 (7) |

**†**Prevalence rates for occupational activities do not add up to 100 because people could report more than one activity

In total, 29 (7%) experienced HRJL (i.e. reported that they stopped working post-operatively mainly or partly because of a problem with the replaced hip). Rates were similar in both cohorts: 6.6% (n=16) amongst GAR participants and 7.6% (n=13) amongst COASt participants. As with non RTW at all, people reporting HRJL were more likely process, plant and machine operatives or elementary workers (group 3 in Supplementary Figure 1).

Those who worked post-THA (N=411) contributed a total of 2,643 person-years to the analysis of risk factors for HRJL. Table 3 shows associations between any exposure to physically-demanding occupational activities post-THA and the risk of HRJL. The adjusted HRs showed more than a three-fold greater risk of HRJL amongst those who reported that they stood >4 hours (HR: 3.81 95%CI:1.62-8.96), and those who knelt/squatted (HR: 3.32, 95%CI:1.46-7.55); and a five-fold increased risk of HRJL for those who reported carrying/lifting ≥10kg (HR: 5.43, 95%CI:2.29-12.88) compared with those who did not carry out these activities.

**Table 3. Physically-demanding occupational activities post-THA and risk of hip-related job loss (HRJL) amongst 411 participants in the survival analyses**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All participants n (%)** | **Hip related job loss (HRJL)** | | **Median time at risk(years) for** | | **Crude HR**  **(95% CIs)** | **Adjusted HR†**  **(95% CIs)** |
| **Occupational activities** |  | **No n (%)** | **Yes n (%)** | **No HRJL** | **Yes**  **HRJL** |  |  |
| **Standing >4 hours/day** | |  |  |  |  |  |  |
| No | 220 (53) | 212 (96) | 8 (4) | 6.0 | 6.3 | 1 | 1 |
| Yes | 189 (46) | 168 (89) | 21 (11) | 6.0 | 4.1 | 3.55 (1.56-8.08) | 3.81 (1.62-8.96) |
| Missing | 2 (1) | 2 (100) | 0 (0) |  |  |  |  |
| **Walking >3km/day** | |  |  |  |  |  |  |
| No | 267 (65) | 250 (94) | 17 (6) | 5.9 | 5.2 | 1 | 1 |
| Yes | 141 (34) | 129 (91) | 12 (9) | 96.0 | 4.2 | 1.44 (0.69-3.02) | 1.71 (0.79-3.72) |
| Missing | 3 (1) | 3 (100) | 0 (0) |  |  |  |  |
| **Carrying/Lifting ≥10 kg** | |  |  |  |  |  |  |
| No | 267 (65) | 258 (97) | 9 (3) | 5.8 | 5.2 | 1 | 1 |
| Yes | 141 (34) | 122 (87) | 19 (13) | 6.0 | 4.1 | 4.03 (1.82-8.91) | 5.43 (2.29-12.88) |
| Missing | 3 (1) | 2 (67) | 1 (33) |  |  |  |  |
| **Carrying/Lifting ≥25 kg** | |  |  |  |  |  |  |
| No | 351 (85) | 327 (93) | 24 (7) | 6.0 | 4.2 | 1 | 1 |
| Yes | 57 (14) | 53 (93) | 4 (7) | 5.8 | 5.9 | 1.13 (0.39-3.28) | 1.29 (0.40-4.12) |
| Missing | 3 (1) | 2 (67) | 1 (33) |  |  |  |  |
| **Digging/shovelling** | |  |  |  |  |  |  |
| No | 378 (92) | 353 (93) | 25 (7) | 6.0 | 5.1 | 1 | 1 |
| Yes | 29 (7) | 26 (90) | 3 (10) | 5. 9 | 3.0 | 1.64 (0.49-5.45) | 2.07 (0.53-8.11) |
| Missing | 4 (1) | 3 (75) | 1 (25) |  |  |  |  |
| **Kneeling/squatting** | |  |  |  |  |  |  |
| No | 263 (64) | 252 (96) | 11 (4) | 5.7 | 6.3 | 1 | 1 |
| Yes | 145 (35) | 128 (88) | 17 (12) | 6.1 | 3.2 | 3.11 (1.42-6.80) | 3.32 (1.46-7.55) |
| Missing | 3 (1) | 2 (67) | 1 (33) |  |  |  |  |
| **Climbing >30 flights stairs/day** | |  |  |  |  |  |  |
| No | 297 (72) | 273 (92) | 24 (8) | 5.7 | 4.6 | 1 | 1 |
| Yes | 111 (27) | 107 (96) | 4 (4) | 6.3 | 5.0 | 0.38 (0.13-1.09) | 0.53 (0.17-1.64) |
| Missing | 3 (1) | 2 (67) | 1 (33) |  |  |  |  |
| **Climbing ladders** |  |  |  |  |  |  |  |
| No | 332 (81) | 311 (94) | 21 (6) | 5.8 | 4.8 | 1 | 1 |
| Yes | 76 (18) | 69 (91) | 7 (9) | 6.5 | 3.2 | 1.28 (0.54-3.03) | 1.83 (0.69-4.82) |
| Missing | 3 (1) | 2 (67) | 1 (33) |  |  |  |  |

† Adjusted for: age at operation, sex, BMI at baseline, time to reach best function, cohort and duration of follow-up

We then included the three occupational activities associated with HRJL into a final mutually adjusted regression model. There was attenuation of the effect of standing >4 hours/day (HR: 2.02, 95%CI:0.80-5.12) or kneeling/squatting (HR: 1.53, 95%CI:0.63-3.75) but the effect of lifting/carrying ≥10kg remained robust (HR: 2.53, 95%CI:1.01-6.32).

Subsequently, we considered whether LTPA contributed to the risk of HRJL (Table 4). People reporting participation in high-impact activities were less likely to report HRJL (HR: 0.20 95%CI:0.04-0.92) compared with sedentary participants. Participants categorised as highly active were also at decreased risk of HRJL (HR: 0.09, 95%CI:0.01-0.92), albeit that one person within this category left their job due to hip problems.

**Table 4. Association between leisure-time and daily physical activities post-THA and risk of hip-related job loss (HRJL) amongst 411 participants in survival analyses**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All participants n (%)** | **Hip related job loss (HRJL)** | | **Median time at risk (years) for** | | **Crude HR**  **(95% CIs)** | **Adjusted HR† (95% CIs)** |
|  |  | **No n (%)** | **Yes n (%)** | **No HJRL** | **Yes HRJL** |
| **Type of impact activities** | |  |  |  |  |  |  |
| None | 15 (4) | 12 (80) | 3 (20) | 7.8 | 10.2 | 1 | 1 |
| Low | 142 (35) | 128 (90) | 14 (10) | 5.9 | 4.8 | 0.55 (0.16-1.93) | 0.48 (0.13-1.86) |
| Medium | 137 (33) | 129 (94) | 8 (6) | 5.8 | 2.2 | 0.33 (0.09-1.24) | 0.32 (0.08-1.29) |
| High | 105 (25) | 101 (96) | 4 (4) | 6.1 | 9.5 | 0.20 (0.04-0.89) | 0.20 (0.04-0.92) |
| Missing | 12 (3) | 12 (100) | 0 (0) |  |  |  |  |
| **Frequency** |  |  |  |  |  |  |  |
| No activity | 15 (4) | 12 (80) | 3 (20) | 9.5 | 10.2 | 1 | 1 |
| <Weekly | 155 (38) | 145 (94) | 10 (6) | 6.5 | 5.5 | 0.32 (0.09-1.18) | 0.28 (0.07-1.07) |
| ≥Weekly | 206 (50) | 194 (94) | 12 (6) | 5.5 | 4.1 | 0.34 (0.10-1.22) | 0.29 (0.07-1.11) |
| Missing | 35 (8) | 31 (88) | 4 (12) |  |  |  |  |
| **Combination of type of impact activity and frequency** | | | | |  |  |  |
| Inactive | 15 (4) | 12 (80) | 3 (20) | 7.8 | 10.2 | 1 | 1 |
| Highly active1 | 53 (13) | 52 (98) | 1 (2) | 6.1 | 4.1 | 0.10 (0.01-0.96) | 0.09 (0.01-0.92) |
| Moderately active2 | 324 (79) | 299 (92) | 25 (8) | 5.9 | 4.4 | 0.42 (0.13-1.40) | 0.38 (0.11-1.37) |
| Missing | 19 (5) | 19 (100) | 0 (0) |  |  |  |  |
| **Years exposed3,** Median (IQR) |  | 6.5  (5.2-9.4) | 6.3  (5-8) |  |  | 0.92 (0.81-1.05) | 0.84 (0.64-1.10) |
| **Hours/week**  Median (IQR) |  | 4  (2-8) | 3  (1.5-7) |  |  | 0.97 (0.90-1.04) | 0.97 (0.90-1.05) |

**†** Adjusted for: age at operation, sex, BMI at baseline, time to reach best function post-THA, cohort and duration of follow-up. 1High impact activities at least once a week, 2Medium and low impact activities regardless the frequency 3Years engaged in leisure or daily activities post-THA

**Discussion**

Using data from two cohorts, we explored the nature and type of work undertaken pre- and post-operatively, the rates of non-return by occupation, exposure to physically-demanding activities post-operatively and their relationship with workability. In total, 62% of respondents, mean age approximately 58 years at the time of THA, returned to work post-operatively. Most (93%) of those who were working pre-operatively returned to work and a further 6% RTW despite not being in work pre-operatively. People mainly returned to the same job sector post-operatively (over 50%) although more changes of occupation (26%) were reported in the caring, leisure and other service occupations sector. The highest rates of non-RTW were amongst process, plant and machine operatives (41%), and workers in elementary occupations (36%). Workers in these sectors were predominantly male and tended to be younger than those in other sectors with similar duration of post-operative follow-up but we could not find any other differences. Amongst those who returned to work, 7% stopped working post-operatively because of a problem with the replaced hip. We found that individuals who stood >4 hours, knelt/squatted, and/or lifted/carried ≥10 kg on an average day at work, were more likely to report HRJL with the most robust risk factor being exposure to carrying/lifting ≥10kg. This finding is particularly important because the workers most likely to need to perform physically-demanding activities at work were already more likely to have failed to RTW post-operatively. People reporting participation in high levels of LTPA were at lower risk of experiencing HRJL (HR: 0.20 95%CI:0.04-0.92) compared with sedentary respondents.

Our finding that 93% of those working pre-operatively were able to return post-operatively is consistent with rates previously reported [18, 24, 26] and importantly, 6% of those not working pre-operatively were able to work post-THA. It is known that prolonged sickness absence is associated with an increasing risk of never returning to paid work and rates of ever working are lower if people have not worked in the 12-months prior to THA.[26] This could have important implications for planning the primary operation as delaying until function is so impaired that the individual cannot work may have longer-term impact on their chances of ever working again.[27] The excellent functional outcomes reported by THA recipients appear to translate into workability, particularly amongst those who were working up until their operation.

Sankar and colleagues found that people who returned to work were generally less work-restricted post-THA than they had been pre-operatively,[28] although some people experience some temporary work restrictions post-THA.[29] However, few studies have explored the relevance of job type on post-operative workability, except amongst highly specialised occupational groups such as the military in which the likelihood of being deployed after THA or hip resurfacing was considerably diminished.[30] For workers in the fire services and police forces, assessment of fitness for return to full duties post-operatively is made on a case by case basis. Our finding that process, plant and machine operatives and people in elementary occupations have lower odds of returning to their work is consistent with findings from others about lower rates of RTW amongst people doing manual and heavy manual jobs.[24, 31, 32] One explanation might have been that workers in these roles were older at the time of THA but this was not the case, nor could we find any differences in their ASA or Charnley scores at baseline. There has been evidence of poorer outcomes after arthroplasty amongst people with poorer socio-economic circumstances. Edwards et al highlighted a social gradient in the demand for THA in Denmark.[33] They found that the demand for THA was highest amongst those of lowest educational attainment and lowest household incomes amongst people aged 45-55 years, effects that diminished with increasing age.[33] They also found a higher risk of THA amongst employers/self-employed workers and unskilled workers than amongst Directors.[33] OA is more common amongst people undertaking some manual occupational activities, which may explain the greater demand for THA among manual/unskilled workers. Moreover, people with better educational attainment are thought more likely to access healthy behaviours and advocate more effectively for healthcare. Certainly, it has been shown that people on welfare benefits, although twice as likely to require THA, were less likely to have the operation.[34] It is possible therefore that non-RTW in our study reflects poorer outcomes related to socio-economic circumstances or delayed access to THA so that severe functional impairment affected pre-operative workability (although in our study, those working in these sectors were younger) or it may be more difficult to remain in certain type of jobs post-THA.

Some respondents changed their job post-THA, particularly workers in the caring, service and leisure occupations. Cowie et al reported that 7.7% of those in physically-demanding jobs prior to hip surgery returned to less physically-demanding jobs post-surgery.[35] Nunley and colleagues reported that 12 of 471 THA recipients changed job post-operatively because of their operated hip.[29] Our findings add to those, showing that people who remain in physically-demanding occupations can struggle, and that the exposures most reported by those who experienced HRLJ were: standing >4 hours/day, kneeling/squatting and particularly, lifting ≥10kg. Importantly, we did not find an effect for lifting/carrying ≥25kg but few respondents reported this exposure, so we may have lacked power to detect an effect or this may be a rare requirement amongst older workers post-THA.

Orthopaedic surgeons advise THA recipientsto avoid high-impact sports.[13-16, 22, 36] In our study, participation in high impact activities at least weekly appeared to be beneficial for workability. These findings need to be interpreted carefully.Those with the best outcomes post-operatively are most likely to RTW, especially those in heavy jobs, and to have good enough function to undertake strenuous LTPA. Additionally,people with better levels of fitness pre-operatively are generally more likely to be fit enough to return to work and previous LTPA post-operatively.

This study has some limitations. An important potential limitation (as with all retrospective studies) is recall bias, which may have affected the responses of the participants. Respondents were asked to report about any job that they had held post-operatively for at least one month but were also asked to report about the associated physical exposures for each job. Duration of recall varied: the median was 7.5 years (IQR 6.2-12.1) but a small minority (12/411, 2.9%) had more than 20 years of follow-up. This should not have made a systematic difference to our results, but we cannot eliminate the possibility that individuals who reported HRJL were more likely to recall exposure to physically-demanding activities than those who did not. Whilst we found that most respondents reported about their job titles accurately, no matter what duration of follow-up, some respondents had difficulty completing the occupational activities questions and there were as a result, a number with incomplete information. In particular, the GAR cohort, with longer follow-up, and currently somewhat older, returned more questionnaires in which the occupational information was incomplete. Secondly, the COASt cohort included more women than men, as would be expected for most studies of THA recipients.[19, 37] However, the GAR cohort included more men than women. Sampling was based on age at THA and a minimum duration of follow-up post-operatively rather than work status but these differences are potentially important because men and women tend to undertake different types of occupations.[38] Specifically, men are more likely to undertake the more physically-demanding occupations. It is therefore possible that there is a slight over-representation of the more demanding occupational activities. Thirdly, this study did not collect information about stopping work because of other health conditions prior to experiencing a HRJL. If for example, people doing sedentary work had a greater chance of stopping work because of e.g. cardiovascular disease, causing a selective bias, it may be that a competing risks analysis would have been appropriate. Unfortunately, we did not collect the data about this so that we could not undertake such an analysis. Comparison of the pre-operative ASA score between those who did and did not experience HRJL showed no significant differences (p=0.45) but we cannot rule out some subsequent effect post-operatively. Additionally,not all the participants with useable occupational exposures completed all items about LTPA. Therefore, to avoid excluding more people from these analyses, we generated a missing category. This latter approach may have caused a bias if, for example, those who were least active post-operatively were less likely to complete the LTPA questions. However, there is no reason to believe that this was the case. Finally, for practical reasons, this study only sampled THA recipients who were aged between 18-64 years at the time of their THA. There may have been some people aged 65 years or more at the time of their THA who were excluded from the current study (approximately 9-10% of UK and Swiss adults work beyond aged 65 years.[39] It is plausible that these older workers were mostly in more desk-based or sedentary jobs and that their inclusion might have somewhat attenuated our findings.

In summary, many people receiving THA will RTW post-operatively and yet there is little data to develop advice for patients or their surgeons.[40] Our findings suggest that physically-demanding jobs may be more difficult to retain if they involve prolonged standing, kneeling/squatting or handling ≥10 kg. These work effects may widen health inequalities, having the most significant impact on those with lower educational attainment and/or income. These results, although subject to replication in other cohorts, may be important to discuss with patients pre-operatively, and could imply a particular role for post-THA rehabilitation amongst people needing to RTW in physically-demanding jobs.

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**COMPETING INTERESTS**

The authors declare that no competing interests exist.

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**Figure 1. Working status pre- and post- hip arthroplasty amongst eligible participants in the Geneva Arthroplasty register (GAR) and the Clinical Outcomes in Arthroplasty Study (COASt).**