Does physical activity change following hip and knee replacement? Matched case-control study evaluating Physical Activity Scale for the Elderly data from the Osteoarthritis Initiative

T.O. Smith, M. Mansfield, J. Dainty, G. Hilton, C.J.V. Manne, C.M. Sackley

Abstract

Objectives To determine whether physical activity measured using the Physical Activity Scale for the Elderly (PASE), changes during the initial 24 months post-total hip (THR) or knee replacement (TKR), and how this compares to a matched non-arthroplasty cohort.

Design Case-controlled study analysis of a prospectively collected dataset.

Setting USA community-based.

Participants 116 people post-THR, 105 people post-TKR compared to 663 people who had not undergone THR or TKR, or had hip or knee osteoarthritis. Cohorts were age-, gender- and BMI-matched.

Main outcome measures Physical activity assessed using the 12-item PASE at 12 and 24 months post operatively.

Results There was no significant difference in total PASE score between pre-operative to 12 months (mean: 136 vs 135 points; p = 0.860) or 24months following THR (mean: 136 vs 132 points; p = 0.950). Whilst there was no significant difference in total PASE score from pre-operative to 12 months post-TKR (126 vs 121 points; p = 0.930), by 24 months people following TKR reported significantly greater physical activity(126 vs 142 points; p = 0.040). There was no statistically significant difference in physical activity between the normative matched and THR(p ≥ 0.140) or TKR (p ≥ 0.060) cohorts at 12 or 24 months post joint replacement.

Conclusions Physical activity is not appreciably different to pre-operative levels at 12 or 24 months post-THR, but was greater at 24 months following TKR. Health promotion strategies are needed to encourage greater physical activity participation following joint replacement, and particularly targeting those who undergo THR

Total hip (THR) and knee (TKR) replacement are two of the most common orthopaedic surgery procedures under-taken worldwide [1]. These procedures are projected to increase annually to an estimated 95,877 THRs and 118,666 TKRs by 2035 in the United Kingdom alone [2]. Whilst a proportion of these procedures are performed for younger people, within the literature, the mean patient age ranges from 68 to 74 years [1,3]. The aim of both THR and TKR is to reduce the pain and disability associated with a degenerative joint pre-operatively, to facilitate greater quality of life and increased physical activity engagement [5].

Physical activity is a generic term which encompasses active living, active transport, and sports and exercise [5]. Active living includes the participation in household and social activities such as gardening, housework, shopping and recreational pursuits [6]. Active transport is defined as the expenditure of physical energy by an individual to move from one place to another [7]. Sports and exercise pursuits which are most commonly undertaken by this population post joint replacement include walking, cycling, golf and swimming [8,9].

Physical inactivity is a leading cause of mortality world-wide [10]. It has been estimated that between 6% to 10% of all deaths from non-communicable diseases are attributed to physical inactivity [11]. There is an established body of lit-erature supporting the adoption and maintenance of physical activity in individual’s lifestyles. Physical and mental health benefits associated with undertaking regular physical activity have included reduced risk of cardiovascular diseases and dia-betes, enhanced mental wellbeing with decreased anxiety and depressive symptoms, and lower risk of some cancers [10].

Hypothetically physical activity should increase follow-ing THR and TKR through pain relief [12]. However recent research suggests that this may not be the case [13–18]. Furthermore, individuals may have considerable reluctance to be more physically active following lower limb joint replacement [12,13]. However the current evidence-base has focused on assessing changing participatory levels of sports and exercise, using general physical activity questionnaires rather than tools which are directed towards people aged 60 and older, or have assessed global physical activity with accelerometery, making it difficult to distinguish what forms of physical activity may (or may not) change [13–18]. It also remains unclear how physical activity relates to the nor-mative, non-joint pathology population. As physiotherapists have a key role both in promoting physical activity [19] and in the rehabilitation of people post joint replacement [20], it is important that these clinicians are aware whether (or not) peo-ple following THR or TKR are at risk of being insufficiently physically active.

The purpose of this study was to determine whether phys-ical activity levels change from pre-operative to 24 months post joint replacement when measured using the Physical Activity Scale for the Elderly (PASE) [21]. Secondly, weaimed to determine whether there was a difference in phys-ical activity engagement between people who undergo THR or TKR (baseline, 12 months and 24 months post opera-tively) and an age-, gender- and BMI-comparable cohort who have not joint pathology nor joint replacement, to ascertain whether there is a difference in physical activity compared to the normative population.

Materials and methods

Ethics approval

Ethical approval was granted by the Committee on Human Research, University of California, San Francisco (IRB approval number 10-00532; Approved 10th March 2015). All participants provided written informed consent prior to enrolling on the study.

Osteoarthritis Initiative dataset

Data used in the preparation of this article were obtained from the Osteoarthritis Initiative (OAI) database. This is available for public access at http://www.oai.ucsf.edu/. The OAI is a large, multicentre (four sites across the USA), lon-gitudinal cohort study originally designed to investigate the role of biomarkers in the development and progression of knee osteoarthritis.

Baseline data were collected between February 2004 to May 2006 from community-dwelling volunteers who were considered at risk of developing knee osteoarthritis. Data were longitudinally collected at 12, 24, 30, 36, 48, 60, 72 and 84-month follow-up intervals. For this analysis, we identified data on: demographic characteristics, medical morbidities (prevalence of type two diabetes, Charleston Comorbidity Score [22]; Centre for Epidemiologic Studies depression (CES-D) score) [23], musculoskeletal health (joint pain), and the PASE [21] reported pre-THR and TKR, and then at 12 and 24-month follow-up intervals. These intervals were selected to ensure that it was possible to compare physical activity participation before joint replacement, at an early interval when recovery typically plateaus, and a later phase when post operative recovery would have ceased [24]. The PASE is a self-administered questionnaire designed for people aged 65 years and over, and consists of 12 questions regarding the duration, frequency, exertion level, and amount of physical activity undertaken during a seven-day period [21]. It assesses a breath of physical activity pursuits including household tasks, occupational activities, active transport and sports and exercise [26]. The specific subsections of the PASE are: mus-cle strength/endurance, strenuous sports, moderate sports, light sports, jobs involving standing or walking, walking, lawn work or yard care, caring for another person, home repairs, health housework, light housework and outdoor gar-dening [21]. It has demonstrated good validity to other forms of physical activity assessment in older people [25–28] andgood test-re-test reliability when assessed as telephone and postal versions [21]. The minimal detectable change for the total PASE score is 87 points [29].

Participants

Using the OAI dataset, we identified all people who under-went a unilateral THR or TKR. We excluded participants who had undergone joint replacement for trauma. We excluded participants with missing data. We identified a ‘control’ cohort of participants who did not have a THR or TKR or a clinical diagnosis of hip or knee osteoarthritis before or dur-ing the follow-up assessments. Three controls were matched per case. Controls were matched to cases on: sex, date of birth (±3 years) and BMI (±2 kg/m2).

Data analysis

Descriptive statistics were undertaken with frequencies and percentages or mean and standard deviation values for the THR, TKR and matched-control groups at each follow-up interval. The normality of the dataset was analysed using the Shapiro–Wilk test.

To determine whether there was a difference between the case and controls for PASE or PASE subsections, a multilevel model was constructed to compare the difference between the two groups at each assessment interval. To minimise the risk of multicollinearity and multiple testing, the PASE sub-sections of frequency of sports and recreational activities and duration of sports and recreational activity participation were combined to form two single variables for the model. Simi-larly the variables for house-based work and tasks including: caring for an individual at home, housework, home repairs and gardening were combined into a single variable for the model.

For each reported analysis, the outcome was adjusted for in the statistical model by the explanatory variables age, gender, body mass index (BMI), self-reported depression, presence of low back or neck pain and the frequency of knee pain. Ran-dom intercept models were compared to random intercept and slope models. In all cases, the random intercept mod-els were preferred (due to model parsimony/best fit tests). A p < 0.050 was deemed statistically significant. All analyses were performed in the R Statistics program (R Core Team; 2015. R: A language and environment for statistical comput-ing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.) using the ‘lmer’ function in the ‘lme4’ package.

Results

Cohort

From the 4796 participants in the OAI cohort, a total of 116 participants post-TKR, and 105 post-THR were eligible. These were compared to a matched cohort of 663 participants who had not undergone joint replacement.

The baseline/pre-operative characteristics are presented in Table 1. As this illustrates, the cohort characteristics across the three groups were similar. The exception to this was the prevalence of diabetes which was higher in the matched cohort (10%) compared to the THR (6%) or TKR (2%) cohorts.

Changes in physical activity over time within THR cases There was no statistically significant difference in total PASE score between pre-operative to 12 month (mean: 136 vs 135 points; p = 0.860) or 24 month intervals (mean: 136 vs 132 points; p = 0.950). As demonstrated in Table 2, there was no difference between pre-operative to 12 month or 24 month follow-up assessments for PASE subsections includ-ing: frequency of sitting (p = 0.270; p = 0.100), duration of sitting time (p = 0.180; p = 0.530), frequency of walking (p = 0.380; p = 0.440), and duration of light, moderate and strenuous sports performed (p = 0.250; p = 0.820). Similarly, there was no significant difference for performing housework, home repairs. Lawn or garden work, gardening or caring for another person at 12 months or 24 months compared to pre-operatively (p = 0.880; p = 0.180). There was a sig-nificant difference for four subsections at 12 months which was not evident at 24 months. These included the number of people who worked being significantly lower at 12 months (p = 0.040; p = 0.007); the duration of walking (p < 0.010; p = 0.860), and the frequency to which people participated in light, moderate and strenuous sports (p = 0.020; p = 0.350). The frequency and duration to which people participated in muscle strengthening exercises was significantly greater 12 months post operatively (p = 0.040; p = 0.010), but not differ-ent at 24 months (p = 0.560; p = 0.820). Whilst the duration to which people worked was not significantly different at 12 months post-THR compared to pre-operatively (p = 0.260), this was lower by a statistically significant level at 24 months (p < 0.010).

Comparison of physical activity levels between THR cases and controls

As Fig. 1 illustrates, there was no difference between the THR and control cohorts for total PASE score at 12 months (mean: 135 vs 152 points; p = 0.870) or 24 months post operatively (mean: 136 vs 147 points; p = 0.380). As reported in Supplementary Table 1, there was no statistically significant difference between cases and controls at 12 or 24 months for PASE subsections: frequency of work at home (p = 0.730; p = 0.230), frequency of sitting (p = 0.630; p = 0.190), duration of sitting (p = 0.710; p = 0.500), frequency of walking (p = 0.670; p = 0.050), duration of walking (p = 0.790; p = 0.140), frequency of light, moderate and strenuous sport participation (p = 0.080; p = 0.930) or duration of light, moderate or strenuous sports (p = 0.780; p = 0.250).

Whilst at 12 months post operatively there was a difference in physical activity, where the control cohort demonstrated higher physical activity levels as measured by frequency and amount of muscle strength exercises performed (p < 0.010; p < 0.010), this was not statistically significant at 24 months (p = 0.420; p = 0.930). Whilst there was no statistically significant difference in the number of participants in work (60% vs 70%; p = 0.380) or duration of work per week (mean: 17 hours vs 17 hours; p = 0.640) at 12 months, this was significantly greater in the control cohort at 24 months (43% vs 67%; p = 0.010; 15 hours vs 16 hours; p < 0.010). Changes in physical activity over time within TKR cases Whilst there was no statistically significant difference in total PASE score from pre-operative to 12 months (126 vs 121 points; p = 0.930), by 24 months people following TKR reported significantly greater physical activity following TKR (126 vs 142 points; p = 0.040). As presented in Table 2, there was a significant increase in physical activity between pre-operative to 12 months post operatively when assessed by frequency of work at home (p < 0.010), paid work (69% vs 52%; p = 0.010), duration of work (35.2 hours vs 34.6 hours; p = 0.020), frequency of walking (p < 0.010), frequency of light, moderate and strenuous sports (p < 0.010) frequency of muscle strengthening exercises (p < 0.010), and the duration of muscle strengthening exercises performed (p = 0.040). This difference was maintained at 24 months for frequency of work at home (p < 0.010), frequency of walking (p = 0.040), and frequency of light, moderate and strenuous sports (p = 0.030). There was no statistically sig-nificant difference between pre-operative and 12 month or 24 month follow-up data for PASE subsections including: frequency of sitting (p = 0.440; p = 0.930), duration of sit-ting daily (p = 0.300; p = 0.600), duration of walking daily (p = 0.910; p = 0.790) or duration of light, moderate or stren-uous sports performed daily (p = 0,160; p = 0.110).

Comparison of physical activity levels between TKR cases and controls

As Fig. 2 illustrates, there was no significant difference between the TKR case and control cohorts for total PASE score at 12 months (126 points vs 152 points; p = 0.160) or 24 months post-TKR (144 points vs 147 points; p = 0.780). As demonstrated in Supplementary Table 2, there was no statistically significant difference between cases and controls at 12 or 24 months post operatively for the PASE sub-sections: frequency of work at home (p = 0.310; p = 0.210), frequency of sitting (p = 0.280; p = 0.760), duration of sit-ting (p = 0.450; p = 0.880), frequency of walking (p = 0.510; p = 0.180), duration of walking (p = 0.610; p = 0.240), duration of light, moderate and strenuous sports (p = 0.550; p = 0.440) or the duration (p = 0.050; p = 0.140) or frequency (p = 0.050; p = 0.110) of paid work. There was a difference in physical activity at 12 months post operatively but not at 24 months, where those following TKR reported higher physical activity compared to controls when measured by frequency of participation in light, moderate and strenuous sports (p = 0.040; p = 0.400), and the frequency (p < 0.010; p = 0.090) and duration of muscle strength exercises per- formed (p < 0.010; p = 0.640). No PASE subsection measures were statistically different between the TKR and controls at the 24-month follow-up interval (Supplementary Table 2).

Explanatory variables for physical activity change within THR and TKR cases

Age was a consistent explanatory variable for physical activity where increasing age was significantly associated with lower total PASE score for THR and TKR (p < 0.010),less frequent working at home for THR (p = 0.020), less likelihood to work following THR or TKR (p < 0.010), and fewer hours worked following THR or TKR (p < 0.010).Gender was a significant explanatory variable for frequency of work at home where females returned to work less often and for a shorter period of time after TKR compared to males (p = 0.004; p = 0.010), and frequency of walking following TKR, where females walked less than males(p = 0.020). Following TKR, women less frequently participated in sports (p = 0.007), performed less sporting activities daily (p = 0.007), performed muscle strengthening exercises less frequently and for less duration (p < 0.010; p < 0.010)and had lower total PASE score (p < 0.010) compared to men. BMI was a significant explanatory variable for duration of sitting per day, where those with a higher BMI were more likely to sit for longer following THR and TKR(p = 0.020; p < 0.010). Self-reported depression was a significant explanatory variable for total PASE score and three subsections following THR. Those who reported depressive symptoms were less likely to work (p = 0.004), undertook fewer hours of work (p < 0.001), less frequently participated in sports (p = 0.050) and reported a lower total PASE score(p = 0.001). The variables of presence of low back pain and the frequency of knee pain were not significant explanatory variables for total PASE score or PASE subsection outcomes following THR, although the presence of spinal pain was associated with a lower frequency of return to work followingTKR (p = 0.040).

Discussion

These results of this study indicate that physical activity does not significantly change from pre- to 24 months post-THR. There was an overall increased in physical activity at24 months post-TKR. There was no statistically significant difference in physical activity engagement between people following either THR or TKR compared to people who have not undergone a joint replacement. Accordingly the level of physical activity engagement may be interpreted as the same as expected with advancing age.

The results of this analysis agree with a recent systematic review investigating physical activity post joint replacement[30]. This concluded no significant change occurs in physical activity levels pre- versus post-THR. Kahn and Schwarzkopf[18] reported similar findings following TKR. Conversely Jones et al. [16] reported an increase in physical activity following joint replacement for 36 leisure activities. The difference between these findings may be attributed to the difference in type of physical activity pursuits measured. Whilst our cohort’s physical activity engagement was measured by active living, active transport and sport and recreational pursuits, Jones et al. [16] evaluated a wider range of sporting and leisure activities than those assessed in the PASE. Nonetheless, the weight of evidence previously represented appears to support the findings from this OAI cohort.

By analysing the THR and TKR results against a normative, matched cohort, it was possible to identify that whilst physical activity did not increase post joint replacement, particularly THR, it was comparable to the normative population. This highlights two important points. Firstly, THR and TKR both demonstrated the capability to increase in some forms of physical activity compared to a matched cohort. This therefore provides evidence that THR and TKR can improve people’s physical activity capacity to those of their non-joint replacement/non-osteoarthritis peers. Secondly, whilst the results indicate that those post joint replacement may beat greater risk of physical inactivity compared to the normative population, it is not possible to ascertain from the data whether either cohort met recommended public health levels of physical activity. In England alone, approximately 60%of men and 70% of women are insufficiently active to bene-fit their health [31]. Accordingly, whilst the THR and TKR cohorts returned to similar physical activity levels compared to the matched cohort, this population may still have significant need for support to increase physical activity. Given this, consideration should be made as to whether there is currently sufficient guidance provided to patients to be active post operatively.

These results question the previously held belief that physical activity increases following joint replacement. Whilst THR and TKR can reduce pain and stiffness [32], these clinical improvements were not conferred with changes in all measures of physical activity either at home or within the community. Smith et al. [12] explored why people following THR or TKR may not engage in physical activity post operatively. The most widely reported barrier to physical activity was education on the levels of exercise and activity people could engage in without causing injury to themselves and, particularly, their joint replacement [12]. These results would suggest that interventions to encourage and maintain physical activity which could be delivered by physiotherapists, are still required and should have a functional-bias to physical activity pursuits.

There appears a difference in physical activity engagement between THR to TKR. Those who underwent THR demonstrated an initial increase in physical activity at 12 post operative months for a small number of measures, whereas this was less evident in the TKR cohort. In contrast, there was evidence of an overall increase in physical activity fol-lowing TKR, but only at 24 months post operatively. This difference may be attributed to the difference in clinical out-comes between the two procedures where THR demonstrated better quality of life and functional outcomes compared to TKR [33]. Residual pain and subsequent reduced function reported in 20% to 30% of people following TKR, may pro-vide a major barrier to physical activity engagement within the first post operative year [33,34]. Furthermore this could impact on expectations and capabilities which this population have to engage in activities, potentially accounting for the reported differences between these two procedures.

This analysis presented with four potential limitations. Firstly, whilst the OAI dataset provided detailed information on participant characteristics, it did not provide the date surgery was undertaken. Therefore surgery may have theoretically occurred anytime within the follow-up interval. This could not be controlled or accounted for in our analyses as this is the process by which the OAI data were reported. To mitigate this, we analysed data in two subsequent phases, to ensure that change over time did not significantly influence outcome given that functional recovery occurs within six to 12 months post joint replacement [24]. Secondly, whilst the PASE is a reliable and valid measure of physical activity, it cannot distinguish between the ease to which and quality of movement undertaken during physical activity. Through this, participants may engage in the physical activity levels reported in the PASE, but the ease to which they can do these may substantially differ. Further analyses to verify the PASE findings to other measures of movement may therefore be indicated to explore this further. Thirdly, whilst the PASE has demonstrated good clinimetric properties in some evaluations [35,36], it has also been shown to have standard error of measurement of 31 and a large minimal detectable change of 87 in those with hip osteoarthritis [29] and even less favourable clinimetric properties in those following joint replacement [37,38]. Accordingly, with such a large measurement error for this detectable change, the PASE may not have distinguished measurement error from real change in physical activity fora proportion of the cohort even when one existed. Given that the PASE was the only physical activity measure consistently used in this dataset, and its particular relevance to the older population, this tool may be regarded as appropriate in this instance. Furthermore since the PASE is self-reported, there is a potential risk for the results to be influenced by social desirability bias and recall bias [39]. This may have been of greater effect since all participants with missing data were excluded. Accordingly, these analyses may not reflect the entire joint replacement population, but only those who were compliant in providing full data. Finally, data were collected from 2004 onwards. Whilst there have been advances with the use of accelerated post operative rehabilitation during this time [40], the post discharge rehabilitation of people following joint replacement has not changed [41,42]. Accordingly no adjustment was made to account for this time period.

To conclude, there is limited evidence to suggest that physical activity increases following THR or TKR. How-ever, the level of physical activity engagement is the same as expected with advancing age. Further study exploring interventions delivered by physiotherapists to encourage and maintain physical activity engagement in people following arthroplasty is warranted given the physical and mental health benefits it can offer.

Ethics approval:

Committee on Human Research, University of California, San Francisco (IRB approval number10-00532. Approved 10th March 2015).Funding: The OAI is a public–private partnership comprised of five contracts (N01-AR-2-2258; N01-AR-2-2259; N01-AR-2-2260; N01-AR-2-2261; N01-AR-2-2262) funded by the National Institutes of Health, a branch of the Department of Health and Human Services, and conducted by the OAI Study Investigators. Private funding partners include Merck Research Laboratories; Novartis Pharmaceuticals Corporation, GlaxoSmithKline; and Pfizer, Inc. Private sector funding for the OAI is managed by the Foundation for the National Institutes of Health. This manuscript was prepared using an OAI public use data set and does not necessarily reflect the opinions or views of the OAI investigators, the NIH, or the private funding partners.

Key messages

• There is no significant change in physical activity from before to 24 months after THR.

• Physical activity following TKR increases from pre-operatively levels, but only after 24 months post operatively.

• Physiotherapists should consider strategies to bet-ter support people, both those following THR and those without joint replacement, to be more physi-cally active.

References

[1] Hooper G, Lee AJ, Rothwell A, Frampton C. Current trends and pro-jections in the utilisation rates of hip and knee replacement in New Zealand from 2001 to 2026. N Z Med J 2014;127:82–93.

[2] 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 Cartilage 2015;23:594–600.

[3] 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 Pract Res Clin Rheumatol 2012;26:637–47.

[5] Department of Health. Start active, stay active: a report on physical activity for health from the four home countries’ Chief Medical Officers. Department of Health; 2011. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment data/file/216370/dh 128210.pdf. [Accessed 4 October 2016].

[6] Winter SJ, Goldman Rosas L, Padilla Romero P, Sheats JL, Buman MP, Baker C, King AC. Using citizen scientists to gather, analyze, and disseminate information about neighborhood features that affect active living. J Immigr Minor Health 2016;18:1126–38.

[7] Van Holle V, Van Cauwenberg J, Van Dyck D, Deforche B, Van de Weghe N, De Bourdeaudhuij I. Relationship between neighborhood walkability and older adults’ physical activity: results from the Belgian Environmental Physical Activity Study in Seniors (BEPAS Seniors). Int J Behav Nutr Phys Act 2014;11:110.

[8] Kuster MS. Exercise recommendations after total joint replacement: a review of the current literature and proposal of scientifically based guidelines. Sport Med 2002;32:433–45.

[9] Kohl HW, Craig CL, Lambert EV, Inoue S, Alkandari JR, Leetongin G, et al. The pandemic of physical inactivity: global action for public health. Lancet 2012;380:294–305.

[10] Lee IM, Shiroma EJ, Lobelo F, Puska P, Blair SN, Katzmarzyk PT, et al. Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. Lancet 2016;380:219–29.

[11] Knai C, Petticrew M, Scott C, Durand MA, Eastmure E, James L, et al. Getting England to be more physically active: are the Public Health Responsibility Deal’s physical activity pledges the answer? Int J Behav Nutr Phys Act 2015;12:107.

[12] Smith TO, Latham SK, Maskrey V, Blyth A. What are people’s perceptions of physical activity before and after joint replace-ment? A systematic review and meta-ethnography. Postgrad Med J 2015;91:483–91.

[13] Lützner C, Kirschner S, Lützner J. Patient activity after TKA depends on patient-specific parameters. Clin Orthop Relat Res 2014;472: 3933–40.

[14] Meira EP, Zeni Jr J. Sports participation following total hip arthroplasty. Int J Sport Phys Ther 2014;9:839–50.

[15] Williams DH, Greidanus NV, Masri BA, Duncan CP, Garbuz DS. Pre-dictors of participation in sports after hip and knee arthroplasty. Clin Orthop Relat Res 2012;470:555–61.

[16] Jones DL, Bhanegaonkar AJ, Billings AA, Kriska AM, Irrgang JJ, Crossett LS, et al. Differences between actual and expected leisure activities after total knee arthroplasty for osteoarthritis. J Arthroplasty 2012;27:1289–96.

[17] Wagenmakers R, Stevens M, Groothoff JW, Zijlstra W, Bulstra SK, van Beveren J, et al. Physical activity behavior of patients 1 year after primary total hip arthroplasty: a prospective multicenter cohort study. Phys Ther 2011;91:373–80.

[18] Kahn TL, Schwarzkopf R. Does total knee arthroplasty affect physical activity levels? Data from the Osteoarthritis Initiative. J Arthroplasty 2015;30:1521–5.

[19] Barrett EM, Hussey J, Darker CD. Feasibility of a physical activity pathway for Irish primary care physiotherapy services. Physiotherapy 2016 [in press].

[20] Artz N, Dixon S, Wylde V, Beswick A, Blom A, Gooberman-Hill R. Physiotherapy provision following discharge after total hip and total knee replacement: a survey of current practice at high-volume NHS hospitals in England and Wales. Musculoskeletal Care 2013;11(March (1)):31–8.

[21] Washburn RA, Smith KW, Jette AM, Janney CA. The Physical Activity Scale for the Elderly (PASE): development and evaluation. J Clin Epidemiol 1993;46:153–62.

[22] Charlson ME, Pompei PA, Kathy L, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: develop-ment and validation. J Chronic Dis 1987;40:373–83.

[23] Eaton WW, Muntaner C, Smith C, Tien A, Ybarra M. Center for Epi-demiologic Studies Depression Scale: review and revision (CESD and CESD-R). In: Maruish ME, editor. The use of psychological testing for treatment planning and outcomes assessment. 3rd ed. Mahwah, NJ: Lawrence Erlbaum; 2004. p. 363–77.

 [24] Fitzgerald JD, Orav EJ, Lee TH, Marcantonio ER, Poss R, Goldman L, et al. Patient quality of life during the 12 months following joint replacement surgery. Arthritis Rheum 2004;51:100–9.

[25] Chad KE, Reeder BA, Harrison EL, Ashworth NL, Sheppard SM, Schultz SL, et al. Profile of physical activity levels in community-dwelling older adults. Med Sci Sports Exerc 2005;37: 1774–84.

[26] Dinger MK, Oman RF, Taylor EL, Vesely SK, Able J. Stability and convergent validity of the Physical Activity Scale for the Elderly (PASE). J Sports Med Phys Fitness 2004;44:186–92.

[27] Schuit AJ, Schouten EG, Westerterp KP, Saris WHM. Validity of the Physical Activity Scale for the Elderly (PASE): according to energy expenditure assessed by the doubly labeled water method. J Clin Epi-demiol 1997;50:541–6.

[28] Washburn RA, McAuley E, Katula J, Mihalko SL, Boileau RA. The Physical Activity Scale for the Elderly: evidence for validity. J Clin Epidemiol 1999;52:643–51.

[29] Svege I, Kolle E, Risberg MA. Reliability and validity of the Physical Activity Scale for the Elderly (PASE) in patients with hip osteoarthritis. BMC Musculoskelet Disord 2012;13:26.

[30] Withers TM, Lister S, Sackley C, Clark A, Smith TO. Is there a difference in physical activity levels in patients before and up to one year after unilateral total hip replacement? A systematic review and meta-analysis. Clin Rehabil 2016 [in press]. [31] Health and Safety Executive. Health Survey for England—2012 [NS]. http://www.hscic.gov.uk/catalogue/PUB13218. (Accessed 11 March 2016).

[32] National Health Service. Guidelines for older adults aged 65 and over. http://www.nhs.uk/Livewell/fitness/Pages/physical-activity -guidelines-for-older-adults.aspx. (Accessed 11 March 2016).

[33] Hamilton D, Henderson GR, Gaston P, MacDonald D, Howie C, Simp-son AH. Comparative outcomes of total hip and knee arthroplasty: a prospective cohort study. Postgrad Med J 2012;88:627–31.

[34] Ali A, Sundberg M, Robertsson O, Dahlberg LE, Thorstensson CA, Redlund-Johnell I, et al. Dissatisfied patients after total knee arthroplasty: a registry study involving 114 patients with 8-13 years of follow-up. Acta Orthop 2014;85:229–33.

[35] Harada ND, Chiu V, King AC, Stewart AL. An evaluation of three self-report physical activity instruments for older adults. Med Sci Sports Exerc 2001;33:962–70.

[36] Dinger MK, Oman RF, Taylor EL, Vesely SK, Able J. Stability and convergent validity of the Physical Activity Scale for the Elderly (PASE). J Sports Med Phys Fitness 2004;44:186–92.

[37] Bolszak S, Casartelli NC, Impel lizzeri FM, Maffiuletti NA. Valid- ity and reproducibility of the Physical Activity Scale for the Elderly (PASE) questionnaire for the measurement of the physical activity level in patients after total knee arthroplasty. BMC Musculoskelet Disord 2014;15:46.

[38] Casartelli NC, Bolszak S, Impellizzeri FM, Maffiuletti NA. Reproducibility and validity of the physical activity scale for the elderly (PASE) questionnaire in patients after total hip arthroplasty. Phys Ther2015;95:86–94.

[39] Yoong SL, Carey ML, D’Este C, Sanson-Fisher RW. Agreement between self-reported and measured weight and height collected in general practice patients: a prospective study. BMC Med Res Methodol2013;13:38.

[40] Johnson RL, Kopp SL. Optimizing perioperative management of tota ljoint arthroplasty. Anesthesiol Clin 2014;32:865–80.

[41] Wainwright AV, Kennedy DM, Stratford PW. The group experience: remodelling outpatient physiotherapy after knee replacement surgery. Physiother Can 2015;67:350–6.

[42] Roos EM. Effectiveness and practice variation of rehabilitation after joint replacement. Curr Opin Rheumatol 2003;15:160–2.