Variation in age and physical status prior to total knee and hip replacement surgery: A comparison of centres in Australia and Europe.

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Abstract

Objective

To investigate whether variation exists in the pre-operative age, pain, stiffness and physical function of people undergoing total knee (TKR) and hip replacement (THR) at a range of centres in Australia and Europe.

Methods

Individual Western Ontario and McMaster Universities Osteoarthritis (WOMAC) Index data (scale range 0 (best) - 100 (worst)) collected within six weeks prior to primary TKR and THR were extracted from sixteen sites (total $n=2835$) according to specified eligibility criteria. Analysis of covariance was used to evaluate differences in pain, stiffness and physical function between centres, with adjustment for age and gender.

Results

There was marked variation in the age of people undergoing surgery across the centres (mean age 67-73 years for TKR, $F_{(6,1004)}=4.21$, $p<0.01$; mean age 63-72 years for THR, $F_{(14,1807)}=7.27$, $p<0.01$). Large differences in pre-operative status were observed between centres, most notably for pain (adjusted mean pain 52.5-61.1 for TKR, $F_{(6,1002)}=4.26$, $p<0.01$; adjusted mean pain 49.2-65.7 for THR, $F_{(14,1802)}=8.44$, $p<0.01$) and physical function (adjusted mean function 52.7-61.4 for TKR, $F_{(6,1002)}=5.27$, $p<0.01$; adjusted mean function 53.3-71.0 for THR, $F_{(14,1802)}=6.71$, $p<0.01$). Large effect sizes (up to 0.98) reflect the magnitude of variation between centres and highlight the clinical relevance of these findings.

Conclusion

The large variations in age and pre-operative status indicate substantial differences in the timing of joint replacement across the centres studied, with potential for compromised surgical outcomes due to premature or delayed surgery. Possible contributing factors include patient preferences, the absence of concrete indications for surgery and the capacity of health care systems.

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Introduction

Joint replacement surgery is an effective and increasingly common intervention for end-stage knee and hip osteoarthritis. However, the specific indications for total knee (TKR) and hip replacement surgery (THR) are neither clearly-defined nor evidence-based (1) and are known to vary substantially between health professionals (2, 3). This lack of consensus could introduce discrepancies into the provision of joint replacement surgery both within and between countries. As early provision of surgery (for example, to younger people with less severe joint disease) or delayed surgery (undertaken in older people with more severe arthritis) can have major health consequences (4, 5), systematic differences between centres have important implications for clinical practice and health policy.

To date, there has been little international research comparing the pre-operative characteristics of people undergoing joint replacement; however, incidental findings from earlier studies suggest that pre-operative physical status may indeed vary between countries. People undergoing TKR or THR in Canada had higher levels of pain and poorer physical function before surgery, compared with those in the United States (6), while those undergoing TKR in the United Kingdom had poorer pre-operative physical function than their counterparts in Australia and the United States (7). As pre-operative pain and function are important predictors of outcome from joint replacement surgery (8-10), further research is essential to verify these findings and explore the extent of variation across a broad range of centres. This study investigates whether variation exists in the pre-operative age, pain, stiffness and physical function of people undergoing total knee (TKR) and hip replacement surgery (THR) at centres in Australia and Europe.

Materials and methods

Study design

A cross-sectional analysis of available individual data extracted from research and clinical databases in Australia and Europe.

Outcome measure

The Western Ontario and McMaster Universities Osteoarthritis (WOMAC) Index is a widely-used, disease-specific measure for knee and hip osteoarthritis (11) and contains 24 items (5 pain, 2 stiffness and 17 physical function items).

Available datasets

Through consultation with international musculoskeletal researchers and clinicians it was identified that pre-operative WOMAC data for inclusion in this comparison were available from the following sites:

- Australia
 - Geelong: clinical dataset
 - Melbourne: research dataset
 - Perth: clinical dataset
 - Sydney: combined research dataset from 3 centres (containing both public and private patients)
- Europe
 - Dundee (United Kingdom): research dataset
 - EUROHIP: combined research dataset from 20 European centres

- Lund (Sweden): research dataset
- Halmstad (Sweden): research dataset
- Hassleholm (Sweden): research dataset

Potential collaborators at each site were invited to contribute pre-operative data for this analysis and were sent a study protocol and data dictionary.

Data extraction

All of the datasets were made available in a de-identified format. Individual age, gender and WOMAC item responses were extracted from each dataset. Information on waiting time and socioeconomic status was either not routinely recorded or recorded in a way that precluded concatenation and therefore not available for this study.

Eligibility criteria

As the datasets were not collected according to a single study protocol, data from each centre were screened according to a set of eligibility criteria (specified *a priori*). For inclusion in the analyses, data were required to have been:

- collected from people undergoing primary unilateral TKR or THR;
- collected using the Likert version of the WOMAC Index; and
- collected within 6 weeks prior to surgery, as minimal waiting-related deterioration was anticipated to occur beyond this time point.

Additionally, individual data were excluded if a WOMAC score could not be calculated due to an insufficient proportion of item responses (11).

After applying these eligibility criteria, it was identified that a number of centres had very small samples (combined TKR and THR samples of $n < 50$). To minimise the likelihood of spurious results, these centres were excluded from the analyses. Details of the excluded data and reasons for exclusion are presented in the Appendix.

Statistical analyses

Analyses were undertaken using Statistical Package for the Social Sciences (SPSS) Version 14.0. WOMAC pain, stiffness and physical function subscale scores were calculated according to published scoring guidelines (11). Pain, stiffness and physical function subscale scores were transformed to a 0 (best) to 100 (worst) scale. Separate statistical analyses were undertaken for TKR and THR as the EUROHIP, Halmstad and Lund databases contained one operation type only (either TKR or THR, see Table 1). As differences in age and gender were observed between the centres (Table 2), analysis of covariance (ANCOVA) was used to evaluate whether there were differences in pain, stiffness and physical function between centres while adjusting for age and gender. Individual age and gender data were used for each ANCOVA. To explore whether there were systematic differences in the age and physical status of people undergoing surgery (for example, surgery being consistently performed on younger patients with less severe joint disease or on older patients with more severe disease), Pearson's correlation coefficient (r) was used to assess the relationship between age, pain, stiffness and physical function.

To gain further insight into the data, the magnitude of variation in pre-operative pain, stiffness and physical function across the centres was estimated using standardised effect sizes (ES). The ES statistic has been described by Cohen for use with independent samples and ESs can be categorised as small (0.20-0.49), medium (0.50-0.79) or large (≥ 0.8) (12). Data from the centre with the highest mean adjusted WOMAC score for each subscale and the centre with the lowest mean adjusted WOMAC score were used for the calculations. ESs were calculated by dividing the difference between the mean WOMAC subscale scores of the two centres by the pooled standard deviation, which was used to account for differences in sample size between centres (13). To view the observed between-centre variation in a clinical context, calculated ESs were compared with ESs for a range of commonly-used conservative osteoarthritis interventions as reported in meta-analyses and Cochrane systematic reviews. Comparisons were also made with reported ESs from studies investigating outcomes from joint replacement surgery.

Results

Demographics

Information about the number of eligible participants, surgery dates, diagnosis and recruitment method used at each of the centres is provided in Table 1. Most participants at each centre had a diagnosis of osteoarthritis (range 91-100%).

Age and gender data for each centre are presented in Table 2. Analysis of variance revealed marked variation in the mean age before TKR (mean age range 67-73 years; $F_{(6,1004)}=4.21$, $p<0.01$) and THR (mean age range 63-72 years; $F_{(14,1807)}=7.27$, $p<0.01$). The ratio of female to male participants also varied considerably between centres (range 42%-63% female for TKR and 46%-61% female for THR).

Comparison of physical status across the centres

Table 3 shows substantial variation in pre-operative pain and physical function across centres for people undergoing TKR ($F_{(6,1002)}=4.26$, $p<0.01$ for pain and $F_{(6,1002)}=5.27$, $p<0.01$ for physical function) and THR ($F_{(14,1802)}=8.44$, $p<0.01$ for pain and $F_{(14,1802)}=6.71$, $p<0.01$ for physical function). There was little variation in pre-operative stiffness across centres for people undergoing TKR ($F_{(6,1002)}=0.94$, $p=0.46$); however, greater variation in stiffness was seen among those undergoing THR ($F_{(14,1802)}=2.81$, $p<0.01$). The extent of the observed variation in pain, stiffness and physical function is described in the following sections. As the unadjusted mean (95%CI) values were comparable to the adjusted values, only the latter have been reported in Table 3.

Total knee replacement

The mean adjusted pain scores for people undergoing TKR ranged from 52.5 to 61.1 (Table 3). People in Geelong (Australia) had, on average, the worst pre-operative pain, after adjusting for age and gender (mean adjusted physical function score 61.1). People in Perth (Australia) and Sydney (Australia) had the least pain, after adjusting for age and gender (mean adjusted physical function score 52.5 and 53.3, respectively).

There was little variation in pre-operative stiffness for people undergoing TKR, with mean adjusted scores ranging from 58.1 in Dundee (United Kingdom) to 63.3 in Geelong (Australia).

The mean adjusted physical function scores for people undergoing TKR ranged from 52.7 to 61.4. People in Geelong (Australia) and Melbourne (Australia) had the worst physical function before surgery, after adjusting for age and gender (mean adjusted physical function score 61.4 and 60.4, respectively). Those in Perth (Australia) and Dundee (United Kingdom) had the best physical function (mean adjusted physical function score 52.7 and 53.2, respectively).

Total hip replacement

The mean adjusted pain scores for people undergoing THR ranged from 49.2 to 65.7, as shown in Figure 1. People in Geelong (Australia) and Szeged (Hungary) had the worst pain prior to surgery (mean adjusted pain score 65.7 and 64.5, respectively). People in Sydney (Australia), Innsbruck (Austria) and Zurich (Switzerland) had the least pre-operative pain (mean adjusted pain score 49.2, 50.3 and 50.3, respectively).

The mean adjusted stiffness scores for people undergoing THR ranged from 55.4 to 68.1. People in Akureyri (Iceland) and Geelong (Australia) had the worst stiffness before surgery (mean adjusted stiffness score 68.1 and 67.4, respectively), while those in Szeged (Hungary) had the least stiffness (mean adjusted stiffness score 55.4).

Figure 2 shows the mean adjusted physical function scores for people undergoing THR at each centre (range 53.3 - 71.0). People in Szeged (Hungary) and Geelong (Australia) had the worst physical function before THR (mean adjusted physical function score 71.0 and 68.5, respectively), while those in Zurich (Switzerland) and Sydney (Australia) had the best function (mean adjusted physical function score 53.3 and 54.4, respectively).

Relationship between age, pain, stiffness and physical function

Figure S1 (supplementary material) shows that for participants undergoing TKR there was no substantive relationship between age and pain ($r=-0.15$, $p<0.01$), age and stiffness ($r=-0.10$, $p<0.01$) or age and physical function ($r=-0.03$, $p=0.36$). Similarly, for participants undergoing THR there was no relationship between age and pain ($r=0.00$, $p=0.89$), age and stiffness ($r=-0.03$, $p=0.15$) or age and physical function ($r=0.08$, $p<0.01$), as presented in Figure S2. These data suggest that at the centres studied, there was no systematic trend towards performing joint replacement surgery on younger patients with less severe joint disease symptoms or older patients with more severe symptoms.

Estimation of the magnitude of pre-operative variation between centres

ESs were calculated to estimate the magnitude of variation in pre-operative status across the range of centres using data from centres who had the lowest and highest WOMAC subscale

scores according to Table 3. These analyses revealed small to medium ESs for TKR (ES for pain=0.44, ES for stiffness=0.21 and ES for physical function=0.47). For THR, medium to large ESs were found (ES for pain=0.93, ES for stiffness=0.50 and ES for physical function=0.98).

To gauge the clinical relevance of these data, the largest ESs for TKR and THR (representing the between-centre variation in physical function) were compared with published ESs for commonly-used osteoarthritis interventions. For TKR, the calculated ES for physical function of 0.47 exceeds the reported ESs for physical function following interventions such as intra-articular corticosteroid injection (ES=0.24, (14)), non-steroidal anti-inflammatory drugs (ES=0.29, (15)) and land-based exercise (ES=0.31, (16)). To interpret these data in a different clinical context, comparison with recent research (17) shows that the calculated ES of 0.47 represents approximately 30% of the improvement in WOMAC physical function scores 6 months after TKR (ES=1.58).

For THR, the calculated ES for physical function of 0.98 exceeds the ES for physical function associated with therapies such as opioid analgesia (ES=0.31, (18)) and aquatic exercise (ES=0.76, (19)). Additionally, compared with the reported improvement in WOMAC physical function scores 6 to 12 months after THR (ES=2.40, (20); ES=2.34, (21)), the calculated ES of 0.98 represents over 40% of the reported benefit from surgery. These comparisons indicate that the magnitude of observed variation between centres can be considered substantial and clinically important.

Discussion

This research has revealed substantial variation in the pre-operative age, pain, stiffness and physical function of people undergoing joint replacement surgery at a range of centres in Australia and Europe. The magnitude of the variability in pre-operative pain and physical function was striking (over 8 WOMAC units before TKR and over 17 WOMAC units before THR) and can be regarded as clinically meaningful, as highlighted by the calculated effect sizes. The differences in physical status were evident even after adjusting for differences in age and gender between centres. These results indicate that the timing of hip and knee replacement surgery is highly variable with respect to severity of joint disease symptoms.

The most important clinical implication is that current variations in care could lead to compromised patient outcomes for those at the extremes of the distribution. Earlier research has shown that provision of joint replacement surgery to people with greater pre-operative pain and functional impairment is associated with poorer post-operative outcomes (8, 10, 22). Conversely, early provision of surgery to people with less severe symptoms results in smaller post-operative improvements (10, 23), and could represent an improper use of health resources. In almost all settings, systems are not available to determine need or urgency for joint replacement and consequently, access to surgery may be highly dependent on local customs. The absence of clear indications for joint replacement surgery is particularly relevant for countries such as the United Kingdom and Australia where general practitioners and orthopaedic surgeons act as 'gatekeepers' (1) to orthopaedic waiting lists and ultimately, to surgery.

The length of time waited for joint replacement surgery may also have contributed to the present findings, with delayed access to surgery manifesting as worse pain and poorer

function (10, 24). This is highlighted by the substantial variation in pain and physical function observed between the Australian centres (Table 3). It is known that centres such as Geelong have protracted waiting times for surgery (up to 19 months for an initial appointment to see an orthopaedic surgeon and up to 27 months for surgery), whereas some of the Sydney participants were recruited from private hospitals with considerably shorter waits (in the order of days or weeks). However, waiting times are unlikely to be the only contributing factor as participants undergoing TKR in another Australian public hospital (Perth) also had considerably less pain and better physical function pre-operatively, compared with Geelong (Table 3). Although this could not be explored in the present study, the capacity of individual centres to undertake joint replacement surgery may have contributed to the observed variation, with likely differences in factors such as health care payment systems. Local rationing of surgical services due to limited resources may also impact on an individual's access to surgery so that only people with the greatest pain and functional impairment can gain access to waiting lists.

Delayed access to joint replacement surgery for particular demographic groups may lead to worse pre-operative pain and functional impairment. Disparities in access to joint replacement surgery have been identified across a range of characteristics including gender (25), age (26), racial background (27, 28) and socioeconomic status (26, 29, 30), and could explain the wide variation across centres in the average age and gender ratios of people undergoing surgery in the present study. Such disparities could occur at several points in the health care process, from access to referring practitioners and orthopaedic surgeons through to entering the waiting list and finally progression along the list. Delayed access to surgery may also relate to an individual's willingness to undergo surgery, with a number of studies

reporting differences in patient preferences for joint replacement according to gender, ethnic group and socioeconomic status (31-33).

Cultural differences in the understanding and reporting of symptoms may have also contributed to the observed variation. Although the WOMAC Index is available in a range of languages (34), it was not primarily designed for cross-cultural application and its cross-cultural stability has not been reported. However, while cultural differences in the interpretation of some of the concepts (for example, pain severity) may have impacted on the findings, this is unlikely to have been a substantial contributor to the variation observed across the Australian centres.

As the international data were collected from a convenience sample of available centres rather than according to a standardised prospective protocol, it is possible that sampling variation may have contributed to differences in physical status between centres. Consecutive recruitment methods were used at each site with the expectation that the samples were broadly representative of their population base; however, it is possible that differences in recruitment rates (data not available) may have influenced this. How representative each centre is of their region or country is not known and it is possible that people with greater disease severity were recruited in some centres but not others, introducing systematic bias. Despite these limitations, this study has a number of strengths which enabled new information to be obtained. The pooling of individual data permitted WOMAC scores to be adjusted for potential confounders such as age and gender. Additionally, although a range of research and clinical datasets were used, the application of eligibility criteria allowed for some standardisation. Finally, this study extends the work of Lingard et al (7), which involved Australian participants recruited predominantly from a private hospital with short waiting

times of less than 2 months (35); the current findings are expected to be more generalisable to people undergoing joint replacement in the Australian public health care system.

In conclusion, large between-centre variation in pre-operative age, pain, stiffness and physical function was observed in people undergoing joint replacement surgery at a range of centres in Australia and Europe. These findings have highlighted the lack of consistency between the centres studied with respect to the timing of joint replacement surgery and raise concerns regarding the quality of care and the appropriateness of services provided. Although this study did not investigate possible contributing factors, a range of patient-, medical professional- and health system-related factors have been proposed including patient preferences, the absence of concrete indications for joint replacement and the capacity of individual health care systems. Given the role of pre-operative physical status as a key predictor of joint replacement outcomes, future prospective research is warranted to uncover the origins and impact of the observed variation.

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Table 1 Characteristics of participating centres

Region	Location (country)	Setting type	TKR (n)	THR (n)	Years of surgery	Diagnosis	Recruitment method
Australia	Geelong	Hospital	79	110	2002 - 2005	Mixed (97% OA)	Consecutive
	Melbourne	Hospital	41	43	2002 - 2005	Mixed (90% OA)	Consecutive
	Perth	Hospital	313	240	2002 - 2005	Mixed (91% OA)	Consecutive
	Sydney	Hospitals [†]	125	87	1994 - 2005	OA	Consecutive
Europe	Akureyri (Iceland)	Hospital	0	56	2004 - 2005	OA	Consecutive
	Dresden (Germany)	Hospital	0	114	2003 - 2004	OA	Consecutive
	Dundee (UK)	Hospital	123	157	2003 - 2005	Mixed (91% OA)	Consecutive
	Halmstad (Sweden)	Hospital	0	87	1997 - 1998	OA	Consecutive
	Hamburg (Germany)	Hospital	0	155	2003	OA	Consecutive
	Hassleholm (Sweden)	Hospital	252	390	2004	OA	Consecutive
	Innsbruck (Austria)	Hospital	0	84	2003 - 2004	OA	Consecutive
	Karlshamm (Sweden)	Hospital	0	50	2003 - 2004	OA	Consecutive
	Lund (Sweden)	Hospital	79	0	1999 - 2001	OA	Consecutive
	Szeged (Hungary)	Hospital	0	58	2003 - 2004	OA	Consecutive
	Ulm (Germany)	Hospital	0	139	2003 - 2004	OA	Consecutive
	Zurich (Switzerland)	Hospital	0	53	2003 - 2005	OA	Consecutive
TOTAL			1012	1823			

[†]Combined sample collected from 3 hospitals (1 hospital was public only, 2 were both public and private)

Table 2 Age and gender by centre

Operation type	Centre (country)	<i>n</i>	Mean age in years (95%CI)	Gender (% female)
Total knee replacement	Dundee (UK)	123	69 (67 to 70)	52
	Geelong (Australia)	79	73 (72 to 75)	63
	Hassleholm (Sweden)	252	71 (70 to 72)	55
	Lund (Sweden)	79	71 (69 to 73)	63
	Melbourne (Australia)	41	67 (64 to 70)	56
	Perth (Australia)	313	70 (69 to 71)	63
	Sydney (Australia)	125	71 (70 to 72)	42
Total hip replacement	Akureyri (Iceland)	56	69 (67 to 72)	46
	Dresden (Germany)	114	65 (63 to 66)	56
	Dundee (UK)	157	67 (65 to 69)	57
	Geelong (Australia)	110	71 (69 to 72)	57
	Halmstad (Sweden)	87	71 (69 to 73)	54
	Hamburg (Germany)	155	66 (65 to 68)	60
	Hassleholm (Sweden)	390	70 (69 to 71)	56
	Innsbruck (Austria)	84	63 (61 to 65)	54
	Karlshamm (Sweden)	50	66 (63 to 69)	50
	Melbourne (Australia)	43	67 (63 to 70)	61
	Perth (Australia)	240	68 (66 to 69)	55
	Sydney (Australia)	87	65 (62 to 67)	51
	Szeged (Hungary)	58	66 (63 to 68)	59
	Ulm (Germany)	139	66 (64 to 68)	53
	Zurich (Switzerland)	53	72 (69 to 75)	55

Table 3 Pre-operative pain and physical function by centre

Operation type	Centre (country)	n [†]	WOMAC pain score*	WOMAC stiffness score*	WOMAC physical function score*
			Adjusted mean [#] (95% CI)	Adjusted mean [#] (95% CI)	Adjusted mean [#] (95% CI)
Total knee replacement	Dundee (UK)	123	58.1 (55.1 to 61.1)	58.1 (54.5 to 61.8)	53.2 (50.2 to 56.1)
	Geelong (Australia)	79	61.1 (57.4 to 64.9)	63.3 (58.7 to 67.8)	61.4 (57.6 to 65.1)
	Hassleholm (Sweden)	252	55.4 (53.3 to 57.5)	59.0 (56.5 to 61.6)	57.8 (55.8 to 59.9)
	Lund (Sweden)	79	58.0 (54.2 to 61.8)	61.3 (56.8 to 65.8)	58.8 (55.1 to 62.5)
	Melbourne (Australia)	41	57.4 (52.1 to 62.6)	62.2 (55.9 to 68.4)	60.4 (55.3 to 65.6)
	Perth (Australia)	313	52.5 (50.6 to 54.4)	58.3 (56.1 to 60.6)	52.7 (50.8 to 54.5)
	Sydney (Australia)	125	53.3 (50.3 to 56.3)	59.4 (55.8 to 63.0)	55.6 (52.7 to 58.6)
			F _(6,1002) = 4.26, p < 0.01**	F _(6,1002) = 0.94, p = 0.46**	F _(6,1002) = 5.27, p < 0.01**
Total hip replacement	Akureyri (Iceland)	56	62.7 (58.1 to 67.2)	68.1 (62.9 to 73.3)	62.7 (58.3 to 67.0)
	Dresden (Germany)	114	58.6 (55.5 to 61.8)	63.2 (59.6 to 66.9)	62.4 (59.3 to 65.4)
	Dundee (UK)	157	60.1 (57.4 to 62.8)	58.7 (55.6 to 61.8)	59.2 (56.6 to 61.8)
	Geelong (Australia)	110	65.7 (62.5 to 69.0)	67.4 (63.6 to 71.1)	68.5 (65.4 to 71.6)
	Halmstad (Sweden)	87	55.6 (51.8 to 59.3)	61.8 (57.5 to 66.0)	60.9 (57.4 to 64.5)
	Hamburg (Germany)	155	50.9 (48.1 to 53.6)	59.1 (56.0 to 62.2)	57.4 (54.8 to 60.0)
	Hassleholm (Sweden)	390	59.2 (57.5 to 60.9)	60.7 (58.7 to 62.7)	60.9 (59.2 to 62.5)
	Innsbruck (Austria)	84	50.3 (46.6 to 54.0)	58.8 (54.5 to 63.1)	55.0 (51.5 to 58.6)
	Karlshamm (Sweden)	50	57.0 (52.2 to 61.8)	60.8 (55.3 to 66.3)	63.7 (59.1 to 68.3)
	Melbourne (Australia)	43	62.4 (57.3 to 67.6)	64.2 (58.2 to 70.1)	61.8 (56.9 to 66.8)
	Perth (Australia)	240	58.3 (56.1 to 60.4)	63.1 (60.6 to 65.6)	62.1 (60.0 to 64.2)
	Sydney (Australia)	87	49.2 (45.5 to 52.8)	57.1 (52.9 to 61.3)	54.4 (51.0 to 57.9)
	Szeged (Hungary)	58	64.5 (60.1 to 69.0)	55.4 (50.3 to 60.5)	71.0 (66.7 to 75.2)
	Ulm (Germany)	139	56.7 (53.8 to 59.6)	64.3 (61.0 to 67.6)	62.4 (59.6 to 65.1)
	Zurich (Switzerland)	53	50.3 (45.7 to 55.0)	59.7 (54.4 to 65.1)	53.3 (48.9 to 57.8)
			F _(14,1802) = 8.44, p < 0.01**	F _(14,1802) = 2.81, p < 0.01**	F _(14,1802) = 6.71, p < 0.01**

*Range: 0-100 for each subscale score; higher score indicates worse pain, stiffness or physical function

[†]Missing age or gender data not able to be included in the ANCOVA analyses: n=3 for Halmstad (THR), n=1 for Hamburg (THR) and n=1 for Hassleholm (TKR)

[#]Adjusted for age and gender

**Analysis of covariance with adjustment for age and gender

Figure 1 Pre-operative pain by centre for participants undergoing total hip replacement

Scores are adjusted for age and gender; range: 0 (least pain) to 100 (worst pain)

Solid vertical line indicates pooled sample mean; dashed vertical line indicates 95% CI for pooled sample mean

*n differs to Table 1 due to missing age or gender data (n=3 for Halmstad, n=1 for Hamburg)

Figure 2 Pre-operative physical function by centre for participants undergoing total hip replacement

Scores are adjusted for age and gender; range: 0 (best function) to 100 (worst function)

Solid vertical line indicates pooled sample mean; dashed vertical line indicates 95% CI for pooled sample mean

*n differs to Table 1 due to missing age or gender data (n=3 for Halmstad, n=1 for Hamburg)

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