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ORIGINAL ARTICLE

Personality, function and satisfaction in patients undergoing total hip or knee replacement

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Abstract
Background The aim of this study was to investigate the relationships between personality and joint-specific function, general physical and general mental health in patients undergoing total hip (THA) and knee arthroplasty (TKA).
Methods One hundred and eighty-four patients undergoing THA and 205 undergoing TKA were assessed using the Eysneck Personality Questionnaire, brief version (EPQ-BV). General physical and mental health was measured using the Short-Form 12 (SF-12) questionnaire and the EuroQol (EQ-5D). Joint-specific function was measured using the Oxford hip or knee score.
Results The "unstable introvert" personality type was associated with poorer pre-operative function and health in patients with hip arthrosis. In patients with knee arthrosis, there was poorer general health in those with "stable extrovert" and "unstable introvert" types. Personality was not an independent predictor of outcome following TKA or THA. The main predictor was pre-operative function and health. Comorbidity was an important covariate of both pre-operative and postoperative function.
Conclusions Personality may play a role in the interaction of these disease processes with function and health perception. It may also affect the response and interpretation of psychometric and patient-reported outcome measures. It may be important to characterise and identify these traits in potential arthroplasty patients as it may help deliver targeted education and management to improve outcomes in certain groups.

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Introduction

Arthroplasty of the hip and knee are among the most commonly performed surgical procedures in the United Kingdom. While the majority of patients are satisfied with the outcome following surgery, and show good improvement in function afterwards, some are dissatisfied with the outcome [1, 2]. Despite ongoing advances in implant design and surgical techniques, the dissatisfaction rate following total knee replacement (TKA) ranges from 11 to 19 % with patients citing either a lack of pain relief or functional improvement [3]. There is greater satisfaction after total hip replacement (THA), where 89 % of patients are satisfied. Satisfaction after arthroplasty is a complex phenomenon and is dependent on many factors, including the level of pre-operative expectation and mental well-being [3].

Postoperative satisfaction is multifactorial and psychological factors play an important role. Neuroticism, perioperative distress and pessimism [4] have been implicated in dissatisfaction and poor function following arthroplasty but further work is needed to characterise these differences. Few studies have demonstrated the effect of personality traits on satisfaction and outcomes following arthroplasty. Identifying and characterising these factors in patients may lead to patient-specific intervention and management of expectations which will improve overall satisfaction.

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Personality is defined as a stable pattern of responses that vary between different individuals as they respond to similar external conditions and stimulations [5]. Personality can affect quality of life and response to treatment in many diseases including oesophageal cancer and Grave's disease and even postoperative stay after abdominal surgery [6]. Certain traits can lead to increased ill health and comorbidities. Furthermore, different personality types have different expectations following surgery and previous studies have demonstrated that a patient's expectation pre-operatively significantly affects their outcome and satisfaction postoperatively [7].

The aim of this study was to investigate the relationship between personality and joint-specific function, general physical and general mental health in patients undergoing THA and TKA.

Materials and methods

The study took place between January 2010 and January 2011 at the Royal Infirmary of Edinburgh. Ethical approval was granted by the National Health Service Research Ethics Committee (REC number: 11/AL/0079). Two hundred patients undergoing THA and 220 patients undergoing TKA were eligible and sent a pre-operative questionnaire. One hundred and eighty-four (92 %) patients undergoing THA and 205 (93 %) patients undergoing TKA elected to participate in the study. One year after treatment, a questionnaire was mailed to the 389 patients to complete the Oxford joint score and EQ-5D score: 168 (91 %) THA patients and 190 (93 %) TKA patients returned this postal follow-up questionnaire.

Personality was assessed using the Eysneck personality questionnaire (EPQ-BV) which is a 24-item questionnaire that can be completed in a short period of time [8]. The EPQ-BV has two scales — the neuroticism scale (EPQ-N), which assesses emotional stability while the extroversion scale (EPQ-E) assesses the need for emotional stimulation [8]. Each scale was divided into high and low categories based on medians derived from literature, an accepted method of analysing this psychometric scale [8]. A high score was defined as an EPQ-E $\geq$39 and an EPQ-N $\geq$26 [9]. This method has a strong evidence-base and has been used by many researchers [10]. This allowed classification of the four cohorts as follows—stable introverts (low EPQ-N, low EPQ-E), stable extroverts (low EPQ-N, high EPQ-E), unstable extroverts (high EPQ-N, high EPQ-E) and unstable introverts (high EPQ-N, low EPQ-E) [10]. Again, the pre-operative and postoperative patient-reported outcome measures (PROMs) were compared between each subgroup.

Comorbidity was measured using the self-reported morbidity questionnaire [11]. The scale of this variable ranges from 0, representing no comorbidity, to 36, representing maximum comorbidity. Patients reported the presence or absence of 12 conditions, scoring a point for having the condition, being limited by it and receiving treatment for it. This score has shown good correlation with the Charlson comorbidity index [12].

General physical and mental health was measured using the EuroQol (EQ-5D). This measure reports a utility index where 1.00 represents full health and 0 represents no health quality. Joint-specific function was measured using the Oxford hip or knee score, as appropriate [13]. Data on comorbidities such as hypertension, diabetes, ischaemic heart disease, back pain or back surgery, arthritis and depression were collected postoperatively.

Satisfaction was measured using a Likert scale (five-level) that assessed the patient's satisfaction with the outcome. They were asked two questions. The first asked their general satisfaction with the outcome of surgery, and the second asked if the surgery had met expectations. The Likert scale is a psychometric scale that allows patients to provide a scaled response to answers [14].

Statistical analysis

We compared the pre-operative and postoperative EQ-5D and Oxford scores between the total hip arthroplasty and total knee arthroplasty groups. Significance was taken to be <0.05. The minimal clinically important difference (MCID) was set at 3 [13] for the Oxford scores. A Chi-square test was used to assess the significance of any difference found in this proportion.

Multivariable linear regression was performed to examine the association between personality type and function. Models were constructed with the pre- and postoperative Oxford joint scores and EQ-5D values as outcome variables. We used the most common personality type, stable introverts, as the reference type, and used dummy variables for the other three types. We controlled for the independent association of age, gender and comorbidity. In addition, we controlled for the effect of pre-operative function when assessing postoperative function. This is recommended when assessing a change from baseline, where the baseline varies throughout the study group. No variable selection algorithm was used and all variables were entered together to assess their overall independent effects on the Oxford scores. The B values (coefficients), along with their respective 95 % confidence intervals and P values were reported. The model fit was reported with the r^2 statistic. This represents the change in the outcome variable caused by a unit change in the predictor variable. The median value and interquartile range were calculated for the results of the satisfaction and expectation questions and compared across personality

types using the Kruskal–Wallis test. This was used because of the non-normal distribution of the results of the satisfaction data.

Results

In the THA group, stable extroverts were the most common (39 %), followed by stable introverts (34 %) (Table 1). Unstable introverts accounted for 28 % of hip arthroplasty patients and unstable extroverts accounted for 9 %. In the TKA group, stable introverts were the most common group (36 %). Unstable introverts accounted for 29 %. Stable extroverts accounted for 27 %, and unstable extroverts made up 8 % of this cohort (Table 1). There were no differences in personality traits of patients undergoing either THA or TKA ($p = 0.921$; Table 1) or gender ($p = 0.603$). However, patients undergoing THA were significantly younger than those requiring TKA (*t*-test; $p = 0.001$) (Table 2).

Table 1 Comparison between total hip arthroplasty and total knee arthroplasty cohorts

Variable	THA ($n = 184$)	TKA ($n = 205$)	*P* value
Age	67.1	70.5	**0.001**
Gender (*n*, %)			
Male	82 (45 %)	86 (42 %)	0.603
Female	102 (55 %)	119 (58 %)	
Comorbidity Score	2.7 (2.3)	3.4 (2.8)	0.044
SF12 PCS			
Pre-operative	29.7	28.6	0.087
One year	42.4	38.5	**<0.001**
SF-12 MCS			
Pre-operative	49.5	49.7	0.904
One year	50.9	51.1	0.862
Oxford Score			
Pre-operative	21.0	19.4	0.056
One year	38.4	35.2	**0.001**
Change	17.4	15.8	0.133
EQ-5D			
Pre-operative	0.41	0.37	0.305
One year	0.72	0.67	**0.043**
Change	0.32	0.29	0.417
EPQ (raw)			
Neuroticism	24.5	24.6	0.904
Extroversion	35.9	35.2	0.412
EPQ personality type (*n*, %)			
Stable			
Introvert	63 (34 %)	74 (36 %)	0.921
Extrovert	54 (39 %)	55 (27 %)	
Unstable			
Introvert	51 (28 %)	60 (29 %)	
Extrovert	16 (9 %)	16 (8 %)	

Bold values indicate $P < 0.05$

THA total hip arthroplasty, *TKA* total knee arthroplasty, *SF12 PCS* short form physical score, *SF12 MCS* short form mental score, *EQ-5D* European quality of life 5-dimension score, *EPQ* Eysneck personality questionnaire

In patients with hip arthrosis, personality was an independent predictor of both the pre-operative Oxford Hip Score (OHS) and EQ-5D, with the "unstable introvert" type having lower joint-specific function ($p < 0.001$) and general health ($p < 0.001$) (Table 3). Comorbidity was the only other significant predictor of both scores. Personality did not have a separate effect on postoperative OHS or EQ-5D (Table 3). The postoperative function and general health was determined by pre-operative function and comorbidity (Table 3).

In patients with knee arthrosis, pre-operative joint function (Oxford Knee Score—OKS) was associated with age ($p \leq 0.001$), comorbidity ($p = 0.004$) and gender ($p = 0.05$). There was no independent effect of personality. The EQ-5D was not associated with these variables, but showed an association with the "stable extrovert" ($p = 0.023$) and "unstable introvert" types. In a similar fashion to patients with hip arthrosis, the postoperative joint-specific and general health outcomes were predicted by comorbidity and pre-operative function. There was no independent effect of personality type on outcome.

Following THA there was no overall difference in satisfaction with the outcome across personality types ($p = 0.453$). Expectations had also been similarly met across the personality types ($p = 0.356$). Following TKA there was a difference in the reported satisfaction across the personality types ($p = 0.026$), with the least satisfied group being the "unstable introverts". Despite this, there was no difference in reported rates of whether surgery met their expectations ($p = 0.102$).

Discussion

This study demonstrates that personality traits influence the pre-operative Oxford joint scores and EQ-5D score. There was no independent effect of personality type on the postoperative scores. One of the most significant predictors of postoperative function is pre-operative function. Therefore, any factor that influences pre-operative function is likely to exert an influence on the final outcome through this effect. Personality did not affect whether expectations were met following surgery in either group. There was, however, an effect of personality on postoperative satisfaction after TKA. The "unstable introvert" group had the poorest satisfaction. This may reflect underlying differences in the effectiveness of these procedures, but also in expectation management around the time of surgery.

Table 2 Multivariable predictors of Oxford hip score and EQ-5D before and after THA. B values represent the difference in outcome score per unit change in predictor variables

Variable	Oxford hip score		EQ-5D	
	B value (95 % CI)	*P* value	*B* value (95 % CI)	*P* value
Pre-operative				
Constant	28.1 (18.8 to 37.5)		0.540 (0.172 to 0.908)	
Age	−0.08 (−0.19 to 0.03)	0.163	0.000 (−0.005 to 0.004)	0.864
Comorbidity	**−0.85 (−1.38 to 0.32)**	**0.002**	**−0.026 (−0.047 to −0.005)**	**0.014**
Gender (female reference)	2.05 (−0.36 to 4.46)	0.095	0.019 (−0.075 to 0.112)	0.693
Personality type				
Stable introvert	Reference		Reference	
Stable extrovert	−2.85 (−5.82 to 0.12)	0.060	−0.024 (−0.138 to 0.091)	0.685
Unstable introvert	**−5.90 (−8.97 to −2.84)**	**<0.001**	**−0.201 (−0.322 to −0.080)**	**0.001**
Unstable extrovert	−1.96 (−6.48 to 2.66)	0.404	−0.515 (−0.222 to 0.130)	0.607
Adjusted r^2	0.143			0.126
Postoperative				
Constant	38.3 (27.4 to 49.2)		0.770 (0.473 to 1.000)	
Age	−0.03 (−0.14 to 0.09)	0.653	0.000 (−0.004 to 0.003)	0.787
Comorbidity	**−1.77 (-2.35 to −1.19)**	**<0.001**	**−0.048 (−0.065 to −0.032)**	**0.001**
Gender (female reference)	0.26 (−2.32 to 2.84)	0.842	−0.006 (−0.081 to 0.068)	0.868
Personality type				
Stable introvert	Reference		Reference	
Stable extrovert	1.63 (−1.55 to 4.81)	0.313	0.040 (−0.051 to 0.131)	0.391
Unstable introvert	0.72 (−2.71 to 4.14)	0.679	0.048 (−0.051 to 0.148)	0.340
Unstable extrovert	0.80 (−4.10 to 5.70)	0.748	0.019 (−0.119 to 0.158)	0.784
Pre-operative value	**0.26 (0.10 to 0.43)**	**0.002**	**0.243 (0.122 to 0.363)**	**<0.001**
Adjusted r^2	0.262			0.285

Bold values indicate $P < 0.05$

Despite the improvement in surgical techniques and prostheses in recent years, there still remains significant variation in satisfaction following TKA [1, 2]. One cohort reported poor functional improvement at 12 months in 15–38 % of patients [1, 2]. Poorer functional outcomes are associated with older age, physical characteristics such as obesity and pre-existing comorbidities, variations in surgical procedures and poor quad strength [15]. These biological and medical factors do not completely explain the sub-optimal outcomes found in knee arthroplasty patients and an increasing amount of evidence suggests that psychological aspects of the patient seem to be related to outcome following TKA [15].

A systematic review carried out by Visser et al. [16] suggested that following TKA, poorer pre-operative mental health was associated with worse final function and pain scores. Pre-operative mental health is also reported to influence patient satisfaction following surgery [17]. While poor mental health correlates with poorer outcomes, the magnitude of improvement is similar regardless of mental health [18].

The expectation of the outcome from surgery is multidimensional and is related to psychological, environmental and physical factors. Depression strongly influences pre-operative expectation and there is a positive correlation between patient expectation and outcomes. There is some evidence suggesting that in most patients, the postoperative results exceed their expectations [1]. Furthermore, greater expectation of pain relief predicted greater reported pain relief at 1 year postoperatively while patient expectation directly affects satisfaction [19]. Personality has been correlated with pre-operative expectation in other surgical procedures; studies in oral and maxillofacial surgery have demonstrated that neurotic personalities have higher, often unrealistic, pre-operative expectations and as a result have lower satisfaction rates postoperatively [20].

There are other psychological predictors of outcome following TKA which include self-efficacy and pain catastrophizing. Self-efficacy can be described as the "conviction that one can successfully execute the behaviour required to produce an outcome". Self-efficacy and expectation helped to explain between 9 and 13 % of the variance in outcome following TKA at 6 months in one study [21].

Pain catastrophizing is a response to pain that leads to negative outcomes and suggests a tendency to focus excessively on the pain in daily life and exaggerate the perceived threat of pain [22]. It can often lead to a belief that the pain cannot be controlled and unsurprisingly, pre-operative pain catastrophizing predicts more pain

Table 3 Multivariable predictors of Oxford knee score and EQ-5D before and after TKA. B values represent the difference in outcome score per unit change in predictor variables

Variable	Oxford knee score		EQ-5D	
	B value (95 % CI)	*P* value	*B* value (95 % CI)	*P* value
Pre-operative				
Constant	4.2 (−5.3 to 13.8)		0.204 (−0.211 to 0.620)	
Age	**0.20 (0.09 to 0.31)**	**<0.001**	0.004 (−0.001 to 0.008)	0.133
Comorbidity	**−0.53 (−0.89 to −0.17)**	**0.004**	−0.014 (−0.030 to 0.001)	0.067
Gender (female reference)	**2.04 (0 to 4.09)**	**0.05**	0.034 (−0.056 to 0.123)	0.459
Personality type				
Stable introvert	Reference		Reference	
Stable extrovert	−0.89 (−3.50 to 1.72)	0.502	**−0.135 (−0.252 to −0.019)**	**0.023**
Unstable introvert	−0.68 (−3.25 to 1.88)	0.600	**−0.167 (−0.277 to −0.057)**	**0.003**
Unstable extrovert	2.68 (−1.20 to 6.55)	0.174	−0.072 (−0.242 to −0.098)	0.405
Adjusted r^2	0.124		0.086	
Postoperative				
Constant	38.3 (27.4 to 49.2)		0.528 (0.197 to 0.858)	
Age	−0.03 (−0.14 to 0.09)	0.653	0.002 (−0.001 to 0.006)	0.227
Comorbidity	**−1.77 (−2.35 to −1.19)**	**<0.001**	**−0.025 (−0.038 to −0.013)**	**<0.001**
Gender (female reference)	0.26 (−2.32 to 2.84)	0.842	−0.037 (−0.109 to 0.034)	0.307
Personality type				
Stable introvert	Reference		Reference	
Stable extrovert	1.63 (−1.55 to 4.81)	0.313	0.028 (−0.066 to 0.122)	0.554
Unstable introvert	0.72 (−2.71 to 4.14)	0.679	−0.040 (−0.130 to 0.051)	0.385
Unstable extrovert	0.80 (−4.10 to 5.70)	0.748	0.052 (−0.083 to 0.186)	0.450
Pre-operative value	**0.26 (0.10 to 0.43)**	**0.002**	**0.295 (0.176 to 0.413)**	**<0.001**
Adjusted r^2	0.262		0.251	

Bold values indicate $P < 0.05$

postoperatively and poorer overall outcomes. Pain catastrophizing is more commonly found in neurotic personalities, and higher levels of neuroticism has been shown to lead to maladaptive mechanisms in coping and anticipating visceral pain that can be detrimental to a patient's quality of life. Neuroticism as a personality trait is thought to be a vulnerability factor as it lowers the threshold at which pain is perceived as threatening, leading to unhelpful thoughts and behaviours such as avoidance.

Our findings correlate with those previously described in the literature [23, 24]. As discussed earlier, mental ill-health and psychological comorbidity are risk factors for severe or moderate pain after primary TKA, which in turn lead to poorer outcomes [25]. Neurotic personalities have lower levels of self-efficacy and extroverts have higher levels, and this could further explain the differences in outcomes. Studies show that motivation plays an important role in postoperative function and return to work and normality, and high levels of self-efficacy are associated with higher motivation [26].

Extroverts have higher self-efficacy and may be more motivated to partake in physiotherapy and exercise as well as adhering to recommended physical activity. On the other hand, introverts may struggle to cope with these activities or be more unwilling to partake, either due to lack of motivation or due to pain catastrophizing. We believe this could be one of the reasons that different patients have varying outcomes. Extroversion also has been demonstrated to be associated with a higher pain tolerance and use of active coping mechanisms and lower perceived intensity of pain [26].

The evidence for psychological factors playing a significant role in satisfaction following total hip arthroplasty is more limited. However, a large systematic review found either limited, conflicting or no evidence for the effect of a wide range of psychological factors affecting function and outcomes of hip arthroplasty [16]. These findings are consistent with our results and this suggests psychological aspects are less important in determining outcomes following hip arthroplasty than they are following knee arthroplasty.

Identification of unstable introverts patients may allow targeted pre-operative explanation and advice together with centrally directed pain neuromodulation. There is some evidence already that such interventions may improve outcomes. Many patients consider that they receive inadequate pre-operative advice about their surgery and rehabilitation [27]. The authors demonstrated that implementing pre-operative classes teaching patients about complications, the surgical procedures and rehabilitation as

well as distributing an information booklet improved satisfaction (99 % overall satisfaction), led to better expectations of surgery and increased function after the operation. Importantly, these interventions led to shorter hospital stays and therapy, leading to a substantial cost saving [27].

Although a validated measure of personality type was used, a limitation of this study is the inherent flaw in all personality testing instruments and the intrinsic issue of test validity. Nevertheless, within the context of this study, the EPQ-BV allowed for personality type to be measured quickly and fairly effectively. It is also not possible to know whether participant responses were honest or reflected the wish to express socially desirable traits, or to know the extent to which self-reporting of personality was affected by personality type. It was also not possible in this study to gauge whether arthroplasty patients with extreme personality types chose not to return the questionnaire. Unstable introverts have been found to exhibit assertive deficits and can become aggressive if they feel coerced into an activity [28], so might be expected to refuse to complete a questionnaire or answer all items [28]. In this study, however, the majority of partial responders were categorised as belonging to the low neuroticism group. The greatest strengths of this research are the relatively large sample size recruited over a short time period of 3 months, a questionnaire return rate of 95 %, the involvement of high volume arthroplasty surgeons, and the use of validated instruments with established psychometric properties that have previously been used in the orthopaedic setting. We were able to construct multivariate models to assess the association of personality type with pre- and postoperative function. We controlled for age and gender in these models. For the models predicting postoperative function, we included pre-operative function. This step controlled for differences in baseline function. It has been demonstrated that pre-operative function is a powerful predictor of post-operative function. This is partially due to the "regression to the mean" phenomenon. In assessment of change from baseline where differences exist in baseline measures, the use of an ANCOVA design (analysis of covariance), such as we undertook, has been recommended.

Future studies should characterise the effect of personality on the length of time before operative interventions take place and the likelihood of a patient undergoing total joint arthroplasty. These should also investigate the effect of personality on the responsiveness and reproducibility of commonly used psychometric and patient-reported outcome measures. This work may identify a subset of patients for whom a different style of explanatory advice, counselling style and targeted peri-operative pain modulation may temper expectation and improve outcome.

Personality strongly influences pre-operative expectation, postoperative function and overall satisfaction in TKA. It is important to characterise and identify these traits in potential arthroplasty patients. Doing so would help healthcare workers deliver targeted interventions and managements to help improve outcomes in certain personality groups.

Conflict of interest The authors declare that they have no conflict of interest.

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