Purpose: This study examined the role of anxiety and upper limb dysfunction, amongst other variables, as predictors of health related quality of life (HRQOL) 6 months after stroke. Method: Participants: Stroke survivors (n = 85) who had previously participated in a randomised controlled trial of a physiotherapy intervention. Dependent variable: HRQOL – Nottingham Health Profile (NHP). Predictor variables: Mood – Hospital Depression and Anxiety Scale; Upper Limb Functioning - Action Research Arm Test; Rivermead Motor Assessment; Activities of Daily Living – Modified Barthel Index; Clinical and demographic factors. Results: Anxiety and depression significantly predicted 49% of variance in overall HRQOL (p < 0.05), but only anxiety significantly predicted NHP pain (13% variance, p < 0.001), emotional reactions (41% variance, p < 0.001), sleep (19% variance, p = 0.02) and social isolation (23% variance, p = 0.02). Depression and anxiety together significantly predicted 30% variance in energy level (p < 0.001). UL motor impairment and activities of daily living predicted 36% of variance in NHP physical activity score (p < 0.001). Conclusions: This study indicates that where anxiety is assessed, it appears more important in determining HRQOL than depression. UL impairment and ADL independence predicted perceived physical activity. Management strategies for anxiety and therapy for UL recovery long after stroke onset are likely to benefit perceived HRQOL.

Keywords: Stroke, health related quality of life, anxiety, upper extremity

Introduction

Stroke is the main cause of complex adult disability in the western world [1], adversely affecting independence in activities of daily living, participation in social and occupational roles and leisure activities [2]. Consideration of the impact stroke has on survivors’ lives is vital to understanding their needs [3,4] and cannot be assumed only from clinical indices of recovery. Measures of perceived health status, social participation and health related quality of life (HRQOL) are increasingly used as patient centred assessment tools [4]. While little consensus exists about how HRQOL should be measured, it is generally regarded as a multi-faceted construct that reflects the interplay between health conditions and physical, social and emotional functioning [5,6].

Studies conducted 3 months or more after stroke onset show that depression [7–11] social support [12–17], demographic factors [7,14,18–20] and physical factors such as independence in daily living [19], motor impairment [21,22] and fatigue [23] are key factors influencing HRQOL. The range of measures and potential predictors across studies probably accounts for the diversity in findings. However, despite the range of potential

Implications for Rehabilitation

• Anxiety is a major predictor of quality of life six months after stroke.
• Post-stroke anxiety should be routinely assessed in rehabilitation.
• Appropriate management strategies for anxiety should occur during rehabilitation with follow-up into the chronic post-stroke period.
• Upper limb impairment is a stronger predictor of perceptions of physical activity than independence in activities daily living six months after stroke.
• Rehabilitation of the upper limb should continue into the chronic post-stroke period.
predictors of HRQOL, two specific factors have been largely overlooked: upper limb (UL) dysfunction and anxiety.

First, UL dysfunction after stroke is common with only 5–20% of survivors making full recovery after 6 months [24,25], depending on initial severity. Poor UL functioning can negatively influence participation in functional and leisure activities [2]. Upper limb dysfunction may be categorised using two constructs from the International Classification of Functioning. Impairment indicates, alteration in body structure or function, for example in movement or sensation whilst activity limitation indicates dysfunction in task performance, such as using cutlery or pouring water from a jug [26]. Since impairment is concerned with movement and activity limitation with task performance, this is an important distinction. However, if and how these constructs differentially influence HRQOL has not been explored [19]. Understanding if and how each construct influences HRQOL will enable therapists, in collaboration with patients, to target therapy interventions at domains that most influence perceived HRQOL.

Second, anxiety and depression are common after stroke and there is strong evidence from many studies that depression influences HRQOL [7–10]. Anxiety occurs in 20–36% of survivors up to 1 year after stroke [27,28] and evidence suggests that it appears more stable and persistent than depression [18,28,29]. Despite its high prevalence, the influence of anxiety on HRQOL is less reported than depression, although both constructs are often examined together [28,30]. A better understanding of the influence of anxiety compared to depression on HRQOL is therefore required in order to develop and target interventions to address these psychological issues, restore HRQOL and support people in return to community living after stroke.

This study examined which factors, including UL activity limitation and impairment, and anxiety at 6 months after stroke onset predicted HRQOL in survivors with UL dysfunction. We hypothesised that these UL constructs and anxiety would emerge as significant predictors of HRQOL measured on the Nottingham Health Profile (NHP). This information will be helpful for planning interventions in the post-discharge phase of recovery after stroke.

**Methods**

**Design and setting**

This was a cross-sectional study to evaluate predictors of HRQOL at 6 months after stroke conducted with a cohort of community dwelling stroke survivors. Participants had all participated in a randomised controlled trial (RCT) with two treatment arms, comparing a 6 week training programme of bilateral to unilateral task training for UL recovery [31]. The present study examines predictors of HRQOL in the 85 participants available for trial follow-up at 6 months after stroke onset. Tayside Committee on Medical Research Ethics provided ethical approval for the study and all participants provided informed written consent.

**Participants**

Patients diagnosed with stroke and admitted to an acute stroke unit who fulfilled the inclusion and exclusion criteria were recruited to the RCT 2–4 weeks after stroke. The present study reports on participants who completed follow-up assessment at 6 months after stroke onset. Inclusion criteria for the trial were: acute unilateral stroke confirmed on CT scan, score below 6 with the paretic arm on the upper-limb sections of the Motor Assessment Scale [32], ability to participate in 30-min physiotherapy sessions; ability to sit unsupported for more than 1 min. Exclusion criteria were: severe neglect, aphasia or cognitive impairment, previous stroke-related disability, pre-morbid arm impairment, hemiplegic shoulder pain, or inability to provide informed consent.

**Measures**

**Dependent variable: health related quality of life**

The NHP (part 1) [33] was used to assess HRQOL across six domains: energy, pain, emotion, sleep, social isolation, and physical mobility. Weighted scores range from 0 to 600, lower scores indicated better HRQOL. Scores were recorded and summed to represent overall HRQOL as well as individual HRQOL domains. Reliability and validity of this generic HRQOL measure have been established in stroke populations and it is widely used in stroke research [34–36].

**Predictor variables**

**Upper limb activity limitation**

The Action Research Arm Test (ARAT) [37,38] comprises 19 tasks organised into four subsections: grip, grasp, pinch, and gross movement. Scores of 0 indicate that no part of an item was performed; three indicates normal item performance. Scores are summed to provide a range from 0 to 57, the maximum indicating normal performance. The ARAT is a validated and reliable measure of UL activity limitation [37,38].

The Nine Hole Peg Test (9HPT) [25] assessed fine manual dexterity at upper ranges of ability. Participants were timed inserting nine pegs in to a nine holed board. Scores were calculated as pegs per second over 50 sec. This valid and reliable test is used extensively in stroke studies [25,39].

**Upper limb impairment**

The Rivermead Motor Assessment (RMA) [40]. The UL section of this assessment was selected as an impairment-orientated measure of UL motor control. Scores range from 0 to 15 with higher scores representing better performance. Reliability and validity have been established in stroke [40,41].

The revised Nottingham Sensory Assessment (NSA) [42] was used to measure UL somatosensory impairment. The test examines the domains of tactile sensation, proprioception and stereognosis and the areas tested were shoulder, elbow, wrist and hand. The UL score maximum score was 84, indicating normal sensation. Reliability and validity have been established.

**Independence in activities of daily living**

The Modified Barthel Index (MBI) [43] was used to assess independence in activities of daily living (ADL) as an indicator of disability. Scores range from 0 to 100 and higher scores indicate greater independence in ADL. Widely used in stroke...
research trials [44] the measure demonstrates good inter- and intra-rater reliability and validity in this population [45].

Mood
The Hospital Anxiety and Depression Scale (HADS) [46] is a 14-item scale which measures the symptoms of generalised anxiety (7 items) and depression (7 items) experienced over the last week, but does not provide a specific diagnosis. Summed total score ranges between 0 and 21. Correlations of $r \geq 0.2$ with the dependent variables were then entered simultaneously into regression equations with demographic and clinical variables and scores on each of the measures as potential predictor variables. Scores of $\geq 8$ on each subscale indicate mood disturbance [47].

Demographic and clinical variables
Age, gender, side of stroke, hand dominance, stroke classification [48], days to hospital discharge, and the presence of ischaemic or haemorrhagic stroke were clinical and demographic factors recorded as potential predictive variables of HRQOL.

Procedures
Potential participants were identified and screened using the medical records in the acute stroke unit by the lead researcher (J.M.). Those meeting the inclusion and exclusion criteria were offered study information and informed consent was obtained. Demographic and clinical data from consenting participants were collected before admission to the trial [31]. Participants were assessed using all RCT measures at baseline which was 2–4 weeks after onset of stroke, and again 6 months later by a specially trained physiotherapist. A standardised data collection approach was used and the order in which measures were delivered was also standardised. Physical measures were collected by observation of performance as per published protocols, and questionnaire data were collected by face-to-face interview. All assessment sessions at six months were conducted in participants’ homes and the session lasted approximately 1 hour.

Statistical analysis
Data were checked for missing values and if this was more than 5%, missing data were imputed using estimated maximisation [49]. Approximation to normality was assessed, and data transformation using square root or logarithmic transformation was performed if skewness was apparent ($z$ scores $> 3.30$, $p < 0.0005$) [49,50].

NHP total score and NHP sub-domain scores at 18 weeks were the dependent variables for use in multiple linear regression equations with demographic and clinical variables and scores on each of the measures as potential predictor variables. Bivariate correlations between potential predictor variables and NHP total score and sub-domains were examined using Spearman's rho or Pearson's $r$ as appropriate. Variables demonstrating significant correlations of $r \geq 0.2$ with the dependent variables were then entered simultaneously into regression equations. Next, potential predictor variables were examined for collinearity. Independent variables demonstrating correlations of $> 0.70$ with other independent variables were removed from the equation [49] and the regression was run again. Variance inflation factor and tolerance statistics were checked for acceptability [50]. Mahalanobis distances were examined and multivariate outliers were removed where present in each equation [49,50]. Linearity and homoscedasticity of the residuals were examined using scatterplots of predicted standardized residual scores plotted against standardized residual scores to ensure that assumptions for regression were met [49]. All data were analysed using SPSS version 11.5 (Norusis 1993).

Results

Data screening
There were missing data on six variables, accounting for less than 1.2% of data, but for each variable the missing data related to the same case. That case was removed from the dataset [49]. The mean Modified Barthel Index and NHP scores at 6 months and all mean Nine Hole Peg Test and Nottingham Sensory Assessment outcome scores showed positive skewness, with $z$ scores $> 3.30$, $p < 0.0005$. Data were transformed to approximate normality using square root.

Participants
In total, 106 participants were recruited to the RCT. Eighty-five of those participants, 49 men and 36 women, with a mean age 67.5 (SD $\pm 11.4$) years, who had completed the original trial, were assessed at 6 months after stroke onset. A total of 43 participants presented with right hemiplegia, 42 with left hemiplegia (Table I). (For a detailed account of the clinical trial methods, findings, participant progress through the original trial and reasons for drop-out consult Morris et al. [31].

Clinical and demographic characteristics are presented in Table I. Scores for each measure at 6 months after stroke onset are presented in Table II. NHP score was 108.5 $\pm 102.8$ with up to 86% of participants reporting some HRQOL related problem.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Frequency/mean (SD)</th>
<th>Median (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>85</td>
<td>–</td>
</tr>
<tr>
<td>Gender M/F</td>
<td>49/36</td>
<td>–</td>
</tr>
<tr>
<td>Age</td>
<td>67.6 (11.4)</td>
<td>69 (36,88)</td>
</tr>
<tr>
<td>Side of hemiplegia R/L</td>
<td>43/42</td>
<td>–</td>
</tr>
<tr>
<td>Handedness R/L</td>
<td>78/7</td>
<td>–</td>
</tr>
<tr>
<td>Dominant side affected Y/N</td>
<td>42/43</td>
<td>–</td>
</tr>
<tr>
<td>Type of Stroke</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TACS</td>
<td>4</td>
<td>–</td>
</tr>
<tr>
<td>PACS</td>
<td>45</td>
<td>–</td>
</tr>
<tr>
<td>LACS</td>
<td>34</td>
<td>–</td>
</tr>
<tr>
<td>POCS</td>
<td>2</td>
<td>–</td>
</tr>
<tr>
<td>Days to hospital discharge</td>
<td>79.7 (59.7)</td>
<td>66.5 (3, 284)</td>
</tr>
</tbody>
</table>

Ischaemic/haemorrhagic stroke

<p>| | |</p>
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</table>
| TACS, total anterior circulation stroke; PACS, partial anterior circulation stroke; LACS, lacunar stroke; POCS, posterior circulation stroke.

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Disability & Rehabilitation

Correlations show that having an affected right side was associated with greater emotion reactions and social isolation (p < 0.05). In addition being older, female and being in hospital longer was associated with reduced physical activity (p < 0.05).

**Upper limb measures**

UL impairment (RMA) and activity limitation were negatively associated with Physical Activity and total NHP score (p < 0.05) indicating that greater UL dysfunction was associated with poorer HRQOL. UL proprioception was also negatively associated with Physical Activity (p < 0.05). The 9HPT, the measure of UL dexterity was not significantly associated with any of the NHP domains.

**HADS anxiety and depression**

Higher Anxiety and Depression scores were significantly associated with higher total NHP scores (p < 0.001). Anxiety was significantly associated with all of the NHP domains with strongest correlation between Anxiety and Emotional Reactions (p < 0.001) indicating that higher levels of anxiety was associated with poorer HRQOL in that domain (Table III). Depression was also significantly associated with all of the NHP domains (Table III) and was also most strongly correlated with Emotional Reactions (p < 0.001).

**MBI activities of daily living**

Independence in activities of daily living was negatively associated with total NHP score and Physical Activity (p < 0.001) and with Energy Level, Sleep and Social Isolation (p < 0.05), indicating that poorer independence in activities of daily living was associated with lower HRQOL.

**Multivariate analysis**

The predictor variables with significant correlations of r ≥ 0.2 with the NHP total and sub-domain scores were next entered simultaneously into regression equations as independent variables [49], with the NHP and NHP sub-domains as the dependent variables. These are shown in Table IV. The ARAT and the RMA demonstrated high collinearity (r = 0.88) [50]. The ARAT demonstrated lower correlation with the NHP total score (r = −0.25) and Physical Activity score (r = −0.39) compared to the RMA (r = −0.30 and r = −0.47, respectively) (Table III) and was therefore excluded from the regression equations. Mahalanobis distances indicated three multivariate outliers with p > 0.001(df = 8; X² > 26.13). These outliers were removed from the analysis and no further outliers were found. The regression analysis was run again. Tolerance and variance inflation factors were within acceptable limits for all equations [50]. Scatterplots of predicted standardized residual scores plotted against standardized residual scores were examined and showed that assumptions for regression were met.

### Clinical and demographic factors

Gender and hand dominance were negatively correlated with total NHP score indicating that being female having the dominant hand being affected by the stroke experienced lower HRQOL (p < 0.05). However, for NHP sub-domains, correlations show that having an affected right side was associated with greater emotion reactions and social isolation (p < 0.05). In addition being older, female and being in hospital longer was associated with reduced physical activity (p < 0.05).

### Predictors of NHP scores

#### Total NHP score

49% of variance in total NHP score was predicted (adjusted \( R^2 = 0.49; F_{6, 74} = 13.9; p < 0.001 \)). Anxiety significantly

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**Table II.** Scores on independent variables and potential predictor variable at 6 months: mean (SD); median (range) (n = 106).

<table>
<thead>
<tr>
<th>Measure</th>
<th>Mean (SD)</th>
<th>Median (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality of Life: NHP Total (Max = 600)</td>
<td>108.5 (102.8)</td>
<td>81.0 (0.0, 432.2)</td>
</tr>
<tr>
<td>Quality of Life: NHP Domains (Max = 100)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy levels</td>
<td>24.5 (31.2)</td>
<td>0.0 (0.0, 100.0)</td>
</tr>
<tr>
<td>Pain</td>
<td>10.9 (16.7)</td>
<td>0.0 (0.0, 94.2)</td>
</tr>
<tr>
<td>Emotional reactions</td>
<td>12.4 (22.9)</td>
<td>0.0 (0.0, 100.0)</td>
</tr>
<tr>
<td>Sleep</td>
<td>17.8 (25.5)</td>
<td>12.6 (0.0, 100.0)</td>
</tr>
<tr>
<td>Social isolation</td>
<td>12.5 (19.2)</td>
<td>0.0 (0.0, 79.9)</td>
</tr>
<tr>
<td>Physical activities (max = 100)</td>
<td>30.7 (22.1)</td>
<td>24.6 (0, 78.7)</td>
</tr>
<tr>
<td>UL activity limitation: ARAT (max = 57)</td>
<td>32.9 (28.9)</td>
<td>36 (0, 57)</td>
</tr>
<tr>
<td>UL impairment: RMA (max = 15)</td>
<td>6.6 (4.1)</td>
<td>8 (0, 15)</td>
</tr>
<tr>
<td>Dexterity: 9HPT Pegs/s</td>
<td>0.15 (0.17)</td>
<td>0.10 (0.00, 0.63)</td>
</tr>
<tr>
<td>Proprioception (max = 12)</td>
<td>9.1 (3.6)</td>
<td>10 (0, 12)</td>
</tr>
<tr>
<td>Tactile sensation (max = 52)</td>
<td>44.9 (8.3)</td>
<td>10 (0, 12)</td>
</tr>
<tr>
<td>Stereognosis (max = 20)</td>
<td>15.4 (6.0)</td>
<td>18 (0, 20)</td>
</tr>
<tr>
<td>ADL: Modified Barthel Index (Max = 100)</td>
<td>85.9 (18.7)</td>
<td>92 (15, 100)</td>
</tr>
<tr>
<td>Hospital anxiety and depression scale</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anxiety score</td>
<td>5.2 (4.1)</td>
<td>4 (0, 17)</td>
</tr>
<tr>
<td>% with anxiety score ≤8/8</td>
<td>60/25 (29)</td>
<td>–</td>
</tr>
<tr>
<td>Depression score</td>
<td>5.0 (3.5)</td>
<td>4 (0, 17)</td>
</tr>
<tr>
<td>% With depression score ≤8/8</td>
<td>65/20 (25)</td>
<td>–</td>
</tr>
</tbody>
</table>

NHP, Nottingham Health Profile; ARAT, Action Research Arm Test; RMA, Rivermead Motor Assessment; 9HPT, Nine Hole peg Test; ADL, activities of daily living.

82 participants (96.5%) had UL impairment measured on the RMA, 66 (88%) had some activity limitation measured on the ARAT and 63 (75%) could not complete the 9HPT by placing 9 pegs in 50 sec. Twenty-five participants (29%) demonstrated scores ≥8 on the anxiety subscale of the HADS and 20 (24%) demonstrated depression scores ≥8, on the depression subscale, indicating mood disturbance. Of the participants reporting symptoms of depression, 15 of those (60%) also reported feelings of anxiety leaving 10 (12%) of the total cohort of participants reporting anxiety only and 5 (6%) reporting depression only.

### Bivariate analysis

Correlations between potential independent variables and NHP total score, and its sub-domains were first examined (Table III). Significant correlations are described below:

#### Gender and hand dominance

Gender was negatively correlated with total NHP score indicating that being female having the dominant hand being affected by the stroke experienced lower HRQOL (p < 0.05). However, for NHP sub-domains,
predicted total NHP score at 6 months (β = 0.38; p < 0.001) as did Depression (β = 0.27; p = 0.01). UL impairment did not predict overall HRQOL.

**Energy**
30% of the variance in Energy Levels at 6 months was explained (adjusted $R^2 = 0.30; F_{2,28} = 12.56; p < 0.001$), with Anxiety (β = 0.37; p < 0.001) and Depression (β = 0.25; p < 0.001) as significant predictors.

**Pain**
13% of the variance in Pain was predicted (adjusted $R^2 = 0.13; F_{2,28} = 6.28; p = 0.002$) with Anxiety as the only significant predictor (β = 0.34; p < 0.01).

**Emotional reactions**
41% of the variance in Emotional Reactions was explained (adjusted $R^2 = 0.50; F_{4,76} = 20.86; p < 0.001$), with Anxiety as the only significant predictor (β = 0.50; p < 0.001).

**Sleep**
19% of variance in Sleep was predicted (adjusted $R^2 = 0.19; F_{3,50} = 7.38; p < 0.001$), with Anxiety the only significant predictor (β = 0.26; p = 0.02).

**Social isolation**
23% of the variance in Social Isolation was predicted (adjusted $R^2 = 0.22; F_{5,75} = 5.64; p < 0.001$) with Anxiety as the only significant predictor (β = 0.30; p = 0.02).
Physical activity

36% of the variance in Physical Activity was predicted (adjusted $R^2 = 0.36$; $F_{7,71} = 7.88$; $p < 0.001$). UL motor impairment on the RMA ($β = -0.33$; $p < 0.001$), and activities of daily living measured on the MBI ($β = -0.26$; $p < 0.001$) were the significant predictors of physical activity.

Discussion

The main finding of this study was that anxiety was the strongest predictor of overall HRQOL in 85 participants with persistent arm dysfunction six months after stroke. Anxiety was associated with lower HRQOL across all domains, and was predictive of pain, emotional reactions, sleep and social isolation, whilst anxiety and depression together significantly predicted energy levels. Greater UL motor impairment and lower independence in activities of daily living predicted poorer perceived physical activity. Although UL impairment and independence in activities of daily living were significantly associated with overall HRQOL they were not significant predictors.

Depression, anxiety and HRQOL

The prevalence of anxiety and depression in our study is in line with that found in other studies [51], suggesting that the sample was fairly typical of the general stroke population. The impact of anxiety on HRQOL after stroke has been studied less frequently than the impact of depression [29,52]. Where it is present however, anxiety appears more stable and persistent than depression [27–29], particularly when it is present early after stroke [29,52]. It also influences recovery from stroke [53] and therefore its impact on HRQOL is likely to be significant. The persistence and stability of anxiety may explain why at 6 months in our study, anxiety and not depression was the main predictor of HRQOL.

Anxiety and depression are linked as dimensions of negative affect [52], but evidence suggests that after stroke they are distinct constructs [54]. In line with that evidence, we also found that the constructs of anxiety and depression were correlated ($r = 0.62$), but not so strongly that removal of one from the model was warranted [49,50] thus justifying our inclusion of both as separate constructs in regression models. Other cross-sectional studies demonstrate that anxiety and depression [18,55] or anxiety alone [16,52] predict HRQOL. Depression has been found to predict HRQOL between 6 months and 4 years after stroke in many studies [7–15,56–58]. However most studies in which depression or anxiety was a significant predictor of HRQOL measured only depression or anxiety whereas in the present study it was possible to examine the relative importance of anxiety and depression. The existing consensus that depression is one of the strongest predictors of HRQOL after stroke should therefore be viewed with some caution, especially where anxiety has not also been considered. We found that anxiety was the more important predictor of overall HRQOL than depression, even though 60% of participants with depression demonstrated co-morbidity with anxiety.

Of the NHP sub-domains, depression was only a significant predictor of energy level. Post-stroke fatigue is a construct broadly aligned with the energy level domain of the NHP, and is experienced by between 30 and 68% of survivors [59]. Other studies specifically examining fatigue have demonstrated that depression and fatigue are linked [59,60], however there is also evidence that post-stroke fatigue can be experienced by patients who are not depressed [60], therefore assumptions cannot not be made that fatigue is always symptomatic of depression in this population. Although we observed that anxiety also predicted energy level, the relationship between anxiety and fatigue is less clear, with another study demonstrating no link between these constructs [61]. Differences in definitions of energy and fatigue in the studies may explain the discrepancy in findings for both anxiety and depression between our study and others. Further exploration of the links between energy or fatigue as a construct of HRQOL and anxiety and depression is clearly required.

Higher anxiety was also predictive of social isolation, a finding noted in other studies [62], indicating that the two are inter-related and suggesting that anxiety may have a significant role in life participation after stroke. The predictive strength of anxiety was however particularly high for emotional reactions, with 50% of variance predicted mainly by anxiety. Emotional reactions and anxiety are clearly linked constructs, and it is not clear that the two selected measures are in fact examining distinct constructs. Autocorrelation between measures of mood and of HRQOL have been previously reported [30], raising the question of how HRQOL differs as a theoretical construct distinct from mood. The relatively strong correlation between the HADS anxiety and NHP emotional reactions scores ($r = 0.67$) in the present study tends to confirm that the two may not be distinct constructs, and suggests a statistical explanation for the finding.

The impact of upper limb dysfunction on HRQOL

UL impairment predicted perceived physical HRQOL, a finding congruent with other studies [19,20]. We considered it useful to try to distinguish the impact on HRQOL of the UL constructs of impairment and activity limitation since therapeutic interventions targeting each may vary in nature [63]. However, high collinearity between the activity limitation measure, the Action Research Arm Test and the Rivermead Motor Assessment Scale, indicated the removal of the ARAT score from the analysis. Strong association between UL activity limitation and impairment has been previously demonstrated [64] and illustrates that these are closely linked constructs. Discriminating these constructs as we had planned to do, may therefore be artificial in relation to real-life use of the affected arm.

Upper limb impairment predicted more variance in the physical activities sub-domain of the NHP than did independence in ADL. Many studies show ADL independence as predictive of HRQOL [3,7,15,17] but unlike the present study, those studies did not also include UL measures as predictors. Where UL functioning is included it may be of greater importance in determining aspects of HRQOL than overall ADL functioning at six months possibly because of the role of upper limb function in completing many basic functional tasks.
Being female was also associated with poorer perceived physical activity, another finding that is congruent with previous studies [65,66]. Poorer perceived physical outcomes in women compared to men may be explained by older age and lower pre-stroke physical functioning. In the present study women were on average 3 years older than men, which may have partly influenced findings.

Dominant side hemiplegia was significantly associated with, but did not predict poorer emotional reactions, social isolation and overall HRQOL. Only seven participants were left-handed, thus most participants with dominant side hemiplegia were right handed with left hemisphere stroke. The left hemisphere controls speech and language function therefore dominant stroke may have had a detrimental effect on social isolation through altered communication ability [67]. The relationship between emotional distress and having the dominant UL affected although not strong \((r = –0.28)\), was also significant, a finding that has been previously attributed again to altered communication during the first 6 months after stroke [68]. These findings are in line with another study that demonstrated a relationship between concordance, (where the paretic hand is the dominant hand) and poorer communication [19]. Although we did not specifically examine communication, we screened participants for ability to provide informed consent and some participants did have communication disorders, which may have influenced social isolation. The finding again demonstrates the impact that stroke has on survivors’ ability to participate fully in life roles.

**Study limitations**

The NHP, a generic HRQOL measure, was selected as the measure of HRQOL because at the time of study design its psychometric properties in stroke were known and there were few stroke specific measures with adequate psychometric properties [35]. Several stroke specific factors included in more recently developed measures, that may influence HRQOL such as communication, cognition and specific stroke related motor impairments were not examined by the NHP. Their exclusion may thus have influenced our findings, and thus indicate future avenues of exploration.

The variables we included explained 49% of variance in total HRQOL score, thus a considerable proportion of the variance of HRQOL was not explained. Because the study was primarily an exploration of physical effects of an UL training intervention, variables relating to social and economic status, marital status, education, race, comorbidities, self-efficacy, memory and cognitive functioning were not included in the model. These factors have been shown to explain some of the variance in HRQOL in other studies [3,7,9,12,13,15,18,21] and inclusion of these factors would have provided a more complete picture of determinants of HRQOL. Future studies should include a wider range of socio-demographic factors when determining predictors of HRQOL.

The study was conducted with a stroke population specifically selected for inclusion in an upper limb trial and may not represent the general stroke population. The study should be replicated with a general stroke population.

**Conclusions**

This study demonstrated that, in a population of people with UL impairment after stroke, anxiety was the most important predictor of overall HRQOL at 6 months after stroke. The present findings show that anxiety adversely influences many aspects of participants’ post-stroke quality of life and suggest that health professionals need to be aware of the impact of anxiety on stroke survivors. Whilst strategies and guidelines are in place in the UK to manage depression and emotional lability after stroke, anxiety is typically less well recognized or managed in the context of rehabilitation [69]. Management strategies, including early detection of anxiety and use of anxiolytics or behaviourally orientated interventions should be considered as a priority to help patients to deal with their anxiety and to avoid it becoming chronic, and interventions should be developed and tested to evaluate their effectiveness [52]. Upper limb impairment was an important predictor of perceived physical activities, suggesting that therapeutic management of UL impairment with physiotherapy and occupational therapy should continue into the chronic post-stroke period, since improved recovery is likely to improve that aspect of HRQOL.

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