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Development and Psychometric Evaluation of the Trinity Amputation and Prosthesis Experience Scales (TAPES)

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ABSTRACT. ***Objective:*** To develop a multidimensional self-report instrument to better understand the experience of amputation and adjustment to a lower limb prosthesis. ***Design:*** One hundred four participants completed a mail questionnaire consisting of 3 sections: psychosocial issues, activity restriction, and satisfaction with a prosthesis. ***Results:*** Factor analysis revealed 3 psychosocial subscales (General Adjustment, Social Adjustment, and Adjustment to Limitation), 3 activity restriction subscales (Functional Restriction, Social Restriction, and Athletic Activity Restriction), and 3 satisfaction subscales (Functional Satisfaction, Aesthetic Satisfaction, and Weight Satisfaction). The subscales displayed high internal reliability, and preliminary evidence indicated various forms of validity. ***Conclusion:*** These findings suggest that the Trinity Amputation and Prosthesis Experience Scales may be applied as a clinical and research tool.

Many challenges arise from losing a limb, most obviously the process of being fitted for and learning to use a prosthetic limb. Review of prosthetic use among those with a lower limb amputation shows that the percentage of "successful prosthetic users" varies considerably from 46% to 96% (Burger, Marincek, & Isakov, 1997; Buyk, 1988; Grise, Gauthier-Gagnon, & Martineau, 1993; Holden, 1987; Jones, Hall, & Schuld, 1993; Moore et al., 1989; Pohjolainen, Alaranta, & Karkkainen, 1990; Stewart & Jain, 1993; Uiterwijk et al., 1997).

In addition to the necessary physical adjustment, individuals must make social

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and psychological adjustments so as to deal with the multiple issues that arise as a result of a lower limb amputation and acquiring an artificial limb. Rates of clinical depression found in outpatient settings have ranged from 21% to 35% (Kashani, Frank, Kashani, Wonderlich, & Reid, 1983; Rybarcyzk et al., 1992; Schulz, 1992; Williamson, Schulz, Bridges, & Behan, 1994). Reactions of anxiety and grief among people with amputations have also been reported (Frierson & Lippmann, 1987; Grossman, 1990; Marshall, Helmes, & Deathe, 1992; Schubert, Burns, Paras, & Sioson, 1992; Shukla, Sahu, Tripathi, & Gupta, 1982). Anger, guilt, and blame of others have also been found (Bhojak & Nathawat, 1988; Butler, Turkal, & Seidl, 1992; Frierson & Lippmann, 1987; Monforton, Helmes, & Deathe, 1993; Parkes, 1972, 1976). These psychosocial problems are not simply short-term issues; clinical levels of psychological distress were reported by 30% of a sample an average of 9.7 years postamputation (Hill, Niven, Knussen, & McCreath, 1995). Burger and Marincek (1997) concluded that lower limb amputation severely changes the social life and free-time activities of those who have had an amputation. Recent research has also shown that coping strategies, social support, social discomfort, perceived social stigma, and public self-consciousness can influence adjustment to a lower limb prosthesis (Hill, Niven, & Knussen, 1995; Rybarcyzk et al., 1992; Rybarcyzk, Nyenhuis, Nicholas, Cash, & Kaiser, 1995; Schulz, 1992; Williamson, 1995; Williamson et al., 1994).

Psychosocial adjustment to wearing a lower limb prosthesis has been found to vary depending on age (Livneh, Antonak, & Gerhardt, 1999; Williamson et al., 1994). The effects of gender have also been investigated but have not been found to predict levels of psychosocial adjustment (Bradway, Malone, & Racy, 1984; Dunn, 1996; Rybarcyzk et al., 1992). Disability-related variables investigated include site and cause of amputation, activity restriction, satisfaction with prosthesis, and time since amputation. These variables not only influence prosthetic use and functional ability but may also influence psychosocial adjustment (Dunn, 1996; Gallagher & MacLachlan, 1999; Livneh et al., 1998; Racy, 1989; Rybarcyzk et al., 1995; Williamson et al., 1994).

This considerable variability in people's adjustment to lower limb amputation has resulted in a search for a method to determine level of adjustment to an artificial limb and the factors related to prosthetic use. This is important because of the variability found in rates of prosthetic use and the continuous search for factors that may be predictive of successful use. Furthermore, it would be beneficial to have an instrument that could play a role in examining other problems specific to amputation. For example, among many people with an amputation, a distressing problem is phantom limb pain, which is pain in the part of the limb that has been amputated (Sherman, 1989). Carabelli and Kellerman (1985) documented how prosthetic training was impeded and walking reduced in individuals experiencing phantom limb pain. Research has also shown how the experience of phantom limb pain can result in greater degrees of despair and withdrawal (Parkes, 1984) as well as depression (Lindesay, 1985; Williamson et al., 1994). Furthermore, pain in the amputation stump contributes to the distress of the person because the discomfort it induces can impede the use of a prosthesis.

Consequently, there is merit in developing an instrument that may be useful in examining these issues.

Overall, adjustment to an artificial limb is a multifaceted endeavor. Consequently, examining any single factor independently of others would not provide a meaningful indicator of adjustment. The aim of this research was to develop a suitable multidimensional evaluation instrument to be used to better understand adjustment to a lower limb prosthesis and to provide initial evidence of reliability and validity.

The development of such a scale is particularly important because the general disability measures used in previous studies of adjustment to artificial limbs are not sensitive to some of the peculiarities of this specific disability (e.g., Nissen & Newman, 1992). Furthermore, Grise et al. (1993) argued that a preponderance of studies have concentrated primarily on physical factors while focusing little or no attention on potential psychosocial, demographic, and disability-related factors. Conversely, those scales that have been developed specifically for people with amputations are narrowly focused, dealing with only one aspect of adjustment to a prosthetic limb. For example, the 22 items in Rybarcyzk et al.'s (1995) Perceived Social Stigma Scale were derived from an initial large pool of attributes that embodied common negative stereotypes about people with disabilities, and their aim was to assess individuals' perceptions that others hold negative attitudes about them because of the amputation. Rybarcyzk et al. (1995) also conceived the 11-item Amputation-Related Body Image Scale, which assesses body image disturbance. In an earlier study, Rybarcyzk et al. (1992) devised two 3-item scales pertaining to the aesthetic and functional aspects of prosthetic limbs. Finally, Williamson (1995) developed a scale designed solely to assess activity restriction among older people with an amputation. Patients rated the extent to which they perceived their amputation to be responsible for restricting nine areas of activity.

The Prosthetic Profile of the Amputee, devised by Grise et al. (1993), is a clinical follow-up questionnaire that measures factors potentially related to prosthetic use and the actual use of the prosthesis by people with a lower limb amputation. It elicits information about the frequency of wear and use of a lower limb prosthesis and identifies factors potentially related to prosthetic use. Although factors were identified, categorized, and prioritized by a group that included people who had lower limb amputations, there was no empirical justification for item content.

Notwithstanding the valuable contributions made by the instruments just described, it would be useful to have an instrument that incorporates more than one dimension. Also, it is desirable that both theoretical and empirical approaches be taken into account in the development of such an instrument. Above all, it is essential in research to have a tool for assessing adjustment, determining the variables related to prosthetic use, and examining the issues specific to amputation (e.g., phantom limb pain and stump pain). Thus, the major purpose of the present study was to develop a multidimensional assessment instrument for use with people who have had a lower limb amputation, one that is devised through theoretical and empirical methods, is psychometrically sound, and is able to provide a brief but comprehensive assessment of the subjective experience of adjustment that could supplement clinical assessment and contribute to research in this area.

STUDY 1

Method

Questionnaire construction. As a means of avoiding false or irrelevant structures and ensuring the full range of possible responses, questionnaire content and subsequent item selection were developed through three processes: a review of the literature and existing measures, expert opinion (clinical and research psychologists, prosthetists, and rehabilitation and orthopedic consultants), and focus groups involving people who have had a lower limb amputation to identify what they considered to be the important factors in adjusting to lower limb amputation and wearing a prosthetic limb. Thematic content analysis of the focus groups revealed that factors such as their perceptions and acceptance of their amputation and related image, social, medical, and practical concerns were important in the adjustment and rehabilitation process (Gallagher & MacLachlan, 2000). These insights were used to develop question themes and wordings.

All of the questions were subsequently worded in simple, unambiguous, and familiar terms and grouped into logical and coherent sections. The predominant form of response was closed-ended questions. The questionnaire was then pretested with five members of the target group. Respondents completed the questionnaire as if they were part of the mail survey. As a means of limiting completion and comprehension difficulties, modifications were subsequently made to the questionnaire, including changing the formulation and presentation of some of the questions and response choices.

Questionnaire. There were three main sections in the Trinity Amputation and Prosthesis Experience Scales (TAPES). The first section, focusing on psychosocial adjustment, consisted of 89 items (original items are available from the authors on request). It was designed to be the most comprehensive section and focused especially on the evaluation of adjustment and the impact of having an artificial limb on various aspects of the respondent's life. Each respondent rated individual statements on a 5-point scale ranging from *strongly agree* to *strongly disagree.*

The second section assessed activity restriction as a result of having an artificial limb. It listed 19 activities to which respondents indicated their level of restriction along a 3-point scale ranging from *limited a lot* (2) to *not limited at all* (0). The original activity restriction items are available from the authors; some of the items in this section were modeled after items from the SF-36 Health Survey (Ware, Snow, Kosinski, & Gandek, 1993).

The third section investigated prosthesis satisfaction. Respondents were asked to rate 10 different aspects of their prosthesis on a 5-point scale ranging from *very dissatisfied* (1) to *very satisfied* (5).

Procedure. Hospital charts of potential participants attending the limb fitting clinic at Cappagh Orthopaedic Hospital (Dublin, Ireland) were reviewed. To be included, participants had to be at least 18 years old and had to have had a lower limb amputation. One hundred eighty-four patients appeared to meet the study criteria. A cover letter, the questionnaire, and a stamped addressed envelope were sent to each of these patients. A short reminder card was sent 2 weeks after the initial mailing.

Sample. Fourteen people were excluded because they no longer lived at the address provided or were deceased. In all, 170 potential respondents constituted the sample, and 104 (61%) completed the questionnaire. The characteristics of the sample are outlined in Table 1. As can be seen, the sample was predominantly male, and the prevalent cause of amputation was trauma–accident. In addition, the most common type of amputation was below the knee.

Statistical analyses. The psychosocial, activity restriction, and satisfaction sections of the questionnaire were each separately factor analyzed to determine how many subscales they comprised, which items belonged to which subscales, and which items could be discarded. Whether factor analysis was an appropriate procedure to use with the data in each section was determined by the overall significance of the correlation matrix (assessed by Bartlett's test), the Kaiser–Meyer–Olkin measure of sampling adequacy, and the adequacy of the sample size.

The principal-component method of extraction, followed by a varimax rotation, was performed on each section separately. Hair, Anderson, Tatham, and Black (1995) suggested that the principal-component method should be used when the objective is to summarize most of the original information into a minimum number of factors for prediction purposes. Although there is considerable debate over whether factor or component models are more appropriate, empirical research has demonstrated similarity in the results produced in many instances (Kline, 1994; Tabachnick & Fidell, 1989). The choice of an orthogonal rotation was made on the basis of the needs of the given research problem: to reduce the number of original variables to a smaller set of uncorrelated variables for subsequent use in regression or other prediction techniques.

To determine the number of factors to represent the underlying structure in the data from each of the sections, we used eigenvalues (Guttman, 1954; Kaiser, 1961), scree cutoff points (Cattell, 1966), and percentage of variance explained as general guides to the dimensionality of the factor space. Subsequently, the interpretability of the factors indicated the exact number of factors to retain. Thus, several factor solutions with differing numbers of factors were examined before the structure was defined for each of the sections in the questionnaire.

In terms of item selection, the items that had high loadings on each factor measured the same underlying construct and so formed a subscale. Thus, once the areas measured by each section in the questionnaire were selected, the number of items was reduced to ensure brevity and to ensure that the items in the subscale

Table 1. Sample Characteristics: Study 1

Characteristic	*n*	%	*M*	*SD*	Range
Gender					
Male	78	75.0			
Female	26	25.0			
Cause of amputation					
Congenital	7	6.7			
Cancer	24	23.1			
Accident	51	49.0			
Diabetes	1	1.0			
Peripheral vascular disorder	9	8.7			
Other[a]	10	9.6			
Not specified	2	1.9			
Type of amputation					
Partial foot	4	3.8			
Below knee	50	48.1			
Through knee	4	3.8			
Above knee	34	32.7			
Hip disarticulation	6	5.8			
Bilateral	6	5.8			
Age (years)			45.3	18.9	18–84
Length of time with prosthesis			8.3	9.9	2 months–58.25 years
Daily prosthetic use (hours)			12.9	3.88	0–19

[a] Other causes include polio, infection of the bones, tuberculosis, osteomyelitis, secondary Raynard's disease, and ulcers.

were the ones most strongly associated with the underlying attribute. Items that failed to load on a factor were discarded. The specific requirements for item selection in each section are described subsequently.

After the subscales for each separate section of the questionnaire had been factor analytically derived, their internal reliability was assessed via Cronbach's alpha (Cronbach, 1951). Face validity, content validity, and predictive validity were subsequently assessed.

Results

Satisfaction with prosthesis. For the 10 items making up the satisfaction scale, Bartlett's test of the correlation matrix was significant at the $p < .0001$ level. The Kaiser–Meyer–Olkin measure of sampling adequacy was .778. In addition, the mean sampling adequacy of each individual item was greater than .7. Finally, with regard to the adequacy of the sample size, there was a 10:1 ratio of observations to variables, which falls into acceptable limits (Nunnally, 1978). Also, the sample size of 100 provided an adequate basis for calculation of correlations between variables. These statistics confirm that factor analysis was an appropriate procedure to use with the data from this section of the questionnaire.

As mentioned earlier, the principal-component method of extraction and varimax rotation were performed on the data. It was determined that a three-factor solution accounting for 69.1% of the variance was not only adequate but also optimal on the basis of scree curve analysis, eigenvalues, variance accounted for, and meaningful interpretation. Table 2 presents the factor loadings for the 10 items. Items with loadings greater than .55 were selected. According to Hair et al. (1995), .55 is a significant factor loading for a sample size of more than 100.

Results from the factor analyses led to the creation of three subscales from the 10 items. The first factor, Functional Satisfaction, accounting for 30.1% of the variance, deals with those aspects of the prosthetic limb that allow it to be functional. For example, the items with the highest loadings included satisfaction with the reliability and the fit of the prosthesis.

The second factor, Aesthetic Satisfaction, accounting for 25.3% of the variance, can be interpreted as satisfaction with the aesthetic characteristics of the artificial limb. Here the highest loading variables included satisfaction with the color, shape, noise, and general appearance of the artificial limb.

The final factor, Weight Satisfaction, accounted for 13.7% of the variance. A single item loaded highly on this factor: the weight of the artificial limb.

Table 2. Factor Analysis of Satisfaction Scale

Item	Factor 1: Functional (30.1% of variance)	Factor 2: Aesthetic (25.3% of variance)	Factor 3: Weight (13.7% of variance)
Reliability	.832		
Fit	.819		
Overall satisfaction	.792		
Comfort	.666		
Usefulness	.630		
Appearance		.887	
Shape		.832	
Color		.787	
Noise		.566	
Weight			.917
M (*SD*)	18.26 (4.23)	14.57 (3.28)	3.60 (1.13)
Potential range	5–25	5–20	1–5
Observed range	6–25	7–20	1–5

As is evident from Table 3, each of the subscales exceeded the minimum desired level of internal reliability. Furthermore, the intercorrelations among the factors were relatively low, indicating the relative independence of each factor.

The descriptive data for the satisfaction subscale scores are also summarized in Table 2. Although each of the subscales had wide ranges of responses varying from unsatisfied to completely satisfied, the mean response for each indicated an overall level of satisfaction with the functional, aesthetic, and weight aspects of the artificial limb.

Activity restriction. In regard to activity restriction, the correlation matrix, assessed with the Bartlett test, was significant at the $p < .0001$ level. The Kaiser–Meyer–Olkin measure of sampling adequacy was .891. In addition, the mean sampling adequacy for each individual item was above .77. Finally, in terms of the adequacy of the sample size, there was a 5:1 ratio of observations to variables, which falls into acceptable limits. Also, the sample size of 100 provided an adequate basis for calculation of correlations between variables. These results indicate that factor analysis was an appropriate procedure to use with the data from this section of the questionnaire.

Again, the principal-component method of extraction and varimax rotation were performed on the data. It was determined that a three-factor solution accounting for 70.6% of the variance and incorporating 12 of the original 19 items was most suitable on the basis of scree curve analysis, eigenvalues, variance accounted for, and meaningful interpretation. Items with factor loadings above .55 were retained (see Table 4).

The first factor, Functional Restriction, accounted for 25.1% of the variance. This factor deals with restrictions in the activities that allow a person to be functional. The mobility involved is rather sedentary and enables the person to undertake simple but rudimentary tasks. For example, the items "Walking half a mile," "Walking 100 yards," and "Climbing one flight of stairs" had the highest loadings.

The second factor, Social Restriction, accounting for 23.7% of the variance, can be interpreted as restriction in social activities. Here the highest loading variables included maintaining friendships and visiting friends. The other variables, working on hobbies and going to work, also referenced activities characterized by social aspects.

The final factor, Athletic Activity Restriction, accounting for 21.8% of the variance, refers to restriction in activities that require added physical effort and

Table 3. Internal Reliability and Intercorrelations of Satisfaction Subscales

Subscale	1	2	3
1. Functional	—		
2. Aesthetic	.405	—	
3. Weight	.298	.233	—
Internal reliability (Cronbach's α)	.854	.777	

Table 4. Factor Analysis of Activity Restriction Scale

Item	Factor 1: Functional Restriction (25.1% of variance)	Factor 2: Social Restriction (23.7% of variance)	Factor 3: Athletic Activity Restriction (21.8% of variance)
Walking half a mile	.813		
Walking 100 yards	.813		
Climbing one flight of stairs	.809		
Walking more than a mile	.650		
Maintaining friendships		.849	
Visiting friends		.832	
Working on hobbies		.773	
Going to work		.661	
Vigorous activities			.830
Running for a bus			.796
Sport and recreation			.634
Climbing flights of stairs			.555
M (*SD*)	3.26 (2.66)	1.66 (2.04)	5.75 (2.02)
Potential range	0–8	0–8	0–8
Observed range	0–8	0–8	0–8

ability. Vigorous activities such as running, lifting heavy objects, and participating in strenuous sports had the highest loading. The other variables, running for a bus, sport and recreation, and climbing several flights of stairs, also incorporated the aspect of athletic activity.

As is evident in Table 5, each of the subscales exceeded the minimum desired level of internal reliability. In addition, the intercorrelations among the factors

Table 5. Internal Reliability and Intercorrelations of Activity Restriction Subscales

Subscale	1	2	3
1. Functional	—		
2. Social	.530	—	
3. Athletic	.630	.465	—
Internal reliability (Cronbach's α)	.865	.838	.763

indicate, as would be expected, that there is some relationship between the different types of restriction experienced.

The descriptive data for the restriction subscales are summarized in Table 4. For each subscale, there was a wide range of responses varying from complete restriction to no experience of restriction. The means from the overall sample demonstrate that the greatest level of restriction occurred with athletic activities and that social activities were associated with the least restriction.

Psychosocial adjustment. The principal-component method of extraction with varimax rotation was performed on the 89 items in the psychosocial adjustment section of the questionnaire. The Kaiser–Meyer–Olkin measure of sampling adequacy (.5) fell into the unacceptable range. Consequently, the mean sampling adequacy for each individual variable was examined. As suggested by Hair et al. (1995), the lowest values were omitted and the factor model respecified to investigate whether the reduced set of variables exceeded the minimum measure of sampling adequacy required. Thus, 6 items whose individual measures of sampling adequacies did not meet the specified requirements (i.e., were less than .5) were removed, and the factor model was respecified. This reduced set of variables met the criteria necessary to indicate that factor-analytic techniques were appropriate for the data. The correlation matrix, assessed with Bartlett's test, was significant at the $p < .0001$ level, and the Kaiser–Meyer–Olkin measure of sampling adequacy was a satisfactory .69.

The sample size met the minimum requirement of 100. Although there was not a high ratio of cases to variables (as advocated by Nunnally, 1978), more recent studies, such as those of Barrett and Kline (1981) and Guadagnoli and Velicer (1988), show that as long as there are more participants than variables, the ratio of participants to variables is not as important as absolute sample size and the sizes of factor loadings. Furthermore, if components possess four or more variables with loadings above .6, the pattern may be interpreted whatever the sample size used. Consequently, the criterion for retention was that an item load .6 on one factor (in keeping with the criteria laid down by Guadagnoli & Velicer, 1988) so that the solution was interpretable irrespective of its sample size. In addition, a difference in loadings between factors of at least .25 was advocated to ensure a parsimonious solution. Factor analysis results led to the development of three composite scales consisting of 15 of the original 89 items and accounting for 67.0% of the variance (see Table 6).

The first factor, General Adjustment, accounting for 23.6% of variance, refers to successful adjustment to and acceptance of the artificial limb. The two items loading most heavily on this factor, "I have adjusted to having an artificial limb" and "As time goes by, I accept my artificial limb more," directly incorporated these sentiments. Furthermore, the remaining items reflected adjustment to wearing the artificial limb: "I have gotten used to wearing my artificial limb;" "Although I have an artificial limb, my life is full;" and "I feel that I have dealt successfully with this trauma in my life."

The second factor, Social Adjustment, accounting for 22.1% of variance, refers

Table 6. Factor Analysis of Psychosocial Adjustment Scale

Item	Factor 1: General (23.6% of variance)	Factor 2: Social (22.1% of variance)	Factor 3: Limitation (21.3% of variance)
I have adjusted to having an artificial limb	.849		
As time goes by, I accept my artificial limb more	.835		
I feel that I have dealt successfully with this trauma in my life	.783		
Although I have an artificial limb, my life is full	.778		
I have gotten used to wearing my artificial limb	.687		
I don't care if somebody looks at my artificial limb		.852	
I find it easy to talk about my artificial limb		.806	
I don't mind people asking about my artificial limb		.803	
I have difficulty in talking about my limb loss in conversation		.773	
I don't care if somebody notices that I am limping		.610	
Having an artificial limb limits the amount of work that I can do			.803
An artificial limb interferes with the ability to do my job			.753
Being an amputee means that I can't do what I want to do			.715
Having an artificial limb limits the kind of work that I can do			.695
Having an artificial limb makes me more dependent on others than I would like			.687
M (*SD*)	18.87 (4.67)	19.5 (3.78)	13.67 (1.13)
Potential range	5–25	5–25	5–25
Observed range	5–25	7–25	5–25

to the infiltration of the artificial limb into social situations. Examples are ease of talking about one's limb and dealing with other people's reactions to it.

Finally, the third factor, Adjustment to Limitation, accounting for 21.3% of the variance, pertains to the restriction as a result of having an artificial limb. It concerns being limited in terms of the amount and kind of work performed and not being able to do what one would like to do (e.g., "Having an artificial limb makes me more dependent on others than I would like").

Each of the subscales exceeded the minimum desired level of internal consistency (see Table 7). Furthermore, the intercorrelations depicted moderate relationships among these subscales. For example, it appeared that a high level of general adjustment was associated with a high level of adjustment to limitation.

Descriptive data for the psychosocial adjustment subscales are summarized in Table 6. Similar to the previous scales, there was wide dispersion of scores on each of the subscales, indicating individual variability. However, overall there appeared to be a high level of general adjustment and social ease and a medium level of adjustment to limitation.

Validity. Each of the questionnaires and their subscales were deemed to have face validity in that they resembled what they intended to measure. Furthermore, content validity was established because the items had the intended content and reflected the full range of salient phenomena.

Perhaps the most clinically meaningful form of validity is predictive validity, because this refers to the ability to predict the nature of people's experience with an artificial limb. Preliminary evidence indicates that the derived scales may have the ability to predict prosthetic use, stump pain, and phantom limb pain.

Multiple regression was used to predict prosthetic use. A stepwise approach was used to determine the best combination of variables for predicting prosthetic use; this was considered the best method for exploratory purposes (Norusis, 1990). Variables found to correlate significantly with the dependent variable were included in the analysis.

Two subscales predicted a significant proportion of the variance (19%) in prosthetic use. The Adjustment to Limitation subscale accounted for 13% of the explained variance, $F(1, 95) = 15.0, p < .0002$. The General Adjustment subscale accounted for 6% of the explained variance, $F(2, 94) = 11.9, p < .0001$. These results suggest that patients scoring high on the General Adjustment subscale and the Adjustment to Limitation subscale wear their prosthesis for more hours on average per day than those who score low on these scales. Not included were the restriction subscales and the Social Adjustment subscale.

Table 7. Internal Reliability and Intercorrelations of Psychosocial Adjustment Subscales

Subscale	1	2	3
1. General	—		
2. Social	.460	—	
3. Limitation	.545	.391	—
Internal reliability (Cronbach's α)	.886	.862	.833

Before it was possible to accept these regression results as valid, it was important to examine the degree of multicollinearity and its effect on the results. Examination of the condition indexes, the decomposition of the coefficient variance, the variance inflation factor, and tolerance values indicated inconsequential collinearity.

Logistic regression was used to predict the probability of a respondent experiencing phantom limb pain and stump pain. Only those variables found to be correlated with the dependent variable were included in the analysis.

Logistic regression revealed that the Adjustment to Limitation subscale significantly discriminates respondents who experience stump pain from those who do not ($p < .01$). For a respondent who was experiencing stump pain, the odds of having a low score on the Adjustment to Limitation subscale were 1.76 times as large as those for a respondent not experiencing such pain. Overall, this model correctly identified 59% of the cases. Thus, low scores on the Adjustment to Limitation subscale are associated with the experience of stump pain. Experience of other medical problems was excluded from the regression equation because it failed to significantly discriminate between those who did and did not experience stump pain.

The Adjustment to Limitation and Aesthetic Satisfaction subscales significantly discriminated those who experienced phantom limb pain from those who did not ($p < .005$). The odds of having a low score on the Adjustment to Limitation subscale were 1.8 times as large among respondents who were experiencing phantom limb pain as among those who were not. Furthermore, the odds of having a high score on the Aesthetic Satisfaction subscale were 1.8 times as large among those experiencing phantom limb pain as among those who were not. Overall, a model incorporating these two variables correctly identified 83% of cases. Low scores on the Adjustment to Limitation subscale and high scores on the Aesthetic Satisfaction subscale were associated with the experience of phantom limb pain. Gender, age, and the experience of other medical problems were dropped from the equation because they did not significantly discriminate between those who did and did not experience phantom limb pain.

STUDY 2

Method

Construct validity was established by sending the revised TAPES along with the measure of validity to 166 people who had lower limb amputations, were more than 18 years of age, and were attending the limb fitting clinic at Cappagh Orthopaedic Hospital. The questionnaire, cover letter, and a stamped addressed envelope were sent to each patient.

Sample. Sixty people (36% response rate) participated in Study 2, designed to test the validity of the TAPES. There were 41 men and 19 women. The characteristics of the sample are summarized in Table 8. As is evident from Table

Table 8. Sample Characteristics: Study 2

Characteristic	*n*	%	*M*	*SD*	Range
Gender					
Male	41	68.3			
Female	19	31.7			
Cause of amputation					
Congenital	7	11.7			
Cancer	13	21.7			
Accident	27	45.0			
Peripheral vascular disorder	7	11.7			
Other	6	10.0			
Type of amputation					
Partial foot	2	3.3			
Below knee	29	48.3			
Through knee	3	5.0			
Above knee	20	33.3			
Hip disarticulation	4	6.7			
Bilateral	1	1.7			
Not specified	1	1.7			
Age (years)			47.1	18.6	19–84
Length of time with prosthesis (years)			10.2	9.3	2 months–47.25 years
Daily prosthetic use (hours)			13.1	3.9	0–19

8, the majority of amputations in this sample arose from accidents. The most common type of amputation was below the knee.

Validity measures. The World Health Organization Quality of Life Questionnaire (short version, or WHOQOL:BREF; WHOQOL Group, 1998) produces scores for four domains related to quality of life: physical health, psychological, social relationships, and environment. The instrument consists of 28 items rated on 5-point Likert scales. Cronbach alpha values for each of the four domain scores range from .66 to .84, demonstrating moderate to good internal consistency. Test–retest reliabilities range from .66 for physical health to .87 for environment. In addition, the domains are integral to the assessment of quality of life, indicating good content validity. The WHOQOL:BREF has been shown to discriminate between ill and healthy respondents, with significant differences apparent on all domains. The WHOQOL Group (1998) envisaged the WHOQOL:BREF to be of use in studies that require a brief assessment of quality of life and to health professionals in the assessment and evaluation of treatment efficacy.

The Impact of Event Scale (IES; Horowitz, Wilner, & Alvarez, 1979) is a self-report measure that can be anchored to any specific life event and can tap the two most commonly reported specific categories of experiences in response to stressful events: intrusion and avoidance (Zilberg, Weiss, & Horowitz, 1982). Cronbach coefficients alpha are .79 for the seven-item Intrusion subscale and .82 for the eight-item Avoidance subscale. These subscales are sensitive in that they discriminate between populations and also detect change over time (Zilberg et al., 1982). Because amputation of a limb is often experienced as a traumatic event, it was assumed that higher intrusive and avoidant scores on the IES would be negatively correlated with the General Adjustment, Social Adjustment, and Adjustment to Limitation subscales of the TAPES.

The Trait Meta Mood Scale (TMMS; Salovey, Mayer, Goldman, Turvey, & Palfai, 1995) is a measure of individual differences in the ability to reflect on and manage one's emotions. It indexes the degree of attention that individuals devote to their feelings, the clarity of their experience of these feelings, and their beliefs about terminating negative mood states or prolonging positive ones. Items in the clarity of emotional perception domain refer to the ability to understand one's mood. Attention to emotions conveys the degree to which individuals notice and think about their feelings. Mood repair is concerned with attempts to counteract unpleasant moods or maintain pleasant ones. Internal consistency, measured via Cronbach's alpha, was high for each scale (Attention: .86; Clarity, .88; and Repair, .82). The TMMS demonstrates good convergent and discriminant validity. Clarity and Repair were found to be negatively associated with adjustment (e.g., distress; Salovey et al., 1995). Salovey et al. (1995) also hypothesized that individuals who reported greater clarity in discriminating mood and who considered negative mood to be repairable would have fewer negative thoughts in general and report more positive thoughts. They demonstrated the importance of clarity in buffering the impact of a stressful event on subsequent mood and quality of thought. Consequently, it was hypothesized that individuals who reported greater clarity of feelings and greater repair would display higher levels of general, social, and limitation adjustment.

Results

There was a significant correlation between respondents' scores on the Psychological scale of the WHOQOL:BREF and general adjustment ($r = .733, p < .0001$) as measured by the TAPES. The Social Relationships scale of the WHOQOL: BREF was strongly correlated ($r = .709, p < .0001$) with the Social Adjustment subscale of the TAPES, and it was correlated to a lesser extent with the Social Restriction subscale ($r = -.356$, $p < .01$). There was no correlation with either the Athletic Activity Restriction or Functional Restriction subscale. The Physical Health scale of the WHOQOL:BREF was strongly correlated ($r = .624, p < .0001$) with the Adjustment to Limitation subscale of the TAPES. There were also strong correlations between the Physical Health scale and the Functional Restriction ($r = -.601$, $p < .0001$), Athletic Activity Restriction ($r = -.634$, $p < .0001$), and Social Restriction ($r = -.618$, $p < .0001$) subscales. Negative correlations were expected with the activity restriction subscales because a high score on each of these subscales is associated with a low score on the Physical Health scale of the WHOQOL:BREF.

A relationship was found between the Social Relationship scale of the WHOQOL:BREF and both the Functional Satisfaction ($r = .402$, $p < .002$) and Aesthetic Satisfaction ($r = .392$, $p < .003$) subscales. This indicated that a more favorable rating of the functional and aesthetic aspects of the artificial limb was associated with better social adjustment.

It was found, as hypothesized, that high levels of intrusion and avoidance on the IES were negatively associated with General Adjustment ($r = -.623, p < .001$, and $r = -.455, p < .001$, respectively), Social Adjustment ($r = -.265, p < .05$, and $r = -.462$, $p < .001$), and Adjustment to Limitation ($r = -.372$, $p < .01$, and $r = -.266$, $p < .05$) scores. However, there was no significant relationship with activity restriction or satisfaction with the prosthesis.

As hypothesised, there was a significant and positive correlation between the Clarity of Feelings subscale of the TMMS and the General Adjustment ($r = .409$, $p < .005$), Social Adjustment (.560, $p < .0001$) and Adjustment to Limitation ($r = .493$, $p < .001$) subscales of the TAPES. There was also a significant and positive correlation between the Repair subscale of the TMMS and the General Adjustment ($r = .547, p < .0001$), Social Adjustment ($r = .578, p < .0001$), and Adjustment to Limitation ($r = .337, p < .01$) subscales.

It was hypothesized that individuals who wore their prosthesis for a longer period of time during the day would be less restricted in social, functional, and athletic activities. This was found to be the case. The average number of hours that the prosthesis was worn per day was significantly and negatively correlated with each of the restriction subscales (Functional Restriction, $r = -.313, p < .02$; Social Restriction, $r = -.376$, $p < .005$; and Athletic Activity Restriction, $r = -.366$, $p < .006$). Furthermore, wearing the prosthesis for a longer period during the day was significantly correlated with more satisfied ratings of the functional aspects of the prosthesis ($r = .394$, $p < .005$) and higher levels of general adjustment ($r = .363$, $p < .01$). Because the majority of lower limb prostheses cannot be detected by others, aesthetic satisfaction with the artificial limb and social adjustment (i.e., talking about the amputation) were not expected to be determinants of prosthetic usage.

Finally, it was found that increasing age was related to greater athletic restriction ($r = .388, p < .005$), more functional restriction ($r = .463, p < .001$), and less satisfaction with the weight of the limb ($r = -.343$, $p < .01$) and its functional aspects ($r = -.301$, $p < .05$). There was no significant correlation with the adjustment subscales, the Social Restriction subscale, or the Aesthetic Satisfaction subscale. This was expected in that individuals of any age will experience difficulty in adjusting to an artificial limb. However, as individuals grow older, the activity restriction experienced, irrespective of limb loss, will be greater. Overall, there appears to be evidence for construct (divergent and convergent) validity.

GENERAL DISCUSSION

In this article, we have described the development and initial psychometric evaluation of a brief self-administered inventory designed to be used in the context of a multidimensional assessment of adjustment to a lower limb prosthesis. In its final format, the TAPES comprises three psychosocial adjustment subscales consisting of 5 items each (General Adjustment, Social Adjustment, and Adjustment to Limitation), three activity restriction subscales with 4 items each (Functional Restriction, Social Restriction, and Athletic Activity Restriction), and three satisfaction subscales consisting of 10 items (Functional Satisfaction, Aesthetic Satisfaction, and Weight Satisfaction).

A fourth section of the TAPES has not been discussed here because it was not factor analyzed. This section looks at the experience of phantom limb pain and stump pain, as well as other medical conditions not related to the amputation. Each of the aforementioned is subdivided into questions relating to how often it is experienced, how long each episode lasts, how the level of pain can be described, and the extent to which it interferes with daily lifestyle. This section also incorporates 2 items requiring respondents to rate their health and physical capabilities. The section is important, because a significant factor in the amputation experience is pain and how the individual experiences pain. Overall, the TAPES consists of 54 items, and the administration time is approximately 5–10 min (see the Appendix for TAPES items).

The Amputation-Related Body Image Scale and the Perceived Social Stigma Scale (Rybarcyzk et al., 1995), as well as the Prosthetic Profile of the Amputee (Grise et al., 1993), had strong theoretical foundations. Conversely, the TAPES not only had a strong theoretical background, formulated on the basis of a review of the literature and existing methods of measurement and focus groups conducted with people who have had an amputation, but there was empirical justification for the final content of the questionnaire. The factor analysis resulted in a smaller number of variables from the original list compiled from suggestions from people who had amputations, previous instruments, and a review of the literature. It is interesting to note that although all types of domains were included in the original list of 89 items in the psychosocial adjustment section of the questionnaire, only a global form of adjustment, social adjustment, and adjustment to limitation emerged. This may suggest that these domains are the most salient for individuals who have a lower limb prosthesis. The findings corroborate the results of Rybarcyzk et al. (1995), who also stressed the importance of social discomfort in adjustment to an artificial limb. Their findings indicated that body image was a significant independent predictor of depression and quality of life after control for age, time since amputation, site of amputation, self-rated health, and perceived social support. Perceived social stigma was a significant predictor of depression. It would be useful to compare scores on these measures with scores on the TAPES.

With regard to the TAPES, there was no assumption that activity restriction was unidimensional. Williamson et al. (1994) developed an activity restriction measure but did not classify the different types of restriction. Factor analysis in this study revealed that activity restriction was not unidimensional and consequently should not be measured as such. It would be useful to sum all item scores only if items were measuring one concept. The importance of understanding the different dimensions involved in activity restriction is demonstrated in the fact that not all of the activity restriction subscales correlated with the same variables. Furthermore, the effects on walking and mobility that were not included in Williamson's (1995) activity restriction scale emerged as significant in the TAPES.

Similar to Rybarcyzk et al.'s (1992) theoretically derived satisfaction scale, functional and aesthetic satisfaction factors emerged in the TAPES. In addition to the color, shape, and noise items included in Rybarcyzk's scale, the Aesthetic Satisfaction scale of the TAPES incorporated an item referring to the overall appearance of the limb, which coincided with the theme of this factor. Furthermore, fit and reliability items were added to the Functional Satisfaction scale. Unlike the case with the Rybarcyzk scale, the weight of the limb emerged as an independent factor distinct from functional aspects. Subsequent statistical analysis also contradicted Rybarcyzk et al.'s (1992) finding of no significant relationship between social discomfort and satisfaction with the functional or aesthetic aspects of the prosthesis. Analysis of the satisfaction subscales of the TAPES revealed relationships between functional and aesthetic satisfaction and social adjustment ($r = .328$, $p < .01$, and $r = .364$, $p < .005$), indicating that a more favorable rating of the functional and aesthetic aspects of the artificial limb was associated with better social adjustment. Associations also emerged with the Social Relationship domain of the WHOQOL:BREF and both functional and aesthetic satisfaction. These relationships suggest that individuals' perceptions of their prosthesis may be related to the extent to which they are uncomfortable in social situations.

Preliminary evidence of the ability of the questionnaire to identify factors associated with stump pain, phantom limb pain, and prosthetic use highlights its potential usefulness and distinguishes it from other instruments. The ability of the TAPES to correctly classify 83% of people experiencing phantom limb pain may be indicative of the usefulness of the Aesthetic Satisfaction and Adjustment to Limitation subscales in this area. Furthermore, adjustment to limitation may be useful when investigating stump pain. However, it is important to note that the 59% of cases correctly identified, although statistically significant, may not be a clinically significant rate; this finding warrants future research. Similarly, the finding that the General Adjustment and Adjustment to Limitation subscales explained 19% of the variance in prosthetic use should be treated with caution because the variance explained is low. It is interesting that satisfaction with the prosthesis was not associated with prosthetic use. This may result from the fact that irrespective of how the artificial limb may fit or appear, an uncomfortable prosthesis is better than no prosthesis. This is supported by the fact that only 1 individual in the sample of 104 people who had an amputation did not wear a prosthesis at all. It is important that further predictive validity studies of the

TAPES be undertaken. The more conventional method of ascertaining predictive validity is to predict future scores on some other measure. However, the data described here suggest that predicting prosthetic usage and the experience of phantom limb pain and stump pain may be possible.

The initial evidence for the psychometric qualities of the TAPES is encouraging. Evidence of internal consistency reliability is excellent. Cronbach alpha coefficients were high for the subscales of the activity restriction, satisfaction, and psychosocial sections of the TAPES. Further research, however, is necessary to depict the instrument's stability over time (i.e., test–retest reliability). Initial evidence of validity indicates that the scales are measuring what they are intended to measure. Construct validity became important because there was no criterion considered fully valid to investigate concurrent validity. According to Cronbach and Meehl (1955), construct validity must be investigated when no criterion is accepted as entirely adequate to define the quality to be measured. Preliminary evidence of construct validity was found in the significant correlations between the TAPES subscales and WHOQOL:BREF domain scores, the Avoidance and Intrusion subscales of the IES, and the Repair and Clarity subscales of the TMMS. Furthermore, there were expected relationships between age and prosthetic use and the subscales of the TAPES. However, further construct validation studies involving different measures are recommended.

In addition, concurrent validity may be measured by administering the TAPES along with the Prosthesis Evaluation Questionnaire (PEQ), recently developed by Legro et al. (1998), to determine whether they are tapping into similar concepts. The PEQ consists of 10 scales: 4 prosthesis function scales (Usefulness, Residual Limb Health, Appearance, and Sounds), 2 mobility scales (Ambulation and Transfers), 3 psychosocial scales (Perceived Responses, Frustration, and Social Burden), and 1 well-being scale. Legro et al. (1998) proposed that these scales describe the function of a lower limb prosthesis and the related quality of life. Future research is also required to investigate validity in greater detail. Specifically, it is important to establish the predictive validity of the TAPES using prospective studies.

The ease of administration of the inventory, its theoretical and empirical foundation, and the preliminary demonstration of good reliability and validity argue for its applicability as a clinical and research tool. If future studies confirm the psychometric qualities shown in this study, the TAPES may provide an initial evaluation of adjustment problems and consequently identify patients experiencing maladjustment. It may also help identify sources of maladjustment and facilitate exploration of the relationships between the different variables and the identification of factors that promote or interfere with successful rehabilitation and adjustment to wearing a lower limb prosthesis. Furthermore, the questionnaire should enable examination in greater detail of the psychosocial processes involved in adjusting to an artificial limb and the specific demands of wearing an artificial limb. Finally, it may make assessment and the planning of future care programs more efficient and effective.

The results of this study suggest that the use of mail survey methodology provides reliable and valid data. This has important implications for future studies addressing some of the complex issues raised here. Furthermore, the results of this study show that there are people who experience multiple problems, such as phantom limb pain, stump pain, psychosocial difficulties, and activity restriction, and are not satisfied with their prosthesis. This becomes particularly important when one considers that, in this study, the average length of time that an individual had his or her prosthesis was about 8 years. It also emphasizes the need for a measure that not only permits systematic evaluation of adjustment but facilitates identification of the factors influencing the adjustment process. Future studies should examine in greater detail the mechanisms involved in phantom limb pain and stump pain. Indeed, future studies are also important in determining the clinical utility of the TAPES. Although the present results are promising, further detailed validation and reliability checks of the questionnaire also need to be undertaken. In addition, confirmatory analyses with other samples would yield more information on the stability of the factors.

In conclusion, it is clear that adjusting to the loss of a lower limb is a multifaceted process. Amputation is not the final act in itself; rather, it signals the beginning of a long rehabilitation process. To establish the adjustment achieved, it is important to attend not only to the obvious physical, medical, and prosthetic factors that play a crucial role but also to the social and psychological issues facing people who have had a lower limb amputation. We have described the initial development of a valuable tool for the assessment of adjustment to a lower limb prosthesis. It is a simple method for assessing adjustment, and we hope that it will prove to be of value in facilitating future research on adjustment to amputation and the development and evaluation of treatment approaches.

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Appendix

Trinity Amputation and Prosthesis Experience Scales (TAPES)

The following are the items included in the TAPES. The questionnaire is designed to investigate different aspects of having an artificial limb. The first set of items addresses respondent characteristics: gender, age, length of time with an artificial limb, type of artificial limb (below knee, through knee, above knee, or other), and cause of amputation (peripheral vascular disorder, diabetes, cancer, accident, congenital causes, or other).

The second section contains a series of statements concerning the psychosocial aspects of wearing an artificial limb. Respondents rate each item on a 5-point scale ranging from *strongly disagree* to *strongly agree.*

1. I have adjusted to having an artificial limb.
2. As time goes by, I accept my artificial limb more.
3. I feel that I have dealt successfully with this trauma in my life.
4. Although I have an artificial limb, my life is full.
5. I have gotten used to wearing my artificial limb.
6. I don't care if somebody looks at my artificial limb.
7. I find it easy to talk about my artificial limb.
8. I don't mind people asking about my artificial limb.
9. I have difficulty in talking about my limb loss in conversation.
10. I don't care if somebody notices that I am limping.
11. An artificial limb interferes with the *ability* to do my work.
12. Having an artificial limb makes me more dependent on others than I would like.
13. Having an artificial limb limits the *kind* of work that I can do.
14. Being an amputee means that I can't do what I want to do.
15. Having an artificial limb limits the *amount* of work that I can do.

The third set of questions concerns activities one might do during a typical day and whether having an artificial limb limits one in these activities and if so, to what extent. Response options are *limited a lot, limited a little,* and *not limited at all.*

1. Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports.
2. Climbing several flights of stairs.
3. Running for a bus.
4. Sport and recreation.
5. Climbing one flight of stairs.
6. Walking more than a mile.
7. Walking half a mile.
8. Walking 100 yards.
9. Maintaining friendships.
10. Visiting friends.
11. Working on hobbies.
12. Going to work.

(Appendix continues)

The fourth set of items assess the extent to which respondents are satisfied or dissatisfied with several different aspects of their artificial limb: color, shape, noise, appearance, weight, usefulness, reliability, fit, comfort, and overall satisfaction. Ratings are made on a 5-point scale ranging from *very dissatisfied* to *very satisfied.*

The final set of questions assesses phantom limb pain, stump pain, medical problems not related to the amputation, and health and physical capabilities.

1. On average, how many hours a day do you wear your prosthesis?
2. In general, would you say your health is very poor, poor, fair, good, or very good?
3. In general, would you say your physical capabilities are very poor, poor, fair, good, or very good?
4. Do you experience residual limb (stump) pain (pain in the remaining part of your amputated limb)? *During the last week,* how many times have you experienced stump pain? How long, on average, did each episode of pain last? Please indicate the average level of stump pain experienced *during the last week* (excruciating, horrible, distressing, discomforting, or mild). How much did stump pain interfere with your normal lifestyle (e.g., work, social, and family activities) *during the last week* (a lot, quite a bit, moderately, a little bit, or not at all)?
5. Do you experience phantom limb pain (pain in the part of the limb which was amputated)? *During the last week,* how many times have you experienced phantom limb pain? How long, on average, did each episode of pain last? Please indicate the average level of phantom limb pain experienced *during the last week* (excruciating, horrible, distressing, discomforting, or mild). How much did phantom limb pain interfere with your normal lifestyle (e.g., work, social, and family activities) *during the last week* (a lot, quite a bit, moderately, a little bit, or not at all)?
6. Do you experience any other medical problems apart from stump pain or phantom limb pain? Please specify what problems you experience. *During the last week,* how many times have you suffered from these medical problems? How long, on average, did each problem last? Please indicate the level of pain experienced as a result of these problems *during the last week* (excruciating, horrible, distressing, discomforting, or mild). How much did these medical problems interfere with your normal lifestyle (e.g., work, social, and family activities) *during the last week* (a lot, quite a bit, moderately, a little bit, or not at all)? Do you experience any other pain that you have not previously mentioned? If yes, please specify.

A fully formatted version of the TAPES is available free from the authors on request.

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