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Dixon, D. and Johnston, Marie and Rowley, David and Pollard, Beth (2008) *Using the ICF and psychological models of behavior to predict mobility limitations.* Rehabilitation Psychology, 53 (2). pp. 191-200. ISSN 0090-5550

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Rehabilitation Psychology. Vol 53(2), May 2008, 191-200.

http://dx.doi.org/10.1037/0090-5550.53.2.191

Running head: MODELING MOBILITY LIMITATIONS

Using the ICF and Psychological Models of Behavior to Predict Mobility Limitations

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Abstract

Objective: To test the ability of a model that integrates the theory of planned behavior (TPB) into the International Classification of Functioning Disability and Health (ICF) to predict walking limitations in adults awaiting hip or knee replacement surgery. ***Study Design and Participants:*** Cross-sectional structural equation modeling study of activity limitations in 190 adults. ***Method:*** A postal questionnaire measuring the TPB, ICF and walking limitations. ***Results:*** The integrated model accounted for more variance in activity limitations (57%) than either the TPB or ICF alone. Control beliefs (TPB) significantly mediated the relationship between impairment (ICF) and activity limitations. ***Conclusions:*** The integrated model provides an interdisciplinary theoretical framework that identifies intervention targets to effect reductions in disability without the need for concomitant reductions in impairment.

Keywords: disability, ICF, theory of planned behavior, osteoarthritis, behavior

Using the ICF and Psychological Models of Behavior to Predict Mobility Limitations

Locomotor disability is associated with increasing age (Martin, Meltzer, & Elliott, 1988). For example, in England the prevalence of locomotor disability in adults aged over 65 is approximately 32% in people who live in private households. The prevalence rises to 76% and 81% for men and women who live in residential or nursing homes (Hirani & Malbut, 2002). What is more, walking difficulties may be especially important to older people because they form a crucial component of their perceptions of health and disability (Partridge, Johnston, & Morris, 1996). Consequently, work that contributes to the development of interventions to reduce this level of disability would be welcome.

Interventions to reduce locomotor disability are likely to be complex. The development of complex interventions for disability may have been hampered by the lack of an interdisciplinary theoretical framework that is able to support both impairment based and psychological approaches to disability. Medicine and psychology have adopted different conceptualizations of disability, each of which has produced a distinct evidence base. This situation is not ideal because it inhibits the generation of cumulative evidence.

The early input of psychology into the field of disability focused on the emotional sequelae of disability rather than on disability *per se*. However, the conceptualization of disability-as-behavior enabled the application of theories of behavior and behavior change to describe, explain and reduce disability (Johnston, 1994). Operant behavior models applied to activity limitations associated with chronic pain were perhaps the original demonstration of both the concept of disability-as-behavior and the importance of psychological constructs in relation to disability reduction (Fordyce, Fowler, & Delateur, 1968).

Current work within the disability-as-behavior paradigm employs social cognition models, such as the theory of planned behavior (TPB), to understand the factors that act to influence behavior. Within the TPB there are two proximal predictors of behavior, namely intention and perceived behavioral control. In turn, attitudinal, normative and perceived behavioral control beliefs predict intention (Ajzen, 1991). In the case of walking disability, an individual's intention to walk and their beliefs about how easy or difficult it is for them to walk would predict locomotor disability.

Social cognition models have been used to predict a wide variety of health related behaviors and health outcomes in clinical and non-clinical samples (Armitage & Conner, 2000; Armitage & Conner, 2001; Godin & Kok, 1996; Hagger, Chatzisarantis, & Biddle, 2002; Hobbis & Sutton, 2005). Control cognitions in particular are consistent predictors of disability. Perceptions of control predict disability associated with several chronic conditions including, osteoarthritis, stroke and myocardial infarction (Bonetti & Johnston, in press; Ewart, 1992; Johnston, Morrison, MacWalter, & Partridge, 1999; Orbell, Johnston, Rowley, Davey, & Espley, 2001; Rejeski, Miller, Foy, Messier, & Rapp, 2001).

In contrast, biomedicine traditionally viewed disability as a consequence of an underlying biological dysfunction or impairment. This approach was exemplified by the WHO's International Classification of Impairment, Disability and Handicap (ICIDH) model of disability (World Health Organization, 1980). The ICIDH model posited that disability was the direct result of impairment to an organ or body part and that handicap was the direct result of disability. Since, this model appeared to exclude the influence of psychological variables such as beliefs, the evidence bases of psychology and medicine could not be integrated in a theoretically meaningful way.

However, the ICIDH was subject to much criticism of the concepts and the evidence base. Evidence indicated that variations in the level of disability were not a simple function of impairment (Johnston & Pollard, 2001; Salaffi, Cavalieri, Nolli, & Ferraccioli, 1991). Consequently, the WHO International Classification of Functioning, Disability and Health (ICF) was developed as a replacement for the ICIDH, see Figure 1 (World Health Organization, 2001).

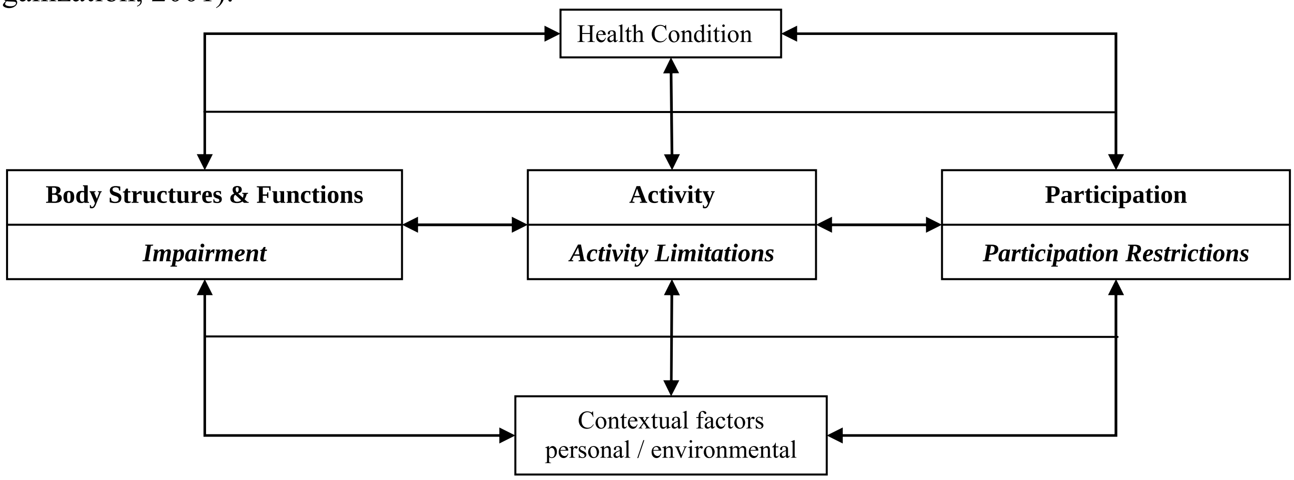

Figure 1. Schematic representation of the ICF (World Health Organization, 2001). The disability versions of the central constructs are shown in italics.

Whilst the ICF continues to recognize a role for impairment (of body structures and functions), the concepts of activity limitations and participation restrictions replace the concepts of disability and handicap. Further, the model proposes reciprocal relationships between the three central concepts and recognizes a role for contextual factors, including personal and environmental factors.

Unlike the ICIDH, the ICF invites psychological theory to contribute to the explanation of disability (activity limitations). First, activity is by definition behavior; consequently, psychological models can be applied to the prediction of limitations in activity (Bonetti & Johnston, in press; Johnston, Pollard, Johnston, Kinmonth, & Mant, 2004; Johnston et al., 1999; Kempen, Van Sonderen, & Ormel, 1999; Orbell et al., 2001; Rejeski et al., 2001). Second, the contextual factors construct takes the form of personal and environmental factors. Learning theory, illustrated by Fordyce's work, is consistent with the notion that environmental factors shape disability behavior. Likewise, the belief systems within social cognition models can be regarded as personal factors that influence behavior. Thus, psychological theory and the ICF are entirely compatible.

However, the ICF has been criticized for being vague about its conceptual origins and the theory that underpins it (Imrie, 2004). The ICF is currently used primarily as a taxonomy of health rather than an explanatory theory or model (Bruyere, Van Looy, & Peterson, 2005). Yet the ICF identifies reciprocal relationships between the constructs within it, which suggest predictive relations between those constructs. Further, in their review of the existing ICF literature, Bruyère, van Looy and Peterson (2005) suggest that the associations and causal links between the constructs in the model merit investigation. Such work should demonstrate whether or not the ICF is capable of functioning as an explanatory model. Currently, the ICF lacks a clear articulation of the processes that support the relations between the constructs and the theory that underpins those relationships.

The integration of psychological models into the ICIDH has been proposed (Johnston, 1994) and would act to strengthen and improve the ICF. First, psychological theory provides a stronger theoretical basis for both the contextual factors and the process variables that link the impairment, activity limitations and participation restrictions constructs. Second, standard methods of operationalizing psychological constructs are available (Ajzen, 2002; Francis et al., 2004), whereas, the WHO has not yet provided standard methods of operationalizing the contextual factors construct. Standard methods of operationalisation would enable the measurement and testing of the model in a manner that facilitates replication, and consequently, the development of a cumulative evidence base.

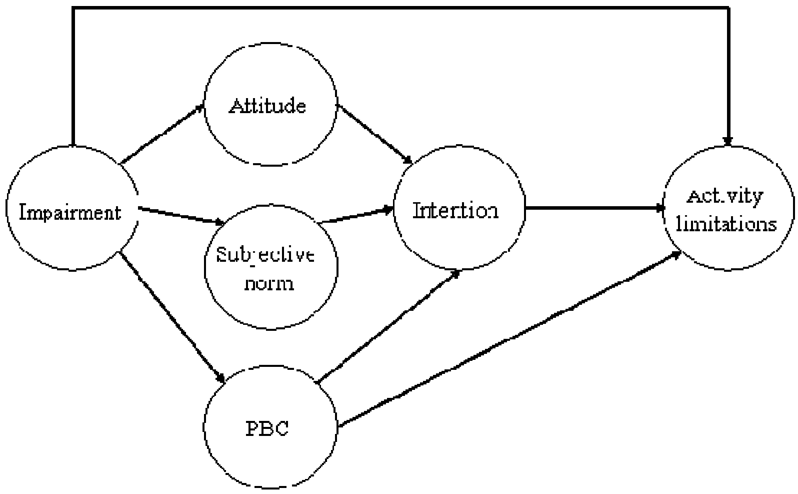

Figure 2. The theory of planned behavior integrated into the ICF. (PBC=perceived behavioral control)

We propose that an integrated model of disability will provide a more complete account of disability than either the ICF or psychological theory alone. Figure 2 shows a schematic of an integrated model that incorporates the TPB into the ICF (Johnston, 1994; Johnston, Bonetti, & Pollard, 2002). In this model, motivational constructs in the form of the TPB act as process variables that mediate the relationship between impairment and activity limitations. The study described in this paper uses structural equation modeling to examine the ability of three models of disability to account for walking limitations in an orthopaedic sample. First, using the ICF, we test the relationship between impairment and activity limitations. Second, the ability of the TPB to predict walking limitations is tested. Finally, we test a model that integrates the TPB into the ICF. The aim was to provide a model of disability that could function to integrate existing knowledge within medicine and psychology and to provide the framework for future interdisciplinary work in the development of complex interventions to reduce disability.

Method

Design

Participants with activity limitations completed a questionnaire that contained measures of the TPB and ICF constructs. Structural equation modeling examined the ability of the ICF and the TPB to account for walking limitations. Then, the ability of the TPB constructs to mediate the relationship between impairment and activity limitations was tested.

Participants

All those attending for elective primary hip or knee replacement surgery at the orthopaedic unit at Ninewells Hospital, Dundee, over a period of 12 months, received a questionnaire approximately 2 weeks before surgery. Four hundred and seventy five patients received a questionnaire and 190 were returned (response rate = 40%). The mean age of the participants was 68.7 years (*SD* 10.2, range 26 to 88). Fifty one percent of participants were female, 68% were married, and 20% widowed. One participant was of Asian origin, the remaining participants were white. Eighty three percent of the participants were not in paid employment, of whom 91% were retired and a further 6% had retired early due to sickness or disability. Twenty percent of participants did not report any health problems in addition to their current orthopaedic condition; of the 80% who reported another health problem, 43% reported having one additional health problem with the remaining participants reporting multiple health problems. High blood pressure was the most frequently reported problem being cited by 30% of the participants who reported at least one other health problem; this was followed by angina (12%), diabetes (9%), high cholesterol (7%) and asthma (6%).

Measures

The questionnaire formed part of a study of the psychometric properties of outcome measures used in orthopedics. The questionnaire contained additional heath outcome instruments not included in this study.

Target Behavior

Limitation in the ability to walk was the locomotor disability behavior examined. To identify the specific walking behavior for the belief based measures used in the TPB and integrated model a pilot sample of 61 joint replacement patients rated the extent of their limitation to walk 100 yards, half a mile and more than a mile (Ware, Snow, Kosinski, & Gandek, 1993). While the longer distances showed ceiling effects, the response profile to the 100 yards distance showed adequate variation (34% limited a lot, 48% limited a little and 16% not limited at all) and was used as the target behavior for the belief based measures.

ICF Measures

The WHO-ICF model was confined to the impairment and activity limitations constructs. For this population, impairment was defined as pain and activity limitations were operationalised in the form of walking limitations (Pollard, Johnston, & Dieppe, 2006). The participation restriction construct was not included.

Impairment. Impairment was measured with four items: “How would you describe the pain you usually have in your joint” (I1); “How often have you had severe pain from your arthritis" (I2); "Does remaining standing for 30minutes increase your pain" (I3); "Have you had any sudden, severe, pain shooting, stabbing or spasms from the affected joint" (I4). The items were rated on 5-point Likert scales, scored from 1 to 5. Item I1 was anchored from *none* to *mild*; items I2 and I3 from *always* to *never* and item I4 from *no days* to *every day*.

Activity limitations. Limitation in the ability to walk was measured by three items. "Does your health now limit you in these activities? If so how much?: Walking 100 yards (AL1); Walking half a mile (AL2)" and "What degree of difficulty do you have walking long distances on the flat (>0.5 mile) (AL3)". Items, AL1 and AL2 were scored on a 3-point scale labeled *limited a lot*; *limited a little* and *not limited at all*. Item AL3 was scored on a 5-point scale anchored with *none* to *extreme*.

Table 1: Discriminant Content Validation Data for the Impairment and Activity Limitation Items

Measurement Item	Theoretical construct		
	Impairment $t(8)$	Activity limitation $t(8)$	Participation restriction $t(8)$
I1	20.9***	n.a.	n.a.
I2	21.9***	n.a.	n.a.
I3	8.4***	1.8	n.a.
I4	31.0***	n.a.	n.a.
AL1	1.0	13.5***	1.5
AL2	1.0	13.5***	1.3
AL3	1.0	13.5***	1.3

Note. ***$p < .001$, all other t-values were non-significant. n.a. = t-test could not be performed because all ratings were zero (Pollard et al., 2006).

Discriminant Content Validity of the ICF Items. Each impairment and activity limitation item had previously been validated as an index of the theoretical definition of impairment using the method of discriminant content validity (DCV) (Pollard et al., 2006). DCV requires judges to decide if an item matches the definition of the theoretical construct, with confidence ratings (from 1 to 10). One sample t-tests are used to assess whether the confidence ratings deviate significantly from zero. The t and p values for each item, assessed against impairment, activity limitation and participation restriction definitions, are shown in Table 1. All impairment items were significant for the impairment construct, with non-significant t values for the activity limitations and participation restrictions constructs. . All activity restriction items were significant for activity limitations, with non-significant t values for the impairment and participation restriction constructs.

Measures used to Validate the ICF Measures

The physical functioning and pain subscales from the Western Ontario and McMaster University Osteoarthritis Index (WOMAC) (Bellamy, Buchanan, Goldsmith, Campbell, & Stitt, 1988) were used to validate the impairment and activity limitation measures respectively. The Cronbach's alphas were 0.94 for the 17 item physical functioning subscale and 0.83 for the 5 item pain subscale. A review of 43 studies, each of which evaluated the measurement properties of the WOMAC, indicated the physical functioning and pain subscales are reliable and valid measures of disability and pain respectively (McConnell, Kolopack, & Davis, 2001).

Theory of Planned Behavior Measures

The TPB is not measured by a standard instrument; rather, a standard protocol (Ajzen, 2002) is used to develop a behavior and sample specific TPB questionnaire. Salient beliefs toward walking 100 yards were identified using the standard protocol of elicitation interviews (Ajzen, 2002). Fifteen people over the age of 65 with walking difficulties due to OA of the hip and knee participated in the elicitation interviews (Francis et al., 2004). The questionnaire employed the most frequently elicited beliefs.

Attitude. Five items measured attitude towards walking 100 yards. Attitude scores were derived from the product of five behavioral beliefs and the evaluation of each belief as recommended by Ajzen (2002) and Francis, et al. (2004). The five behavioural beliefs were: "I think doing a walk of 100 yards: Helps maintain my independence (ATT1); Gives me a feeling of satisfaction (ATT2); Helps keep me fit (ATT3); Is painful (ATT4); Makes my joints stiff (ATT5)". Behavioral beliefs were scored on a 5-point scale anchored with *strongly agree* to *strongly disagree*; ATT4 and ATT5 items were reverse scored to ensure that a higher positive score indicated a more positive attitude. Evaluative belief items asked participants to rate the personal importance of each behavioral belief, e.g. "Being independent is important to me"; and were rated on a 5-point scale anchored with *strongly agree* to *strongly disagree*, and scored using a bipolar scale that ranged from –2 to +2, as recommended by the standard TPB protocol (Francis et al., 2004).

Subjective Norm. A single item measured subjective norm, "People who are important to me think I should do a walk of 100yards", scored on a 5-point scale anchored with *strongly agree* to *strongly disagree*.

Perceived Behavioral Control. Four items measured perceived behavioural control (PBC). "It is entirely my decision to do a walk of 100 yards" (PBC1); "There are likely to be plenty of opportunities for me to do a walk of 100 yards" (PBC2); "I have complete control over doing a walk of 100 yards" (PBC3); "I feel in complete control of whether I do a walk of 100 yards" (PBC4). PBC items were scored on a 5-point scale anchored with *strongly agree* to *strongly disagree*.

Intention. Three items measured intention. "I intend to do a walk of 100 yards" (INT1); "I would like to do a walk of 100yards (INT2); "It is likely that I will do a walk of 100 yards" (INT3). Intention items were scored on a 5-point scale anchored with *strongly agree* to *strongly disagree*.

Procedure

The pre-operative assessment nurse at Ninewells Hospital sent a questionnaire pack to each participant's home approximately four weeks prior to surgery. The questionnaire pack consisted of an invitation to participate, patient information sheet, consent form, questionnaire and a postage paid return envelope. The participants completed the questionnaire at home and returned it by post to the research team at Ninewells Hospital. The patient information sheets detailed the purpose of the study and what would be required of participants. Contact details for named members of the research team were also provided should potential participants wish to discuss the study further. Potential participants were assured that their participation was voluntary, that their decision would not affect their treatment in any way, that all information would be treated in the strictest confidence and that

Tayside National Health Service Medical Research Ethics Committee had approved the study. Participants were asked to complete the questionnaire in their own time but before their surgery. The questionnaire contained measures of the ICF, the TPB, WOMAC and additional health status measures not relevant to the current research questions.

Data Analyses

First, bivariate correlations examined the relationships between the construct measures. In addition, multiple regression analyses (SPSS v.14) examined the ability of demographic factors to affect the predictive validity of the theoretical models.

Second, data were analyzed using two-stage structural equation modeling (SEM) with the EQS (6.1) software package (Bentler, 2004). The subjective norm construct was indicated by a single measure; consequently, its error variance could not be estimated and was set to zero throughout. Models were estimated using covariance matrices and maximum likelihood (ML) procedures. All variables showed acceptable levels of univariate skew and kurtosis. However, multivariate kurtosis was evident, consequently, the 'robust' correction procedure for non-normal data was applied throughout (Satorra & Bentler, 1994). The possibility of multicollinearity between constructs was investigated using the method of principle components within the collinearity diagnostic function in SPSS (v.14). A series of uncorrelated components were produced from the original correlated predictor variables. Condition indices were then calculated from the ratios of the variances between pairs of components. Two features of the principle components analyses were used to diagnose multicollinearity. First, if the number of components and the number of predictors is the same, collinearity amongst predictors is unlikely. Second, condition indices greater than 30 indicate multicollinearity may be a problem (Belsley, Kuh, & Welsch, 1980).

Assessment of Fit

Four fit indices were used: χ^2, the root mean square error of approximation (RMSEA) (Browne & Cudeck, 1993), the non-normed fit index (NNFI) and the comparative fit index (CFI). A nonsignificant χ^2 indicates acceptable fit; a RMSEA value of 0.07 or below indicates an acceptable fit, a good fit is indicated by a value of 0.05 and if the whole of the 90% *CI* for the statistic falls below 0.06; NNFI and CFI values of ≥0.95 indicate acceptable fit (Hu & Bentler, 1999). In addition to these frequently used fit indices the Yuan Bentler Residual Based F-test was also used, as it has been demonstrated to be more reliable than χ^2 for smaller samples (Bentler, 2004). However, this was only referred to when the χ^2 statistic was significant in order to confirm the other fit indices. R^2 values indicated the strength of the relationship between the target latent construct each indicator item. The Lagrange multiplier (LM) test was the modification index estimate used to investigate the effect on the fit indices of freeing specific paths.

Ethics

The ethics committee of the Tayside National Health Service approved the study.

Results

Validity of the Measures of Impairment and Activity Limitations

In addition to the DCV data (see above and Table 1), the impairment and activity limitation measures were validated against the pain and physical functioning scales from the WOMAC osteoarthritis index (Bellamy et al., 1988). Participants' mean score was 16.8 (*SD*

3.3) and 55.5 (*SD* 10.9) on the WOMAC pain and physical function scales respectively. The correlation between the impairment measure and the pain subscale from the WOMAC was significant ($r = .72, p \leq .001$). The correlation between the activity limitations measure and the WOMAC physical functioning scale was also significant ($r = .56, p < .001$).

Descriptive Data

The reliability (Cronbach's alpha) and descriptive data for each construct measure together with the correlations between the demographic and theoretical variables used to estimate each model are shown in Table 2. The correlation between age and impairment was significant ($r = .27, p < .01$); older participants reported less pain. Age was not related to any other measure. The relationships between gender and marital status and the ICF and TPB variables were examined further. Women reported higher impairment ($t(181) = -2.0, p < .05$) and activity limitations ($t(181) = -2.3, p < .05$), lower control over walking ($t(181) = 2.9, p < .01$), lower social pressure to walk ($t(181) = 3.8, p < .01$) and lower intention to walk ($t(181) = 2.9, p < .01$) compared to men. The marital status data were collapsed into two categories, married (69%) and a category made up all other responses (single (3%), widowed (20%), divorced (7%) and other (1%)). Married participants reported higher control over walking ($t(179) = -3.3, p < .01$), more social pressure to walk ($t(179) = -3.4, p < .01$) and higher intention to walk ($t(179) = -3.3, p < .01$). Marriage was not related to either impairment or activity limitations. Men were significantly more likely to be married than women ($\chi^2(1) = 23.1, p < .01$).

Linear regression analyses were used to examine the effect of age, gender and marital status on the predictive ability of the models. Age was not predictive of impairment ($F(1,177) = .54$, n.s.). Gender predicted intention to walk ($F(1,181) = 8.3, p < .01$) but this relationship reduced to non-significance when the TPB variables (attitude, subjective norm and PBC) were entered into the regression equation. Similarly, gender also predicted activity limitations ($F(1,181) = 5.1, p < .05$) but this relationship was reduced to non-significance when intention and PBC, or impairment, were entered into the regression equation. Finally, although marital status predicted intention to walk ($F(1,179) = 10.9, p < .01$) this relationship was reduced to non-significance when the TPB variables were included in the regression equation.

In summary, gender, age and marital status made no significant contribution to the prediction of activity limitations or intention after the variance explained by impairment or the TPB constructs had been accounted for. Consequently, the demographic variables were not included in the SEM analyses.

Correlations between the predictor variables in each model were below the mean scale reliability suggesting that multicollinearity was not a threat to the stability of the analyses (see Table 2). In addition, principal components analysis was used to evaluate multicollinearity in each structural model. In each case the number of components was the same as the number of predictors. The largest condition indices were as follows: 12.5 and 11.7 for the TPB (intention regressed onto attitude, subjective norm and PBC, and activity limitations regressed onto intention and PBC respectively); 12.1 for the ICF, and 20.2 for the integrated model. Although all condition indices were below 30, the integrated model was further investigated through an examination of how much variance in the regression coefficient of each predictor variable was associated with the high condition index. If this association is greater than .5 for two or more predictors multicollinearity may be a problem (Belsley et al., 1980). The variance proportions for the condition index of 20.2 in the integrated model were .88, .1 and

.01 for the impairment, PBC and intention measures respectively. Consequently, multicollinearity was not considered to be a serious threat to the stability of the analyses.

Finally, discriminant validity analyses were performed for those construct measures with correlations above 0.7. The correlation between perceived behavioral control and subjective norm and between perceived behavioral control and intention was .72 (CI_{95} .56, .88) and .83 (CI_{95} .72, .94) respectively, and the correlation between subjective norm and intention was .71 (CI_{95} .55, .87). None of the 95% confidence intervals spanned unity therefore the discriminant validity of the constructs was supported.

Table 2**:** Descriptive Data for and the Correlations between Constructs used in the Structural Models and the Demographic Measures

	Construct measure							
	AL	I	Attitude	SN	PBC	Int	Gender	Age
Activity Limitations	*.80*[a]							
Impairment	.51**	*.69*[a]						
Attitude	-.34**	n.t.	*.86*[a]					
SN	-.53**	n.t.	.50**	n.a.				
PBC	-.69**	-.32**	.62**	.72**	*.87*[a]			
Intention	-.56**	-.26**	.63**	.71**	.83**	*.90*[a]		
Gender	.17*	.15*	-.12	-.27**	.21*	-.21*		
Age	.05	-.27**	-.12	-.02	-.08	-.03	-.01	
Marital Status	-.10	-.05	.08	.25**	.24*	.24*	-.36**	-.12
M (*SD*)	8.8 (1.8)	14.7 (2.5)	17.3 (2.6)	3.4 (1.1)	14.4 (4.0)	7.3 (2.2)		68.7 (10.2)

Note. $^{*}p \leq .05$, $^{**}p \leq .01$, [a]Cronbach's α values shown on diagonal (*italics*). n.a.= α is not applicable for a single item measure. n.t. = not tested because the two constructs do not appear in the same model.

ICF Model

Measurement Model

The model was an adequate fit to the data ($\chi^2(13) = 13.6$ $p \leq .38$; NNFI = .99; CFI = .99; RMSEA (CI_{90}) = .02 (0.0, .08); Yuan-Bentler residual based F-test, $F(13,170) = 1.43$ n.s.) and the standard residuals were small and normally distributed. However, R^2 values for the I1 (.40), I3 (.39) and I4 (.18) items were below the recommended .5 level suggesting the relationship between these items and the impairment construct was less than ideal[1]. The implications of this observation are considered in the discussion section.

Structural Model

Fit indices indicated the model was an adequate representation of the data ($\chi^2(13) = 13.8$, n.s.; NNFI = .99;CFI = .99, RMSEA = .02 (CI_{90} 0.0, .08); Yuan-Bentler residual based F-test =

[1] Parameter estimates for each item used in each of the three models are available upon request from the corresponding author.

$F(13,170) = 1.43$, n.s.). The path coefficient between impairment and walking limitations was significant and positive indicating that higher pain perceptions were related to greater walking limitations. The R^2 value indicated that impairment accounted for 28% of the variance in walking limitation.

Theory of Planned Behavior Model

Measurement Model

The model did not fit the data ($\chi^2(95) = 321.6, p \leq .001$; NNFI = .82; CFI = .86; RMSEA ($C.I._{90}$) = .12 (.1, .13). The ATT4, ATT5 and INT2 items were poor indicators of their latent constructs having R^2 values of .03, .01 and .17 respectively. Whilst, the standardized residuals were small and normally distributed, that between the ATT4 and ATT5 items was high (.67). Further, the INT2 item showed evidence of significant skew (-1.4) and kurtosis (2.9). Based on these data, the ATT4, ATT5 and INT2 items were removed from the analyses and the modified measurement model re-estimated.

With the exception of the χ^2 statistic all fit indices for the modified measurement model indicated adequate fit ($\chi^2(56) = 89.3, p \leq .01$; NNFI = .97; CFI = .98; RMSEA ($C.I._{90}$) = .06 (.03, .09); Yuan-Bentler residual based F-test = $F(56,125) = 1.29$, n.s.). The adequacy of the model was supported by the small and normally distributed standardized residuals and the lack of any significant LM tests.

Structural Model

The structural model of the TPB is shown in Figure 3. Inclusion of the structural paths did not significantly affect the fit indices.

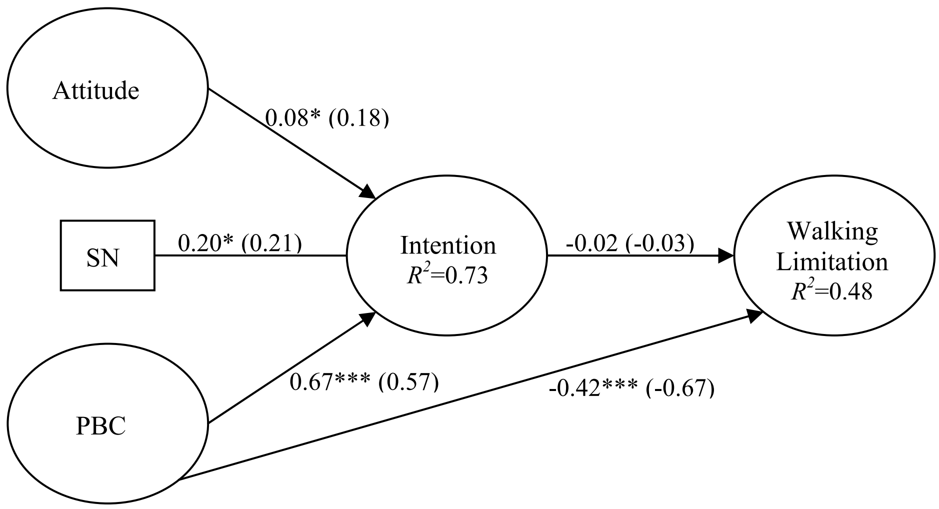

Figure 3. TPB structural model. SN=subjective norm. $^{**}p \leq .01$, $^{***}p \leq .001$. Numbers represent Beta weights (standardized beta values (β) in parentheses). Fit Indices: $\chi^2(58) = 91.7, p \leq .003$; NNFI = .97; CFI = .98; RMSEA ($C.I._{90}$) = .06 (.03, .08); Yuan-Bentler residual based F-test = $F(58,123) = 1.22$, n.s.

The path coefficients between attitude, subjective norm, perceived behavioral control and intention were all positive and significant. Together, attitude, subjective norm and perceived behavioral control accounted for 73% of the variance in intention. Only PBC was predictive of walking limitations; higher perceived behavioral control was associated with lower walking limitation. The model accounted for 48% of the variance in walking limitation.

Integrated Model

Measurement Model

In the integrated model the TPB was operationalised in its core proximal form of PBC and intention. The model was an adequate fit to the data ($\chi^2(59) = 97.7$ $p \leq .001$; NNFI = .95; CFI = .96; RMSEA ($C.I._{90}$) = .06 (.04, .08); Yuan-Bentler residual based F-test = $F(56,122) = 1.3$, n.s.). The standardized residuals were small and normally distributed and none of the LM tests were significant. Consequently, this model was used as the basis of the estimation of the structural model.

Structural Model

The structural model is displayed in Figure 4. The fit indices remained unchanged from the measurement model.

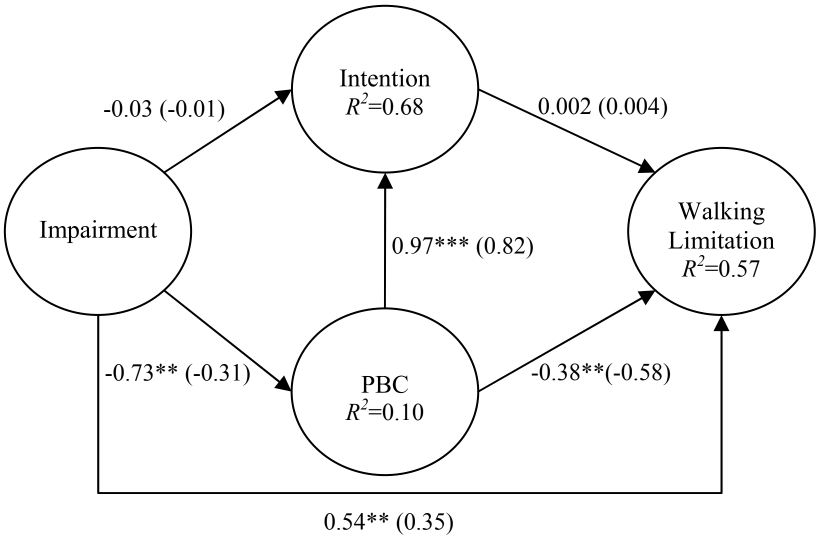

Figure 4. Integrated structural model. $**p \leq .01$, $***p \leq .001$. Numbers represent Beta weights (standardized beta values (β) in parentheses). Fit Indices: $\chi^2(59) = 97.7$, $p \leq .001$; NNFI = .95; CFI = .96; RMSEA ($C.I._{90}$) = .06 (.04, .08); Yuan-Bentler residual based F-test = $F(59,122) = 1.3$, n.s.

The path coefficients between impairment and both PBC and walking limitations were significant. Higher impairment was associated with lower perceptions of control and greater walking limitation. Impairment was not significantly associated with intention, and intention was not predictive of walking limitation. PBC was significantly related to walking limitations. Together, impairment and perceived behavioral control accounted for 57% of the variance in walking limitation.

EQS enables decomposition of effects into direct and indirect path coefficients; these analyses are the equivalent of mediation analyses in regression. A significant path coefficient for the indirect path between impairment and walking limitation, via perceived behavioral control ($B = .28, p < .01; \beta = .18$), indicated perceived behavioral control significantly mediated the relationship between impairment and walking limitations.

Discussion

This study examined whether the integration of the ICF and psychological models of disability was possible. The aim was to provide an interdisciplinary theoretical model that could support the consolidation of existing evidence and guide future interdisciplinary work. Three theoretical models of disability were examined. First, the ICF, which includes impairment as a potential predictor of disability. Second, a psychological model that proposes disability can be understood as a form of behavior. Third, an integrated model that proposes the ICF could be improved through the inclusion of psychological models of behaviour. All three models were found to be adequate representations of the pattern of responses generated by the participants.

First, the ICF model indicates that impairment will predict activity limitations. The significant relationship between impairment, in the form of pain, and activity limitations, in the form of limitation in walking, lent support to this portion of the ICF. Second, the ability of the TPB to account for walking limitations supported the concept of disability-as-behavior. Indeed, the TPB was able to account for a greater proportion of the variance in walking limitations than impairment was able to (48% v 28%). Thirdly, the use of the TPB to operationalise the personal factors construct in the ICF generated an integrated model that accounted for more variance in walking limitations that either model alone (57%). Within the integrated model the relationship between impairment and walking limitations was significantly mediated by PBC. This finding is consistent with previous work that has demonstrated the importance of perceived control constructs relative to impairment in predicting both activity and activity limitations (Fisher & Johnston, 1996; Johnston et al., 1999; Kinne, Patrick, & Maher, 1999; Orbell et al., 2001).

The demonstration that activity limitation is not only a disability related construct but is also a behavioral construct has important implications for theory and practice. Theoretically it serves to normalize disability; it removes the category distinction between people with disabilities and those without. The ability to perform a particular behavior, such as walking a specific distance, becomes a continuum of performance ability that is equally applicable to everyone. However, the disability-as-behavior concept does not preclude a role for impairment, indeed, although the relationship between impairment and walking limitations was attenuated in the integrated model it remained significant. The integrated model, therefore, suggests that impairment is an influence on disability beyond its ability to influence motivational beliefs. It should be emphasized that the role for motivational factors in the integrated model is not an argument for placing the responsibility or blame for the consequences of disablement on those with disabilities. Rather, motivational factors function to normalize disability and to place disability within the same ontological category of action as other forms of activity or performance.

The integrated model also has practical implications. It provides an opportunity to intervene to reduce disability without reducing impairment. This possibility is important for those chronic conditions that are not amenable to curative treatment. The integrated model has the advantage of providing a strong theoretical framework within which such interventions can be developed and tested. This study has identified control cognitions as important predictors of disability. Psychological research has established strategies by which control related beliefs can be modified to effect positive change in behaviour (Bandura, 1997). Existing evidence indicates that activity limitations can be reduced in people with impairments, without reducing those impairments, by interventions which increase control beliefs (Fisher & Johnston, 1996; Johnston et al., 2007). These strategies could be incorporated into rehabilitation programmes and intervention protocols to bolster improvements in functional status.

There are, however, limitations to the study that require consideration. The study relied on self-report measures of behaviour. In addition, behaviour and cognitions were measured at the same time. The resources available for the study precluded objective measures of mobility limitations. Evidence indicates that the relationship between cognitions and behaviour is inflated for self-reported compared to objective measures of behaviour (Armitage & Conner, 2001). However, this may be less of a problem when investigating disability as control cognitions are equally predictive of self-report and objectively assessed activity limitations (Johnston et al., 1999). Similarly, concurrent measurement of behaviour and cognitions acts to increase the apparent association between the two. Nevertheless, when investigated prospectively control cognitions, measured as perceived behavioral control (TPB) or self-efficacy (Social Cognitive Theory), predict recovery from walking limitations, allowing for initial levels of impairment (Bonetti & Johnston, in press). We acknowledge that the use of self-report and a cross-sectional design may have inflated the absolute level of variance in behaviour accounted for by each model. However, this inflation applied to all three models. It is reasonable to suggest that the observed *relative* predictive utility of the three models would be less affected by the use of self-report.

Participants in the study self-reported co-morbidities, in addition to their physician diagnosed orthopaedic condition. These co-morbid health conditions might also have affected the impairment and walking limitations experienced by the participants. Equally the experience of co-morbidities might also affect cognitions in relation to walking. It should be borne in mind that the measures of the ICF and TPB constructs may not be a simple consequence of the experience of a single orthopaedic condition. The measures may reflect composite constructs influenced by the experience of multiple co-morbidities.

The TPB identifies intention as a proximal predictor of behaviour. The observation that intention did not predict walking limitations is somewhat unusual (Armitage & Conner, 2001). However, previous studies have found comparable results. For example, intention failed to predict both self-reported and objective measures of physical activity and smoking in coronary heart disease patients (Johnston et al., 2004). Further, other studies have shown that the relative predictive utility of intention and PBC varies with level of motivation toward a behavior (Weinstein, Lyon, Sandman, & Cuite, 1998), indicating the relationship between these three constructs may be complex.

There were also some limitations with the measurement models used in the study. Although we employed a theoretically based, *a priori* approach to the selection of impairment items, the measurement model was not ideal. The factor loadings (R^2) for the impairment items were variable and fell below the generally recommended value of 0.5 for 3 of the 4 items. Factor loadings are taken as an indication of the validity and reliability of the latent construct measure, however, this interpretation is based upon the assumption that the latent construct is unidimensional (Bollen & Lennox, 1991). In the current study the low R^2 values were interpreted as an indication of the heterogeneity of the latent pain-as-impairment construct. We recognize that a replication study would greatly assist in the resolution of this issue. It is possible that pain is a multidimensional construct best represented by a hierarchical structure of first and second-order factors.

Similarly, only 3 of the 5 items formulated to indicate the attitude construct were adequate indicators of attitude. However, this is likely to have been a trivial result of including negatively worded items in the questionnaire. A previous study using the Perceived Health Competence Scale, found that the measure had a two-factor structure, one factor for positively worded items and one for negatively worded items (Bonetti et al., 2001). In the present study, the three retained attitude items were worded positively, while the rejected items asked about NOT being in pain or NOT having stiff joints. On the other hand, the two rejected items were concerned with the impact walking may have on bodily impairment. Consequently, future studies should consider the possibility that attitudes to walking, which evoke perception of joint impairment, may be distinct from other types of attitude. If that were the case, such beliefs may be differentially predictive of disability.

Finally, it is recognized that the integrated model requires testing in other clinical populations and requires replication of testing in other orthopaedic samples before it is possible to conclude that the model is generally applicable.

In sum, the integrated model proposed here accounted for more variance in disability than either the ICF or psychological models alone. This model can account for findings that are incompatible with either model alone. It provides a theoretical framework for designing interventions to reduce disability in situations where impairment reduction is, or is not, possible.

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This work was supported by the MOBILE programme at the Medical Research Council – Health Service Research Collaboration and an MRC-HSRC PhD award to support Diane Dixon.

The authors would like to thank all the patients and staff at the Orthopaedic Unit at Ninewells hospital for their valuable and continuing contribution to this programme of work. We would also like to thank the individuals who reviewed earlier versions of this manuscript for their time and effort and insightful comments.

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