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Assessing the quality of walking in adults with chronic pain: The development and preliminary psychometric evaluation of the Bath Assessment of Walking Inventory

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Abstract

Walking is fundamental to many activities that are detrimentally affected by chronic pain. When in pain, people adapt how they walk. This article reports the development of an observational rating scale for the assessment of the quality of walking in adults with chronic pain called the Bath Assessment of Walking Inventory. The BAWI was designed explicitly for clinical and research use. A review of the literature on movement assessment, and a professional focus group, yielded 36 items capturing specific characteristics of walking that were organised into 11 domains. Investigation into the psychometric properties reduced the final measure to 23 items in 8 domains that demonstrated good internal consistency (Cronbach 0.71) and adequate intra (Kappa 0.61- 0.98) and inter-rater reliability (Kappa 0.61- 0.98). Validity was established in comparison with well-used measures of functioning. Further independent study is required to develop this instrument. A robust measure of walking will enable accurate clinical assessment, and the investigation of psychosocial and biomechanical influences on walking quality, and of the communicative function of pain related movement.

1. Introduction

Chronic pain has widespread detrimental effects on normal functioning. Patients commonly complain of unwelcome changes in their capacity, ability and quality of movement. Although the measurement of function is a frequent component of clinical assessment, instruments often rely on patient self-report of remembered global function (e.g. Ware and Sherbourne, 1992) on specific tasks of physical capacity (e.g. Harding et al., 1994) or are global measures of bodily awareness (e.g. Gyllensten et al., 1999, 2004). To date walking assessment has relied on a laboratory setting (Lamoth et al., 2006a, Pierrynowski et al., 2005). No unobtrusive, clinically easy to use instruments exist to measure the quality of walking when in pain.

An abnormal gait is not of itself a clinically significant problem. Indeed many patients report a lack of awareness of how they walk. Walking is often only a means to achieve a goal. However, the social context of pain behaviour and the effect of pain behaviour on observers are often clinically important. Judgements about pain are known to be based on verbal and facial behaviour (Prkachin 2005, Williams 2002). However, other physical movement can be deliberately activated to give specific culturally relevant meanings (e.g. head-nodding as a signal of affirmation or agreement) or can be the site of inadvertent meaning (e.g. 'head lowering' as a signal of embarrassment). Judgements are commonly made about someone's health status based only on observed movement such as walking pattern or performance in weight-bearing tasks. We know very little about this. Unknown is the extent to which the walking behaviour of a person with pain predicts the behaviour of observers, be it solicitous, punishing, or neutral. Unknown is the extent to which the presence of observers affects walking behaviour in chronic pain. Furthermore the contribution of psychological variables to walking performance is largely theoretical. For example, Asmundson et al (1999) proposed that walking performance is altered on exposure to the threat of pain in avoidance of perceived negative consequences. Also not clearly understood is how these psychosocial factors influence or are influenced by physiological responses found in chronic pain sufferers such as altered muscle reactivity (Haig et al., 1993 and Watson et al., 1997) and recruitment patterns (Hodges and Richardson, 1999 and Lamoth et al., 2006b). Finally, we do not know what the critical factors are which, when therapeutically manipulated, can lead to sustained improvements in walking quality. Establishing instruments to measure the quality of walking is a critical first step in enabling future research into the 'biopsychosocial' influences on walking quality.

Understanding the complexity of walking is essential in clinical formulation and treatment planning; achieving a reliable measure of walking quality will also allow for the further investigation of pain related function. The primary objective of this study was to develop an assessment tool designed specifically to assess the quality of walking in adults with chronic pain for use in clinical and research settings.

2. Method

2.1 Bath Assessment of Walking Inventory (BAWI) Development

Domain definition and item writing were informed from a range of sources including guidance from existing measurement tools in related areas.

In particular, useful source material was found measuring movement behaviour in chronic pain (Harding et al., 1994, Keefe et al., 2001, Moores and Watson, 2004), neurological disease (Keenan et al., 2004; Lord et al., 1998; Mackey et al., 2003; McGinley et al., 2003; Rodriquez et al., 1996), and older people (Thigpen et al., 2000). A focus group of expert physiotherapists working in UK chronic pain management was held, and source material for items recorded. Three physical therapists with experience in chronic pain management then checked the items for face validity, sense, language, and repetition. The final item pool consisted of 36 items in total covering 11 categories or domains of movement, with each domain consisting of a median of three items (range 2-5). For example the domain of ‘heel strike’ consisted of three items: ‘bilateral heel strike’, ‘unilateral heel strike’ and ‘no heel strike’.

Items definitions were written to capture distinct characteristics within each domain. An attempt was made to write items in a language that was free from theoretical interpretation regarding the social or psychological function of a movement (e.g. guarding and bracing), and also free from a biomechanical technological description (e.g. trendelberg, winging scapula). Instead care was taken to write items that simply described the movements in space that could be assessed visually (e.g. limping, stride length). Observers were required to judge simply whether a movement was present or absent. The 36 items and their definitions comprising the original version of the BAWI item pool are shown in appendix 1.

A scoring system was devised in which higher numbers were selected to indicate a poorer walking quality. A range of 0–2 was possible for each domain. Items were allocated a score according to the degree of variation of symmetry, responsiveness and ability to follow test instructions, details are provided in appendix 1.

2.2. Participants

The 57 participants in this study were patients undergoing treatment on a residential programme of cognitive behaviour therapy at a UK tertiary care pain management centre (McCracken and Eccleston 2005). Of these seven did not participate in the final test; they excluded themselves from treatment and so were unavailable. To be included patients were required to be over 17 years of age, reporting pain of at least 6 months in duration, with intact limbs and without any structural impairment that restricted range or pattern of movement.

2.3. Procedure

Patients were invited to take part in the study on the first orientation day of a treatment programme. All assessments took place at the beginning of the first day of treatment prior to any exposure to psychological or physiotherapeutic intervention. First, patients were required to complete the battery of self-report assessment measures. Second, patients were asked to complete a two minute timed walk test covering the farthest distance possible during the time period. Patients were asked to use only their own-supplied walking aids if they normally used these indoors. The test was completed in a corridor, closed to pedestrians, in a clinical environment, with standardised instructions, without observers other than the therapist. To examine treatment sensitivity the test was repeated 18 days later on the last day of treatment. Participants consented to video recording and understood that it would enable development of a walking quality assessment tool. The same therapist was present for all participants. The two-minute walk test is a standard physical capacity outcome measure used within treatment. The BAWI was developed to be used alongside this test to provide quality assessments. Each walk test was digitally recorded and the image files uploaded to a portable computer. Two therapists independently coded the videotapes, observing the first minute, coding for 20 seconds and then observing the final 40 seconds before completing the coding sheet. Therapists had been made familiar with all items and their definitions prior to coding. Therapists were instructed to tick one item that was observed on one or more occasions that was positioned lowest within the domain. Windows media player software was used when coding the images.

2.4. Measures

A range of measures were employed for validation and comparative purposes.

2.4.1. Two minute timed walk test (TMTWT)

Participants were instructed to walk between two floor markers spaced ten metres apart as many times as possible during the two minute period. Total distance walked in metres was recorded. Brooks et al., (2004) found this to be a valid and sensitive measure of functional capacity in a sample of cardiac surgery patients. Although this is a common measure in physiotherapy and has been used in clinical evaluations there are no validation studies with the chronic pain population.

2.4.2. One minute sit to stand (STS)

Participants were instructed to repeatedly rise from a sitting position to a standing position and return to a chair as many times as possible in one minute. The total number of sit to stand movements within the minute was recorded. This is a standard measure of physical function used in rehabilitation and has been shown to have good psychometric properties for use as an inventory of physical function with adult chronic pain patients (Harding et al., 1994).

2.4.3. Sickness Impact Profile (SIP)

The Sickness Impact Profile (Bergner et al., 1981) was employed. The SIP assesses the perceived effect of illness on 12 categories of daily activity. It provides an overall score and individual scores. Three individual scores in the domains of body care and movement, mobility, and ambulation also combine to give a composite score of "physical dimension". Physical dimension scores range from 0 – 100, 0 reflecting no disability. Example items for each domain respectively are; "I get in or out of bed or chairs by grasping something for support or by using my stick or walker", "I am only getting around within one building" and "I walk by myself, but with some difficulty, for example, limp, wobble, stumble, have stiff legs". Participants are asked to tick statements that describe their state of health today. The SIP has a good track record of use in chronic pain (e.g. Cano et al., 2005; Slater et al., 1997). In particular it has shown good comparative reliability with measures of physical performance (Cress et al., 1995, Follick et al., 1985) and activities of daily living (Watt-Watson and Graydon, 1989).

2.5. Analysis Plan

The analysis of the BAWI was approached in six stages. First, item frequency distributions were examined for any failing items. Second, an analysis of intra- and inter-rater reliability was undertaken. The ability to reliably observe and code each item was fundamental to the application of this inventory. To test intra-rater reliability, the primary observer, a physiotherapist with 5 years experience with chronic pain patients, rated each patient's recording before and after a gap of 48-hours. To test inter-rater reliability, two observers, the primary observer and a second observer, a physiotherapist with 3 years experience with chronic pain patients, rated each patient's video footage independently. The total number of agreements per domain was then calculated. For example a count was made of the number of times both primary and second observer marked the same item within the domain. This number was then used to calculate the total percentage of agreement of the two observers/observations within each domain. A chance corrected kappa score was then calculated. For example where 3 items made up a domain, the percentage agreement occurring due to chance was 33.3%, for 4 items 25% chance etc. Studies (McGinn et al., 2004, Maclure and Willett 1987) have interpreted kappa values of greater than 0.8 as excellent, 0.6 to 0.8 as moderate, between 0.4 and 0.6 as fair and below 0.4 as poor. Dworkin and Whitney (1992) suggested kappa scores over 0.6 were acceptable for observation-based designs. Third, an analysis of the internal consistency of the inventory was completed by calculating Cronbach co-efficient alpha (Cronbach 1951). A cut off of Cronbach 0.7 (Kline 1999) was used to examine if consistency could be improved by removal of any domains. Corrected item total correlations were also calculated between each domain score and the total score. A reliable scale required all domains to correlate with the total. A value less than 0.3 indicated that the item did not correlate with the total score (Field 2005). Fourth, review of intra, inter rater reliability and internal consistency of domains was undertaken. Where a domain either failed to demonstrate adequate intra rater reliability or failed to demonstrate both adequate inter rater reliability and internal consistency the domain was discarded. Fifth, treatment sensitivity was assessed by using split half reliability and calculating Cohen *d* (Cohen 1994). Cohen *d* was calculated from the primary observer's mean scores before and after treatment on her first observation. An untreated sample of participants tested twice with a two-week time point was unavailable. Possible was a split half procedure with a therapist coding time gap. The sample was split into the 1st and 2nd minute for each participant. The primary observer, a physiotherapist with 5 year's experience with chronic pain patients, rated the first minute of each patient's recording and after a two-week gap rated the second minute of each patient's recording. Finally, comparative validity was examined. In particular a measure of concurrent validity of quality of movement was possible in comparison with the two minute timed walk and repeated sit-to-stand test. Further comparisons were made with the self-reported physical dimensions of the SIP.

3. Results.

3.1 Participants

57 consecutively referred patients were invited to participate. 49 patients completed the study. There were no differences between those participating and those not participating on any biographical or clinical measure. A higher proportion was female (57.9%) and the mean age was 48.4 years (SD 10.7). All participants were white European and most were married (63.2%). Just under half of the participants reported they were not working or had retired

(63.2%) or worked part-time (19.3%) due to pain; 5.3% had retired due to reasons other than pain and only 1.8% were working full time. 10.4% stated that none of these categories was applicable. A high proportion (86%) was receiving wage replacement benefits such as disability living allowance. 50.9% reported the primary site of pain to be back, full body (14%), lower limbs (12.3%), cervical pain (10.5%) and other areas (12.3%). Table 1 shows the sample characteristics.

Table 1 about here

3.1. Item endorsement frequency.

The most commonly endorsed items were ‘limping’, ‘absent arm swing bilaterally’, ‘did not touch wall’ and ‘no aids’ (frequency > 40). Five items in three domains were never endorsed or endorsed only once or twice. These items were ‘step to foot’ and ‘two foot swing’ in the ‘stride length’ domain, ‘responsive neck movement’ in the ‘Head and Neck’ domain and ‘2 walking sticks/elbow crutches’ and ‘Delta/Zimmer frame’ in the domain of ‘Aids’. ‘Step to foot’ was excluded from further analyses because it was judged to have content already captured in the item ‘limping’. The other four items were left intact despite low endorsement because it was judged that despite infrequent use they captured relevant content within a wider distribution range, the absence of which was as important to capture as the presence. The item pool entering further analyses therefore consisted of 35 items across 11 domains of movement, with each domain consisting of a median of three items (range 2-5).

Table 2 about here

3.2. Tests of intra- and inter-rater reliability

Of the 11 domains, 8 domains demonstrated adequate intra–rater reliability with kappa scores above 0.6. The 3 domains with less than adequate kappa scores were ‘Heel strike’ (0.43 kappa), ‘Trunk’ (0.57 kappa) and ‘Head and neck’ (0.52 kappa).

Inter-rater results found that reliability was adequate in 7 domains (>0.6 kappa). In the remaining 4 domains reliability was compromised ‘Heel strike’ (0.5 kappa), ‘Base of support’ (0.5 kappa), ‘Trunk’ (0.29 kappa), ‘Head and neck’ (0.41 kappa).

Table 3 about here

3.3. Tests of internal consistency

The overall Cronbach coefficient alpha value (0.71) met with the 0.7 cut off point before treatment. Deletion of ‘Head and neck’ improved the overall Cronbach alpha. Corrected item correlations revealed domains ’Trunk’, ‘Head and neck’ and ‘Aids’ did not adequately correlate with the total score (See table 4).

Table 4 about here

3.4. Final inventory

A review of intra, inter rater reliability and internal consistency of domains was undertaken at this stage. Three domains failed to demonstrate adequate intra rater reliability ‘Heel strike’ (0.43 kappa), ‘Trunk’ (0.57 kappa) and ‘Head and neck’ (0.52 kappa) and were discarded.

Inter rater reliability and internal consistency results were then reviewed. Two domains demonstrated adequate intra rater reliability and internal consistency but failed to achieve above 0.6 kappa within inter rater reliability analyses; ‘base of support’ (0.5 kappa) and ‘walking line’ (0.55

kappa). These items were retained. The domain ‘Aids’ was retained because it demonstrated adequate intra and inter rater reliability, but corrected item total correlations showed that it did not correlate with the total score. Overall Cronbach alpha did not improve when this domain was deleted.

In sum, 8 domains were retained containing a total of 23 items: ‘Stride length’, ‘Base of support’, ‘Walking line’, ‘Arm swing’, ‘Turning ‘, ‘Wall touch’, ‘Rest’ and ‘Aids’. Resulting in a scoring range of 0 to 16, where higher numbers indicate a poorer walking quality. The remaining results were calculated using the revised inventory.

3.5 Tests of split-half reliability and treatment sensitivity

Three domains demonstrated adequate split half reliability (>0.6 kappa) ‘Stride length’, ‘Wall touch’ and ‘Aids’. The remaining five items had kappa scores less than 0.54. (See table 5).

Treatment sensitivity was assessed using rater one’s mean scores before 8.65 (range 1 – 13) and after treatment 6.2 (range 1 –11). A large effect size was found: Cohen’s *d* 1.02.

Table 5 about here

3.6 Tests of comparative validity

Larger walking distances r = -0.57 p = < 0.01 level (one tailed) and higher number of sit to stands r = -0.44 p = < 0.01 level (one tailed) were found to be moderately associated with greater walking quality before treatment. Good quality walking yielded a lower score on the BAWI. Higher levels of self-reported disability (SIP total) were moderately related to higher scores on the inventory indicating poorer walking quality r = 0.36 = < 0.01 level (one tailed) as measured by the inventory before treatment. Poorer walking quality as measured by the inventory was associated with lower levels (less disability) of the physical dimension of Sickness Impact Profile ($r = 0.47$ $p = < 0.01$ level (one tailed) and its subscales body care and movement ($r = 0.39$), ambulation ($r = 0.45$ $p = < 0.01$ level (one tailed) and mobility ($r = 0.41$ $p = < 0.01$ level (one tailed) before treatment.

4. Discussion

The final Bath Assessment of Walking Inventory consists of 8 domains that encompass key movement quality parameters affected by chronic pain. The BAWI demonstrated good intra rater reliability and internal consistency. For the most part it's inter rater reliability was established. Calculations of split half reliability indicate that the inventory should be used with the two-minute walk test in its entirety. Further, validity was established in comparison with well-used measures of physical function and in response to changes through treatment.

Of the original 11 domains 3 were discarded; 'Heel strike', 'Trunk' and 'Head and neck' did not demonstrate adequate intra rater reliability. The ability to reliably observe and code each item was fundamental to the application of this inventory. Therefore an inability to demonstrate within rater agreement was a significant threat to the reliability of the inventory.

A decision was taken to retain two domains 'base of support' and 'walking line'. They demonstrated moderate intra rater reliability; the domain scores correlated with the total score and Cronbach's alpha did not improve if the domain was deleted, therefore indicating adequate internal consistency. The domains did not show adequate inter rater reliability. Taken with the small magnitude by which the scores did not achieve an adequate kappa, it was concluded that these domains did not demonstrate a significant threat to the reliability and internal consistency of the inventory.

The domain ‘Aids’ demonstrated adequate intra and inter rater reliability but corrected item total correlations showed that it did not correlate with the total score suggesting that it measured a different construct from the other domains. Cronbach alpha did not improve when this domain was deleted. Therefore adequate evidence exists to suggest significant psychometric robustness for the domain to be retained.

Calculations of split half reliability indicated that the inventory should be used with the two-minute walk test in its entirety. This result is not unexpected as patients suffering from pain commonly report an increase in their symptoms on activity, resulting in a change in speed and quality of walking. Therefore it seems reasonable that observations made in the first minute would differ to those made in the second minute. The aim of this walking inventory is to provide an observation based measure of overall walking quality as such we would argue for it to be used throughout the whole of the two minute timed walk test to capture the full range of walking quality characteristics within this time frame. The treatment effect size results indicate that this inventory is sensitive to treatment. However it will be necessary to review the inventory alongside validated physical and functional measures comparing correlation analyses of treatment induced changes before being able to demonstrate robustly that this inventory is sensitive to treatment, nonetheless initial results are promising.

There are limitations to the study; first, this study was undertaken with a small group of complexly disabled patients recruited from a tertiary pain clinic. Second, because of our focus on a simple observation tool, fine grained movements could not be observed. In particular spinal curvature and pelvic tilt were not observable. Third, walking was assessed in a relatively confined context of a clinical test of physical performance. No attempt was made to capture naturally occurring movement. Fourth, no attempt was made to control for any effects of therapist presence. Finally, no normative data from people without chronic pain exist for this new measure. Further study is necessary before recommendation for use can be made.

A number of studies are required to develop this instrument further. Not all of these can or should be performed in the same research centre, hence our communication of the measure at this stage of its development. First, more information is required on the characteristics of the judges. The starting point for this study was the goal that a clinically useful, technologically simple (paper and pencil) observation measure was needed in which the real-time assessment of walking in any standardised environment could be undertaken. Therefore clarity and simplicity of observable movements were guiding principles. Whether the judges need, therefore, to be qualified or experienced physical therapists remains an empirical question. Second, related to this, is the need to examine how much training (for both therapists and non-therapists) is necessary to achieve adequate inter-rater reliability. Can, for example, volunteer or student staff be trained easily to undertake these judgements? A repeatable means of training raters requires development; which should include providing moving image examples of the specific movement to be rated. Third, will this measure achieve similar levels of reliability and validity in other pain treatment settings? Independent replication, and/or multi-site studies would greatly improve our confidence in this instrument. Achieving a reliable instrument for use by therapists in a range of chronic pain situations remains a highly desirable goal for both theoretical and clinical reasons.

Quantifying observable parameters of walking quality will allow the study of the effects of psychosocial factors on walking, a core component of many activities. There has been a recent re-examination of the effects of pain on activity. Bousema et al., (2007) have shown that contrary to traditional accounts, patients with chronic pain do not automatically show reduced patterns of activity (see also van den Berg-Emons et al., 2007). Rather than reduce overall activity, patients may persevere in activities, developing patterns of “boom or bust”, swinging between the engagement in valued goal driven activity and the avoidance of pain (McCracken and Samuel, 2007). We hypothesize that walking quality will be sacrificed by those chronic pain patients with avoidant or confrontational activity patterns, in the pursuit of primary goals.

Woby et al., (2007) has started a move by physiotherapists to identify the relation of cognitive factors to levels of pain and disability in a chronic pain sample attending physiotherapy. The assumption being that where cognitive factors are found to be influential, treatments that use cognitive-behavioural principles would better induce long-term meaningful change. Self-report questionnaires were used to find that higher levels of functional self efficacy uniquely related to the prediction of disability and pain intensity as an outcome. Lower levels of depression were associated with disability as an outcome and reduced levels of catastrophizing with less pain intensity. The

BAWI could enable further investigation within this field; first by providing a means to assess the role of specific cognitive factors in relation to an observed functional task, and second as an outcome measure that can be used to evaluate the efficacy of cognitive behavioural treatments.

Walking is a crucial component of activities that are detrimentally affected by chronic pain. When in pain, people adapt how they walk. Successfully measuring walking quality as affected by pain will enable the study of the communicative effects of movement, the role of altered movement in the maintenance of disability, and the efficacy of physical therapy in altering walking pattern. The BAWI offers promise as a quick, valid, and reliable tool for use in clinical environments, and deserves further investigation.

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Table 1

Biographical and clinical details of participants including mean and standard deviations, (n = 57).

Variable	mean (SD), n=57
years of education	13.3 (3.9)
out of work (months)	58.5 (1.7)
chronicity of pain (months)	137.6 (105.9)
usual pain intensity 0-10	7 (1.6)
level of distress of pain in past week 0 -10	7.2 (2.2)
number of visits to GP in past 6 months	4.3 (4.9)
number of doctors visited due to pain	5.6 (2.7)
Number of uptime hours (i.e. not resting or sleeping)	3.8 (4.1)
number of hours sleeping at night	5.2 (4.7)

Table 2

Frequency of endorsement of items within each domain

Before treatment **N= 57**		**Frequency of coding**		
		Rater 1	**Rater 2**	**Rater 3**
Heel strike	Bilateral heel strike	28	38	38
	Unilateral heel strike	16	10	12
	No heel strike	13	9	7
Stride length	Appears Equal	3	4	6
	Limping	54	53	51
	Two foot swing	0	0	0
Base of support	Normal	3	15	3
	Tightrope	29	28	20
	Feet wider than normal	25	14	34
Walking line	Maintains walking line	4	2	1
	Drifts within walking line	29	25	37
	Deviates from walking line	24	30	19
Trunk	Responsive trunk movement	2	1	0
	Absent trunk movement	30	10	23
	Side flexion or rotation	24	41	33
	Side flexion & rotation	1	5	2
Arm Swing	Bilateral arm swing	3	3	3
	Unilateral arm swing	11	14	10
	Absent arm swing bilaterally	43	40	44
Turn	Pivot/ Step turn	8	3	11

	Stepping to turn	36	47	32
	Loss of balance	13	7	14
Head and Neck	Responsive neck movement	0	1	0
	Absent neck movement	10	15	6
	Flexion	12	20	6
	Side flexion or rotation	33	19	39
	Side flexion & rotation	2	2	6
Wall touch	Did not touch wall	43	44	45
	Touched wall	14	13	12
Rest	Did not stop and rest	28	39	24
	Stopped and rested	29	18	33
Aids	No Aids	47	47	47
	1walking stick/elbow crutch	9	9	9
	2walking sticks /elbow crutch	1	1	1
	Delta/ Zimmer frame	0	0	0

Table 3

Intra and Inter rater reliability; Frequency of agreements per domain, percentage agreement and chance corrected Kappa scores.

Before treatment n= 57	**Intra rater Rater 1 and 3**			**Inter rater Rater 1 and 2**		
	Number of agreements	**%**	**Kappa**	**Number of agreements**	**%**	**Kappa**
Heel Strike	35	61.4	0.43	38	66.7	0.5
Stride Length	54	94.7	0.92	53	92.9	0.89
Base of Support	45	78.9	0.68	38	66.7	0.5
Walking Line	43	75.4	0.63	40	70.2	0.55
Trunk	39	68.4	0.57	27	47.4	0.29
Arm Swing	49	85.9	0.79	46	80.7	0.71
Turning	42	73.7	0.61	42	73.7	0.61
Head & Neck	35	61.4	0.52	30	52.6	0.41
Wall Touch	55	96.5	0.93	54	94.7	0.89
Rest	47	82.5	0.65	46	80.7	0.61
Aids	56	98.3	0.98	56	98.3	0.98

Table 4

Internal consistency calculations for each domain and the total score.

Before treatment **n= 57**	**Cronbach alpha when item deleted**	**Corrected item-total**
Heel Strike	0.69	0.46
Stride Length	0.70	0.47
Base of Support	0.70	0.47
Walking Line	0.70	0.34
Trunk	0.71	0.24
Arm Swing	0.70	0.43
Turning	0.69	0.54
Head and Neck	0.72	0.15
Wall Touch	0.67	0.58
Rest	0.66	0.60
Aids	0.71	0.25
Overall Cronbach Co-efficient alpha	0.71	

Table 5

Split half reliability of final inventory; Frequency of agreements per domain, percentage agreement and chance corrected Kappa scores.

Before treatment n= 57	**Split half reliability Time 1(first minute) and Time 2 (second minute)**		
	Number of agreements	**%**	**Kappa**
Stride Length	49	85.9	0.79
Base of Support	39	68.4	0.52
Walking Line	36	63.2	0.45
Arm Swing	37	64.9	0.47
Turning	33	57.9	0.37
Wall Touch	52	91.2	0.82
Rest	44	77.2	0.54
Aids	48	84.2	0.79

Appendix 1 The original Bath Assessment of Walking Inventory (item pool)

Domain	Item	Definition	Score	Item observed (tick)
Heel strike	Bilateral heel strike	Both heels make the first contact of the feet with the floor.	0	
	Unilateral heel strike	Only one heel makes the first contact of the foot with the floor.	1	
	No heel strike	Both heels do not make the first contact of the feet with the floor	2	
Stride length	Appears Equal	Step length is equal on both sides	0	
	Limping	Weight transference time is not equal on both legs	1	
	Two foot swing	Both feet are swung forward together	2	

Base of support	Normal	Feet are placed less than 2inches apart (eyeballing medial arch to medial arch)	0	
	Tightrope	Walking so one foot or both feet cross midline to some extent	1	
	Feet wider than normal	Feet are placed wider than normal distance apart	2	
Walking Line	Maintains walking line	Walks in centre of 50cm walking width markers taking the most direct walking line including at turns	0	
	Drifts within walking line	Drifts side to side within the 50cm width of walking line	1	
	Deviates from walking line	Deviates outside of the 50cm walking width markers	2	
Trunk	Responsive trunk movement	Trunk observed to move in preparation for or during turning	0	

	Absent trunk movement	Rigidly remains in sagital plane and/or no preparatory movements seen prior to or in response to turns	1	
	Side flexion or rotation	Trunk moves into or holds an inefficient position of side flexion **OR** rotation	1	
	Side flexion and rotation	Trunk moves into or holds an inefficient position of side flexion **AND** rotation	2	
Arm swing *(excludes momentary movements that function to improve ability to complete the test eg flicking hair out of eyes.)*	Bilateral arm swing	Active bilateral glenohumeral flexion and extension	0	
	Unilateral arm swing	Active unilateral glenohumeral flexion and extension	1	
	Absent arm swing bilaterally	Absent arm swing or passive – momentum induced glenohumeral flexion and extension	2	

Turning	Pivot/ 2 Step	Completes a 180-degree turn in 2 or less steps. Therefore 2 or less rotated steps are seen, before the foot is back in line with the walking line	0	
	Stepping	Completes a 180-degree turn in 3 or more steps. Therefore 3 or more rotated steps are seen, before foot is back in line with the walking line	1	
	Loss of balance	Loses balance during or as comes out of turn, requiring restorative steps or realignment.	2	
Head and Neck	Responsive neck movement	Head observed to move in preparation for or during turning.	0	

Movements generated by the head and neck, rather than momentum induced	Absent neck movement	Rigidly remains in sagital plane and/or no preparatory movements seen prior to or in response to turns	1	
	Flexion	Head/neck moves into or holds an inefficient position of flexion	1	
	Side flexion or rotation	Head/neck moves into or holds an inefficient position of side flexion **OR** rotation	1	
	Side flexion and rotation	Head/neck moves into or holds an inefficient position of side flexion **AND** rotation	2	
Wall touch	Did not touch wall during test	Did not touch wall, radiator, doors etc during test	0	
	Touched wall during test	Touched wall, radiator, door etc during test with arm	1	

Rest	Did not stop and rest during the test	Completed each interval consecutively	0	
	Stopped and rested during the test	Stops and takes an unrequired rest	1	
Aids	No Aids	Uses no aids	0	
	1 walking stick/ elbow crutch	Uses one walking stick, elbow or axilla crutch	1	
	2 walking sticks/ elbow crutches	Uses 2 walking sticks, elbow or axilla crutches	2	
	Delta/ Zimmer frame	Uses a three wheeled delta rollator, wheeled or un-wheeled zimmer frame	2	

Scoring definitions	
0 =	Symmetrical Responsive component of movement Compliant with test standards
1 =	Asymmetrical unilaterally (Compensatory movement in one plane) Rigidly remains in sagital plane.

2 =	Symmetry altered bilaterally (Compensatory movement in two or more planes) Loss of balance Deviates from test instructions