Identifying factors which increase the balance confidence of soldiers using a prosthesis following below-knee amputation attending a rehabilitation institute in Ragama, Sri Lanka

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Abstract— Introduction. *War injuries in Sri Lanka resulted in many soldiers dependent on a lower limb prosthesis following below-Knee amputation. The Balance Confidence is defined as "confidence in one's ability not to fall" and is scored by the Activities-specific Balance Confidence (ABC) scale which measures the degree of adaptation to the prosthesis. A low balance confidence level has been shown to correlate with a reduction in both preserved prosthetic capacity (what can be done) as well as prosthetic performance (what is actually done). Identifying this group is important as they will require further intervention for improving their balance confidence level.* Objectives. *To assess the balance confidence level of soldiers using a lower limb prosthesis following below knee amputation and to identify factors, socio-demographic, amputation-related or health-related, which independently increase the balance confidence level.* Methodology. *One hundred and twenty soldiers with a lower limb prosthesis following below-knee amputation and attending a rehabilitation institute in Ragama were selected over a three month period, using a convenient sampling method. A self-administrated, pre-tested questionnaire containing the Activities-specific Balance Confidence (ABC) scale with 16 global and situation-specific activities commonly encountered in daily living was used to score the balance confidence level. Independent samples t-test, one way ANOVA and multiple linear regression method were used for uni-variable and multi-variable data analysis respectively.* Results. *An ABC scale score of 80 was determined by previous studies as a cut off point with only 22% of individuals obtaining a 'satisfactory' score (ABC scale score ≥ 80) while the majority of 78% had a balance confidence level deemed unsatisfactory (ABC scale score < 80) and therefore required intervention. The factors found to independently increase the balance confidence included engaging in sports activities, increased hours of prosthesis use in a day, low/absent alcohol intake and higher monthly family income level.* Discussion and Conclusion. *The majority (78%) of amputee solders in the study had a balance confidence level deemed "Unsatisfactory" and hence require intervention to improve their balance confidence. Engaging in sports activities, increasing the number of hours using the prosthesis and a reduced/ absent alcohol intake were found to independently increase the balance confidence level. These measures should now become a vital part of their future management.*

Keywords—**Balance confidence, Amputee soldiers, Lower limb amputation**

I. INTRODUCTION

The ultimate goal of a rehabilitation programme for amputees is to train them to be as independent as possible while using the definitive prosthesis and to assist them to return to normal activities, within the functional limitation (Downe, 1995).

Balance confidence is defined as "confidence in one's ability not to fall" so that you do not lose balance or become unsteady while performing an identified activity (Powell & Myers, 1995). Fear of falling is defined as "an ongoing concern about falling that ultimately limits the performance of an individual's daily activities" (Tinnete *et al. 1990*). Balance confidence and fear of falling are related concepts where an increase in fear of falling results in a decreased balance confidence. The preliminary purpose of developing the concept of balance confidence was to provide a sensitive measure of the fear of falling (Powell & Myers, 1995; Tinnete *et al. 1990*; Myers *et al.* 1998). A few published studies have attempted to investigate the level of balance confidence among community-dwelling, non-military unilateral lower limb amputees of vascular causes (like peripheral vascular disease, diabetes mellitus, vascularitis etc.) and non-vascular causes (like trauma, cancer, congenital malformation).(Miller *et al.* 2002; Miller & Deathe, 2004; Miller *et al.* 2001). However, studies conducted with amputee military personnel are limited. We believe that balance confidence would be an important measure among those with lower limb amputations. It results in altered gait pattern due to use of prostheses (Batani & Olney, 2002), altered postural sway (Fernie & Holliday, 1978) and standing balance (Hermodsson et al. 1994) and possible loss of sensory feed-back (especially the proprioception) from the removed part of the limb. Evidence suggest that balance confidence level of unilateral lower limb amputees is strongly associated with mobility

capability (what people can do), mobility performance (what people do), and participation in social activities (Miller *et al.* 2001).

Our descriptive study was conducted to examine the balance confidence level of soldiers with unilateral below-knee amputation attending a selected rehabilitation institute in Sri Lanka. Our objective was to identify any socio-demographic, amputation-related or health-related factors which independently increase the balance confidence level.

II. METHODOLOGY

A. Design and Sample

Our descriptive cross-sectional study surveyed a sample of male soldiers (currently in service, retired or medically condemned), within the age group of 18 – 60 years, who underwent unilateral below-knee amputation due to war related injuries. Those who had any other co-existing severe disability, such as upper limb amputations and problems restricting optimal functioning of the upper limbs or the unaffected lower limb (e.g. unhealed fractures or peripheral nerve palsies) were excluded. To ensure that subjects had become accustomed to using their prosthesis, only those who had been ambulating using their prostheses for a minimum of 12 months following discharge from the formal prosthetic rehabilitation programme and were wearing their prostheses on a daily basis were included. All the included subjects could read and write either Sinhala or English.

A convenience sample of hundred and twenty (n=120) amputee soldiers who attended the selected rehabilitation institute in Ragama, Sri Lanka between May 15 and August 15, 2012 for prosthetic services were included in the study. Over the three month study period data collection was carried out in a weekly basis from 8.00 a.m. to 12.00 noon. This institute provides rehabilitation services, including prosthetic fitting and prosthetic training. It assures life-time follow-up for prosthetic services, including prosthetic repairs and replacements for soldiers discharged from the formal rehabilitation programme.

B. Data Collection

Information for the analysis was collected using a pre-tested self-administrated questionnaire consisting of a participant data sheet and the Activities-specific Balance Confidence (ABC) scale. The participant data sheet collected socio-demographic, amputation-related, and health-related data. The variables were included because of their clinical relevance or because of previously reported importance in studies of balance confidence in amputee population. Written instructions were given to the participants at the relevant places, regarding answering the items in the questionnaire. Any questions from the respondents were clarified by the researcher during the completion of the questionnaire.

1) Socio-demographic factors: The age, current marital status, education level, current employment status, and monthly family income level were collected. The unmarried, widower participants were coded as "Singles." Participant who worked on part-time basis were also considered as "Employed."

2) Amputation-related factors: The number of years since amputation, current mobility device use, and number of hours using the prosthesis in a typical day were collected. The number of years since amputation was based on the date of first trans-tibial amputation surgery following trauma. Participants reported current mobility device use by checking whether they used crutches, canes or no device when ambulating with the prosthesis.

3) Health-related factors: The number of falls in the past 12 months, engagement in sports activities during leisure and the degree of alcohol consumption, and cigarette smoking were collected. The fall history was ascertained by asking whether the respondent had fallen in the past 12 months prior to the study and self-reported answers were recorded as either "yes" or "no." This method of determination of fall history has been used by many researchers (Miller *et al.* 2002; Miller & Deathe, 2004) Self-reports of alcohol consumption were scored as "frequent," "occasional," or "never used."

4) Outcome Measure: The 16-item Activities-specific Balance Confidence (ABC) scale (Powell & Myers, 1995) was used to determine balance confidence level. Participants were asked to rate their levels of confidence on a scale of 0% to 100%, while performing a variety of activities, such as climbing stairs, reaching above the head, and walking on different surfaces. Those participants who had not performed a particular activity in a question were requested to imagine how confident they would be if they had to do the activity. Those who had been using a walking aid for performing an activity, were asked to rate their confidence as it they were using those supports.

Myers *et al.* (1998) has pointed out that deleting a few items from the ABC scale dose not decrease the internal consistency of the scale appreciably and thus, omission of the last item ("walking on the icy sidewalks") will not invalidate the scale in countries with warmer climates (Myers *et al.* 1998). We had to omit the last item in the ABC scale ("walking on icy sidewalks") as the study was performed in a tropical country. Myers and colleague in 1995 have recommended that, a participant should answer at-least 75% of the items (12 items of the 16) in the ABC scale to be eligible for calculating overall ABC scale score (Myers *et al.* 1998). Participants who answered 12 or more out of the 15 items of the ABC scale (as the last item of the scale was omitted) were considered as "complete respondents." Only "complete respondents" were included in the data analysis and none of the information was used

from incomplete respondents. The overall ABC scale score (ranging from 0 to 100) for a particular individual is calculated by summing the ratings for all responded items and dividing by the number of responded items.

The ABC scale is a psychometrically sound tool for measuring balance confidence among people with unilateral lower limb amputation with satisfactory reliability and validity (Miller *et al.* 2003). It has been administrated for younger individuals with lower limb amputation, within the age group of 23-55 in previous studies (Miller *et al.* 2002; Miller & Deathe, 2004).

C. Data Analysis

All the continuous variables were transformed into categorical-level variables to simplify the correlation analyses and presentation of the descriptive statistics. The variables were collapsed into categories, based on the statistical distribution. Three categories each were used for age, monthly family income, and number of years since amputation. The number of hours using the prosthesis in a day was categorized into two groups, by using its median value for the total sample as a cut-off point. Participants who used their prosthesis more than median number of hours in a day were categorized as "Higher Prosthesis Users," and those who used the prosthesis for median number of hours or less than that as "Lower Prosthesis Users."

The education level was originally an ordinal variable and was collapsed in to two groups i.e. those who educated up to grade 11 or above and those who educated below grade 11. Categorical variables such as current marital status, current employment status, use of mobility devices, presence of a fall in the past 12 months, engagement in sports activities and cigarette smoking were collapsed into binary responses. Alcohol intake was originally a variable with three responses and was collapsed into tertiary responses.

Statistical analyses included calculation of means and percentages for descriptive purposes and to examine the correlation of independent variables with the mean ABC scale score. Statistically significant difference of mean ABC scale score between two groups was assessed using independent-samples *t*-test and among three groups was assessed using one-way ANOVA.

Multiple linear regression analysis was performed to examine the multivariate relationships of the independent variables with mean ABC scale scores. The objective of this analysis was to identify a reliable group of independent variables that best predicts or describes the outcome measure i.e. mean ABC scale score. The forward selection procedure was used to assess multivariable relationships, with $p < .05$ used for entry (PIN) of the independent variables to the regression model. The forward selection regression started with the best predicted independent variable of the dependent variable i.e. with the highest Adjusted R square (R^2) that statistically significant at $p < .05$. Then, the independent variables were entered into the regression model one at a time according to a criterion i.e. entered independent variable should increase R^2 the most and that improvement should be statistically significant at $p < .05$. The process continued until no more independent variables passed the criterion. All the statistical analyses were conducted using SPSS (Statistical Package for Social Sciences) for Windows version 17. The conventional standard of $p < 0.05$ was used to determine statistical significance.

III. RESULTS

Data analysis was done on the 85.83% (103/120) eligible completed responders. The mean age of the total sample was 34.89 years (SD = 7.90) Descriptive statistics for the total sample are presented in Table 1 and include the mean ABC scale score for each of the variables considered in the study. The mean ABC scale score for the entire sample was 67.05 (SD= 16.5); 22.3 % of the sample were found to have an ABC scale score over 80.

Table 2 shows the results for the final regression model containing all variables that were found to influence the study sample. The results of the multiple linear regression analysis indicated that monthly family income level ($\beta = 0.270$, $p = 0.002$), alcohol intake ($\beta = - 0.238$, $p = 0.008$), engagement in sports activates ($\beta = 0.260$, $p = 0.003$), and number of hours using the prosthesis in a day ($\beta = 0.212$, $p = 0.016$) were independently related to balance confidence. Hence, engaging in sports activities, increased hours of prosthesis use in a day, low or absent alcohol intake and higher monthly family income level were found to independently increase the balance confidence level. These four variables, concerned in the study explained 31.2% of the total variance, ($R^2 = 0.340$, $F (4,95) = 12.24$, $p < 0.0$

IV. DISCUSSION AND CONCLUSION

This study seeks to identify the balance confidence level of soldiers with unilateral below-knee amputation attending a selected rehabilitation institute in Sri Lanka. Our objective was to identify any socio-demographic,

Socio-Demographic Factors	Percentage	Mean ABC scale score
Age (years)*		
20 - 30	35.0	73.39
31 – 40	40.7	66.35
41 – 50	24.3	58.80
Current marital status*		
married	72.8	68.95
single	27.2	61.69

Education level		
below grade 11	53.4	67.36
grade 11 or above	46.6	67.09
Current marital status*		
employed	37.9	69.23
unemployed	62.1	60.95
Monthly income*		
SLR 14,000-30,000	41.7	59.67
SLR 31,000-45,000	30.1	68.69
SLR 46,000-60,000	25.2	77.72
Amputation-related factors		
Number of years since amputation		
less than 5 years	30.1	65.66
5 to 10 years	34.0	66.22
more than 10 years	35.9	68.80
Use of mobility devices		
not used	61.2	65.44
used	38.8	66.86
Number of hours using prosthesis in a day*		
high prosthesis users	75.7	59.47
low prosthesis users	24.3	69.38
HEALTH-RELATED FACTORS		
Falls in last 12 months		
yes	37.9	65.18
no	62.1	69.54
Engagement in sports*		
yes	72.8	70.1
no	27.2	58.61
Alcohol intake*		
frequently	22.0	55.61
occasionally	42.1	66.22
never used	35.9	79.93
Cigarette smoking		
yes	44.6	66.53
no	55.4	67.37

SLR = Sri Lankan Rupees

¶Significance levels were determined by independent-samples *t*-test for two sub-groups and Analysis of Variance (one way ANOVA) for three sub-groups.

* denotes all sub-group means are significantly different at $p < 0.05$.

Table 1. Descriptive and Mean Activities-specific Balance Confidence (ABC) scale scores for total sample ¶ (n= 103)

amputation-related or health-related factors which had independently increased the balance confidence level. An ABC scale score was used for this purpose. A score of 80 was determined as the cut off point from a previous study by Myer et al (Myers *et al.* 1998). An ABC scale score ≥ 80 was deemed a 'Satisfactory' score whereas a score < 80 was deemed 'Unsatisfactory' and those subjects would require interventions. The mean ABC scale score was 67.05, (SD = 16.5) for the total sample in our study was well below this cut-off point. It is highly noteworthy that the majority (78%) of the study subjects had an ABC scale score < 80. This signifies the current status of balance confidence in soldiers with lower limb prosthesis and highlights the immediate need for a carefully thought out approach to improving and increasing their level of confidence. As indicated earlier, this intervention would need to include many aspects like education, balance training and activity. It is also interesting that 22% of individuals in the study had an ABC scale score ≥ 80.

Multi-variable analysis of the subject population yielded some very interesting results. Although a vast number of socio-demographic, amputation-related and health-related factors were analysed, four factors were found to independently increase the balance confidence level of the sample. These were engaging in sports activities, increasing the number of hours using the prosthesis, higher monthly family income level and a low or absent alcohol intake. Subjects who engaged in sports activities had a significantly higher balance confidence level when compared with those who did not. All these participants were engaged in physical demanding sports such as cricket, volleyball, athletics, swimming etc. Therefore further investigation into the degree and type of sports activity is important as it would identify the most effective ways sports may be used as an intervention for improving the balance confidence. Subjects who used their prosthesis for a long time (> 12 hours) in a day had higher balance confidence level, when compared to lower users. Using the prosthesis much may help the individual to be accustomed to the prosthesis. This rationale may explain the present findings. Therefore, continuous prosthetic use may be important concerns for improving balance confidence. Those who consume alcohol were found to have higher balance confidence compared with those did not. This finding is in marked contrast to a previous study conducted among non-military community-dwelling amputees in Canada 2002 reported that, alcohol intake was not an independent predictor of balance confidence level (Miller *et al.* 2002).

Subjects who received relatively low monthly family income reported lower balance confidence. This was an unexpected finding, because we did not anticipate an independent relationship of monthly family income level with balance confidence level. In contrast income level was not found to be an independent factor, predicting balance confidence level in a study conducted among

Factor	β	b	SE	95% CI
Engage in sports activities	0.270	9.818	3.152	3.562,16.075
Number of hours using prosthesis	-0.238	-9.313	3.412	-16.086, -2.540
Alcohol intake	0.260	9.432	3.135	3.209,15.655
Monthly family income	0.212	7.814	3.172	1.516,14.111
R^2	0.309*			

β= standardized regression coefficient, b = unstandardized regression coefficient, SE = Standard Error of the regression coefficient, CI = Confidence Interval

* denotes Adjusted R^2

Table 2. Final multiple linear regression model of mean Activities-specific Balance Confidence (ABC) scale score for total sample

Canadian non-military lower limb amputees by Miller *et al* .(2002). As our study was conducted in a developing country, this may explain the reason for different findings in two studies.

We considered those in part-time work as employed as they engaged in income generating tasks for their family. In the original study, employed participants had higher balance confidence, when compared to unemployed. We also anticipated the current results, because employed participants usually engage in an active life style for generating income for their families. These findings were however in contrast to a previous study conducted among non-military amputees of all causes where employed subjects had lower levels of balance confidence, than the unemployed (Miller *et al.* 2002).

Although some studies indicate that the use of a mobility device significantly increased the balance confidence level (Miller *et al.* 2002; Miller & Deathe, 2004) we did not find this in our study. A mobility device can be used by an amputee to improve the balance, as well as to reduce weight bearing on the stump for reducing pain. However, we did not analyse the reasons for using these devices.

It is also important to note that the number of falls in the past 12 months of our study sample did not have a significant effect on the balance confidence level, as was the case in previously described studies (Miller *et al.* 2002; Miller & Deathe, 2004).

We identified several limitations in our study. The outcomes of this study cannot be generalized since we used a convenient non-probable sample from a single setting. Because the study design was cross-sectional, a temporal relationship cannot be made by findings. The respondents were required to rely on memory to answer the question, any fall in the past 12 months. They may susceptible to recall-bias. Moreover, we could not examine the effect of problems associated with prosthetic use on balance confidence level.

The finding of a low balance confidence level in the majority of our own study sample signifies how important it is to have a regularised intervention programme for the majority of prosthesis wearers. A randomized trial conducted by Brouwer et al. in 2003 indicated that education and activity training programs were effective for reducing fear of fall among community-dwelling seniors (Walker & Rydahl, 2003). Another randomized trial conducted by Liu-Ambrose *et al.* (2004) reported that resistance training and agility training were effective for improving balance confidence among elderly women with low bone mass.

In our own country, the effectiveness of different interventions to improve balance confidence among lower limb amputees has not been closely evaluated. The development of interventions and studies assessing the efficacy of these interventions among people with lower

limb amputation is essential for ensuring complete rehabilitation for those who use prosthetic limbs. We identified several aspects to be further investigated in relation to present study. This study elaborates baseline levels for balance confidence. It seeks to emphasize the importance of developing methods of improving the balance confidence of these young amputee soldiers.

A significant (78%) number of amputee soldiers of our sample had a balance confidence level deemed “Unsatisfactory” and hence need of intervention. Engaging in sports activities was an important aspect of their management. Increasing the number of hours using the prosthesis and a reduced/ absent alcohol intake were also found to independently increase the balance confidence level. These measures could now become a vital part of their future management.

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