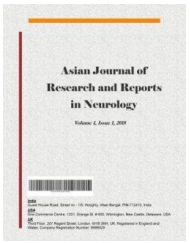

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Bobath versus Proprioceptive Neuromuscular Facilitation in Retraining of Balance and Functional Independence in Activities of Daily Living

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Authors' contributions

This work was carried out in collaboration between all authors. Authors CIE and SUU conceived, designed the study, wrote the protocol. Data collection was done by author SUU. Author MCN performed the statistical analysis and wrote the first draft of the manuscript. Authors CUU and EMU critically revised the manuscript. All authors approved the final manuscript.

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ABSTRACT

Aim: To ascertain the comparative efficacy of Bobath and Proprioceptive Neuromuscular Facilitation in retraining of balance and functional independence in the activities of daily living.
Study Design: Pre-post experimental design.
Place and Duration: The study took place at the University of Nigeria Teaching Hospital, Enugu between May and August 2013.
Methodology: In this study, a total of 50 (29 men and 21 women) stroke survivors with a modal age of 60-65 years were purposively recruited, examined, treated and re-evaluated four-weekly. This study lasted for 12 weeks. Functional independence in activities of daily living (ADL) and balance were assessed using the Barthel Index (BI) and the Berg Balance Scale respectively. The gain in function was calculated as the differences between baseline and post-treatment scores. Data were analysed using SPSS version 23, with Î± set at 0.01.

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Results: Comparing gain in functional independence in ADL between Bobath and PNF, the result showed significantly consistent higher gain with the use of Bobath ($p < 0.001$, 0.02 and 0.04). No statistically significant difference was found in the balance between Bobath and PNF in any of the months ($p= 0.16$, 0.25 and 0.08). However, going by the clinical important difference of 3 on the Berg balance scale, Bobath was found to be more efficacious than PNF after three months.
Conclusion: Bobath appears superior to PNF in the retraining of balance and functional independence in ADL.

Keywords: Stroke; Bobath; PNF; balance; functional independence; ADL.

1. INTRODUCTION

Stroke is one of the leading causes of death and the commonest cause of long- term disability in adults [1,2]. It is the third most common cause of death in developed countries [3] and the leading cause of death in a nation like China [4]. The global prevalence rate is 5 per 1000 person/ years, which amounts to 33 million people living with stroke [5]. Approximately two-thirds of stroke patients have long- standing neurological deficits, and this impedes performance functional independence and hence, activities of daily living [4]. Post-stroke impairment differs from person to person, and it varies chiefly with a factor such as the region of the central nervous system that sustained damage [6]. Stroke can result in a large variety of symptoms and signs, but the most common and widely recognised impairment caused by stroke is motor impairment, which typically affects movement control of the face, arm and leg of one side of the body [7]. Motor impairment often leads to balance impairment [8,9], and impaired postural control and mobility [10].

The focus of stroke rehabilitation is largely on the recovery of impaired movements and functions. This is in a bid to reduce stroke-associated disabilities while facilitating functional independence in daily activities. Several factors have been associated with a delay in post-stroke functional recovery including choice of therapeutic approach, which is interestingly paramount. In stroke rehabilitation, many different physiotherapy approaches such as Bobath approach, motor re-learning approach, Brunnstrom, Rood approach, proprioceptive neuromuscular facilitation have been developed based on different theories about how people recover after a stroke [11]. Of these, the commonly used approaches in this setting are Bobath and proprioceptive neuromuscular facilitation [12]. The Bobath concept explained movement dysfunction in hemiplegia from a neurophysiological perspective and stated that patients must be active while the therapist assists patients to move using key points of control and reflex-inhibiting patterns [11]. The PNF utilises proprioceptive, cutaneous and auditory input to produce functional improvement in motor output [13,14]. The basis for choosing between Bobath and proprioceptive neuromuscular facilitation is, however, poorly understood. There is a paucity of evidence in respect to superiority of PNF over Bobath or vice versa. Generally, for optimum functional recovery, therapists commonly engage both approaches in the treatment [12]. Lack of manpower and excessive workloads which characterise resource- constrained settings pose a severe hindrance to a combination of approaches [15]. Therapists have often reported burn-out syndrome, and this has resulted in poor post-stroke rehabilitation outcomes [16]. Therefore there is a need to determine the more efficacious of the two most common approaches utilised in the rehabilitation of stroke survivors in the present setting. The study sought to determine the comparative efficacy of the Bobath and proprioceptive neuromuscular facilitation in retraining of balance and functional independence in daily activities. It was hypothesised that there would be no significant difference in the effects of the Bobath and PNF on functional independence and balance.

2. MATERIALS AND METHODS

The work is a pretest-post test experimental study of stroke survivors attending outpatient physiotherapy clinics of the University of Nigeria Teaching Hospital (UNTH) Enugu. Using Cohen's power table, a minimum sample size of 46 (23 per group) was used to detect an effect size of 1 standard deviation at power ($1-\beta$) of 0.9 and level of significance (α) of 0.05 [17]. Participants were conveniently sampled, while simple random method was used to allocate participants into the study group. All the participants had physiotherapy sessions

twice weekly. This study lasted for 12 weeks, and participants were re-evaluated on a monthly basis. The following participants were excluded: participants who received extra physiotherapy outside the clinic during the research period, participants who had severe arthritis, history of mental illness, pregnant, on a muscle relaxant and/or had cardiovascular complications. Ethical approval was sought and obtained from the Health Research and Ethics Committee of UNTH. Informed consent was sought and received from the participants.

Despite randomisation, significant differences in baseline outcome, variables were found between the two groups. To reduce the potential bias associated with the baseline difference, gain or change in outcome variables were used instead of ordinary scores. This allowed the exact effects of each Bobath and PNF on functional independence in ADL and balances to be estimated with minimal bias. Therefore, functional gains were calculated as the difference between baseline and post-treatment scores. Functional independence in activities of daily living (ADL) was assessed using the Barthel Index (BI), and the balance was assessed using the Berg Balance Scale respectively. Participants were age and sex matched.

2.1 Assessment of Functional Independence in Activities of Daily Living

Barthel Index was used for the assessment of functional independence in ADL. It contains a total of 10 items describing different activities. The scoring is done by adding individual item score to give a total score ranging from 0 (totally dependent) to 100 (completely independent). Lower scores indicate greater dependency. Scores on Barthel Index were interpreted as 80–100, independent, 60–79 needs minimal help with ADL, 40–59, partially dependent, 20–39 very dependent, and score < 20, totally dependent [18]. It has good internal consistency with a Cronbach's alpha coefficient of 0.98; intra-rater and inter-rater reliabilities are high, with a Pearson's *r* score ranging from 0.89 to 0.99 [19]. The instrument has been validated among stroke survivors in Nigeria [20] and used in several Nigerian studies to evaluate functional independence in activities of daily living [21,22,23]. The interview guide used in this study was similar to that of Badaru et al. [23].

2.2 Assessment of Balance

The balance was assessed using the Berg balance scale. It is a 14 item list with each item consisting of a five-point ordinal scale ranging from 0 to 4, with 0 indicating the lowest functional level and 4 the highest functional level. A score of 56 indicates functional balance while score < 45 indicates individuals may be at greater risk of falling [24]. It has good high intra rater and inter rater reliability (ICC =0.98 and 0.96 respectively) [25]. Test-retest reliability in 22 people with hemiparesis is also high (ICC= 0.98) [26]. The Berg balance scale has not been validated among Nigerian stroke survivors; however, it has wide utility among studies focusing on Nigerian stroke survivors [27], Hamzat and Fashoyin [28] and Ekechukwu et al. [29].

2.3 Procedure

The participants of both groups were involved in the baseline assessment by the Barthel Index and Berg Balance Scale. Each participant's vital signs were measured to ascertain fitness. Thereafter participants were called for usual treatment by certified therapist following Bobath technique or PNF technique. The Bobath technique used in this study is consistent with Kannabiran et al. [11]. Clinical applications assessed upper limb function, sitting up over the side of the bed, balanced sitting, standing up and down, and balanced standing. The PNF patterns in the set used in the study are as described by Knott and Voss [30]. Repetitions of each pattern were done before proceeding to the next pattern, consistent with what was recorded in previous PNF studies [31,32]. After the set of patterns was completed, it was repeated twice in each treatment session making 3 sets per session. Each participant received treatment twice a week for 12 weeks making 24 sessions in all. At the end of every fourth week, both groups were reevaluated using the Barthel Index and the Berg Balance Scale.

2.4 Data Analysis

Between-group comparisons of gender and age distributions were done using Chi- square. One sample t-test was used to compare gains in balance and functional independence in ADL with the hypothetical clinical important differences. Analysis of Variance was used to test the consistency of the effects of each of Bobath and PNF on functional Independence and balance. Independent T-test was used to

compare the effect of Bobath and PNF on PNF on functional Independence and balance.

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Demographics

A total of 50 stroke survivors (29 men and 21 women) participated in this study. The result shows that participants in this study were age and sex matched (p=0.66 and 1.0) respectively.

Table 1. Distribution of participants based on sex and age

Demographics	Bobath	PNF	X^2	P
Sex				
Male	14	15	0.774	0.5
Female	11	10	4.14	0.39
Age				
40-45 yrs	-	2		
45-50 yrs	2	-		
50-55 yrs	5	5		
55-60 yrs	7	8		
60-65 yrs	11	10		

**: significant at α=0.05*

3.1.2 Comparison of Baseline Functional Independence (Barthel Index Score) and balance (Berg Scale Score)

Results show significant differences exist between baseline scores on the Barthel index and the Berg balance scale (p=0 .05 and 0.03 respectively) (Table 1). To control for this baseline difference, treatment effect or actual gain (the difference between pre-test and post-test scores) in balance and functional independence were calculated and used subsequently (Table 2).

3.1.3 Comparison of gain in functional independence and balance, due to each of Bobath and PNF, with hypothetical clinical important differences

One sample t-test was used to compare gains in balance and functional independence in ADL with the hypothetical clinical important differences (CID) (Barthel index: CID=2; Berg balance scale: CID=3). For Bobath, result shows significant differences between functional gains in ADL and balance in each month and hypothetical value (p= <0.001, <0.001, <0.001, 0.02, <0.001 and <0.001) respectively. As for PNF, the result shows significant differences between gain in functional independence and balance in each month and hypothetical values except in this first month (p= 0.13, <0.001, <0.001, 0.18, <0.001 and <0.001) (Table 3).

3.1.4 Consistency of treatment effect of each of Bobath and PNF functional independence and balance

Analysis of Variance was used to test for consistency of the effects of each of Bobath and PNF on balance and functional Independence in ADL. The result shows consistent and significant changes in functional independence and balances with use of the Bobath (p=<0.001) among the three months, with largest and least gains recorded in the third and first month respectively (Table 3). Also, significant changes in functional independence and the balance were found with PNF approach among the three months (p=<0.001) (Table 3). Largest and least gains were recorded in the third and first month respectively.

3.1.5 Comparison of Post-treatment gain in functional independence and balance between Bobath and PNF

Independent sample t-test showed that at the end of the treatment (three months), a subject who received Bobath had significantly better functional independence score (p<0.001) and balance scores (p<0.001) than those who received PNF (Table 5).

3.2 DISCUSSION

Coincidentally, the differences in baseline scores of balance and functional independence in ADL between participants who received Bobath and those who received PNF validated the fact that the functional requirement of Bobath is lesser than that of PNF. This is consistent with the inclusion criteria obtained in previous studies, in which PNF criteria ranged from having attained Brunnstrom recovery stage IV, being able to walk 10m independently [33,34], as against Bobath approach which accommodates patients at early recovery stage of stroke [11,35]. The present study shows improvement in balance and functional independence in activities of daily living. This is consistent with the findings of Van Vliet et al. [36] and Wang et al. [33] in which, effects of Bobath therapy on the symmetry of weight distribution over hemiplegic and non-

Hemiplegic sides and balance control were found to be positive in within four weeks. Bobath approach aims to regain motor control and function of the hemiparetic side after stroke without promoting compensation. It engages the facilitation of normal movement components no matter how small and task-specific practice using specific manual guidance. This early response in balance and functional activities of daily living to Bobath may be because Bobath accommodates patients at early recovery stage of stroke [11]. Evidence opines that early intensification is facilitatory to optimum function recovery. This is supported by the theory that there is a time window in which the greatest gains in function is to be made [37]. During this window of neuroplasticity, the subjects must practice therapist-guided task-specific movements, to drive Hebbian plasticity to regain lost functions [38].

Table 2. Baseline scores on Barthel Index (BI) and Berg Balance Scale (BBS), and chi-square test showing association between treatment approach, and each of age and sex

	BI score Mean±SD	BBS Score Mean±SD	Age (yrs) Mean±SD	SEX			
				Male	Female	X^2	P
Approach							
Bobath	58.40±16.88	19.36±13.25	58.36±5.06	14	11	0.082	1.00
PNF	68.40±16.88	28.16±14.02	57.68±5.74	15	10		
P	0.047*	0.027*	0.659				

**significant at α=0.05, X^2: chi-square*

Table 3. One sample t-test Illustrating functional gains in ADL and balance with Bobath and PNF approaches

	Bobath				PNF			
	Gain in ADL		Gain in balance		Gain in ADL		Gain in balance	
	Mean±SD	P	Mean±SD	P	Mean±SD	P	Mean±SD	P
1st	9.60±6.11	0.000*	6.08±6.23[a]	0.021*	13.33±12.98	0.126	4.00±3.65[a]	0.184
2nd	20.00±9.46	0.000*	17.20±10.18	0.000*	13.20±9.56	0.000	14.48±6.25[b]	0.000*
3rd	31.80±13.38	0.000*	24.64±9.07	0.000*	23.60±14.03	0.000	20.00±9.31[c]	0.000*

**= significant at α = 0.05*

Table 4. Analysis of variance comparing functional gains in ADL and Balance with each of Bobath and PNF

	Bobath		PNF	
	Gain in FI Mean±SD	Gain in balance Mean±SD	Gain in FI Mean±SD	Gain in balance Mean±SD
Month				
1st month	9.60±6.11[a]	6.08±6.23[a]	13.33±12.98	4.00±3.65[a]
2nd month	20.00±9.46b	17.20±10.18[b]	13.20±9.56	14.48±6.25[b]
3rd month	31.80±13.38c	24.64±9.07[c]	23.60±14.03	20.00±9.31[c]
F-value	30.255	29.155	25.784	35.615
P	0.000*	0.000*	0.000*	0.000*

**significant at α=0.05; FI= functional independence*

Table 5. Comparison of post-treatment gain in functional independence and balance between Bobath and PNF

	Gain in FI			Gain in balance		
Approach	Mean±SD	t	P	Mean±SD	t	P
Bobath	10.4±6.28	4.789	0.000*	11.20±9.17	3.867	0.000*
PNF	3.40±3.74			3.68±3.25		

**significant at α=0.05.*

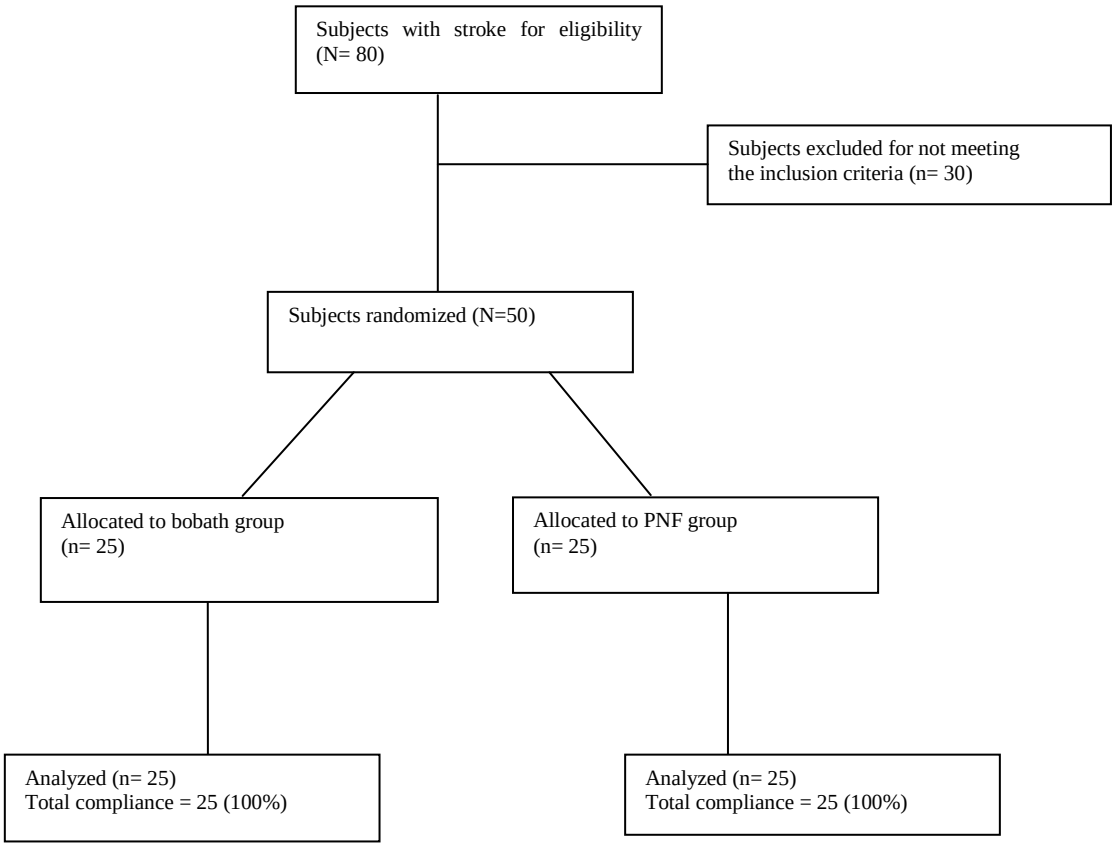

Fig. 1. Flow chart showing process from recruitment to finish

The finding that PNF caused consistent functional gains in daily activities and balance only after four weeks is consistent with the findings of Lee et al. [39], Jeong et al. [40] and Kim et al. [34] in which, improvements in ADL and/or balance were recorded in the sixth or eight weeks of PNF application. Chol et al. [41] reported that coordination movement using a tapping and PNF combination pattern enhanced the balance of stroke patients. The mechanism of the effect of PNF on functional independence in ADL and balance is believed to be through stimulation of proprioceptive senses of muscles and tendons and plasticity dependent relearning [42,43]. The PNF, when used as a gradual resistance exercise that employs a diagonal pattern, maximises motor unit recruitment through proprioceptive stimulation [44,45,42]. PNF promotes maximum usage of muscle fibres due to the intense circumstances caused by manual resistance; moreover, verbal cues and fine handling act as forms of sensory facilitators stimulating proprioception and thus helping to improve balance and functional independence in ADL [34]. Evidence suggests that active exercises such as PNF when applied after cerebral stroke could lead to neural plasticity in the cerebral cortex, resulting in improved motor function and hence balance functional independence [43]. A time period of at least four weeks was necessary to ensure sufficient plasticity-mediated recruitment of motor units needed for improved balance and performance of daily activities.

Comparing functional gains in ADL between Bobath and PNF, the result shows Bobath is clinically more efficacious than PNF. Consistent with this finding, Krukowska et al. [46] shows that compared to the proprioceptive neuromuscular facilitation technique, after 6 weeks of training, Bobath approach is a more effective method for improved postural sway and balance [46]. There is a paucity of literature in respect to comparison of effects of Bobath and PNF on functional independence in ADL. However, the fact that the Bobath approach accommodates patients at early recovery stage thereby facilitating spontaneous neuroplasticity and consequent function recovery explains why Bobath therapy is superior to PNF in the rehabilitation of patients with stroke. Bobath takes advantage of the window period following stroke through early intensification.

A recognised limitation in this study was the difference in baseline scores on BI and BBS between the two groups. This is expected to confound the actual treatment effect. This limitation was, however, addressed by computing for the treatment effect or actual gain in balance and functional independence in ADL.

4. CONCLUSIONS

Bobath appears superior to PNF in retraining of balance and improving functional independence in daily activities. The study therefore, recommends Bobath as the technique of choice when it is not feasible to combine both approaches, especially on account of excessive workload which is common in resource-constrained setting.

CONSENT AND ETHICAL APPROVAL

Ethical approval was sought and obtained from the Health Research and Ethics Committee of UNTH. Informed consent was sought and received from the participants.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Appendix 1: Barthel Index

THE Name _____
BARTHEL Rater Name: _____
INDEX Date: _____

FEEDING
0 = unable
5 = needs help cutting, spreading butter, etc., or requires modified diet
10 = independent
Activity Score _____

BATHING
0 = dependent
5 = independent (or in shower)
Activity Score _____

GROOMING
0 = needs to help with personal care
5 = independent face/hair/teeth/shaving (implements provided)
Activity Score _____

DRESSING
0 = dependent
5 = needs help but can do about half unaided
10 = independent (including buttons, zips, laces, etc.)
Activity Score _____

BOWELS
0 = incontinent (or needs to be given enemas)
5 = occasional accident 10 = continent
Activity Score _____

BLADDER
0 = incontinent, or catheterized and unable to manage alone
5 = occasional accident
10 = continent Activity Score _____

TOILET USE
0 = dependent
5 = needs some help, but can do something alone
10 = independent (on and off, dressing, wiping)
Activity Score _____

TRANSFERS (BED TO CHAIR AND BACK)
0 = unable, no sitting balance
5 = major help (one or two people, physical), can sit
10 = minor help (verbal or physical) 15 = independent
Activity Score _____

MOBILITY (ON LEVEL SURFACES)
0 = immobile or < 50 yards
5 = wheelchair independent, including corners, > 50 yards
10 = walks with help of one person (verbal or physical) > 50 yards
15 = independent (but may use any aid; for example, stick) > 50 yards
Activity Score _____

STAIRS
0 = unable
5 = needs help (verbal, physical, carrying aid)
10 = independent
Activity Score _____
TOTAL (0–100): _____

Grading

0-20	Very severity disabled
25-45	Severity disabled
50-70	Moderately disabled
75-90	Mildly disabled
100	Physically independent but not necessary normal or social independent

Appendix 2: Berg Balance Scale

Patient Name: _____ Date: _____

Grading: Please mark the lowest category which applies.

1. Sitting to Standing

Score:
Instruction: Please stand up. Try not to use your hands for support.

Grading:
4: Able to stand no hands and stabilize independently.
3: Able to stand independently using hands.
2: Able to stand using hands after several tries.
1: Needs minimal assistance to stand or to stabilize.
0: Needs moderate or maximal assistance to stand.

2. Standing Unsupported

Score:
Instruction: Stand for two minutes without holding.

Grading:
4: Able to stand safely 2 minutes.
3: Able to stand 2 minutes with supervision.
2: Able to stand 30 seconds unsupported.
1: Needs several tries to stand 30 seconds unsupported.
0: Unable to stand 30 seconds unassisted.

3. Sitting Unsupported Feet on Floor

Score:
Instruction: Sit with arms folded for two minutes.

Grading:
4: Able to sit safely and securely 2 minutes.
3: Able to sit 2 minutes under supervision.
2: Able to sit 30 seconds.
1: Able to sit 10 seconds.
0: Unable to sit without support 10 seconds.

4. Standing to Sitting

Score:
Instruction: Please sit down.

Grading:
4: Sits safely with minimal use of hands.
3: Controls descent by using hands.
2: Uses back of legs against chair to control descent.
1: Sits independently but has uncontrolled descent.
0: Needs assistance to sit.

5. Transfers

Score:
Instruction: Please move from chair to bed and back again. One way toward a seat with arm rests and one way toward a seat without arm rests.

Grading:
4: Able to transfer safely with minor use of hands.
3: Able to transfer safely definite need of hands.
2: Able to transfer with verbal cuing and/or supervision.
1: Needs one person to assist.
0: Needs two people to assist or supervise to be safe.

6. Standing Unsupported with Eyes Closed

Score:
Instruction: Please close your eyes and stand still for 10 seconds.

Grading:
4: Able to stand 10 seconds safely.
3: Able to stand 10 seconds with supervision.
2: Able to stand 3 seconds.
1: Unable to keep eyes closed 3 seconds but stays steady.
0: Needs help to keep from falling.

7. Standing Unsupported with Feet Together

Score:
Instruction: Place your feet together and stand without holding on.

Grading:
4: Able to place feet together independently and stand 1 minute safely.
3: Able to place feet together independently and stand for 1 minute with supervision.
2: Able to place feet together independently but unable to hold for 30 seconds.
1: Needs help to attain position but able to stand 15 seconds with feet together.
0: Needs help to attain position and unable to hold for 15 seconds.

8. Reaching Forward with Outstretched Arm

Instruction: Lift arm to 90 degrees. Stretch out your fingers and reach forward as far as you can. (Examiner places a ruler at end of fingertips when arm is at 90 degrees. Fingers should not touch the ruler while reaching forward. The recorded measure is the distance forward that the fingers reach while the subject is in the most forward lean position.)

Score:

Grading:
4: Can reach forward confidently more than 10 inches.
3: Can reach forward more than 5 inches safely.
2: Can reach forward more than 2 inches safely.
1: Reaches forward but needs supervision.
0: Needs help to keep from falling.

9. Pick Up Object from the Floor

Instruction: Pick up the shoe/slipper which is placed in front of your feet.
Score:
Grading:
4: Able to pick up slipper safely and easily.
3: Able to pick up slipper but needs supervision.
2: Unable to pick up but reaches 1 to 2 inches from slipper and keeps balance independently.
1: Unable to pick up and needs supervision while trying.
0: Unable to try/needs assistance to keep from falling.

10. Turning to Look Behind Over Left and Right Shoulders
Score:
Instruction: Turn to look behind you over toward left shoulder. Repeat to the right.
Grading:
4: Looks behind from both sides and weight shifts well.
3: Looks behind one side only; other side shows less weight shift.
2: Turns sideways only but maintains balance.
1: Needs supervision when turning.
0: Needs assistance to keep from falling.

11. Turn 360 Degrees
Score:
Instruction: Turn completely around in a full circle. Pause. Then turn a full circle in the other direction.
Grading:
4: Able to turn 360 degrees safely in less than 4 seconds each side.
3: Able to turn 360 degrees safely one side only – less than 4 seconds.
2: Able to turn 360 degrees safely but slowly.
1: Needs close supervision or verbal cuing.
0: Needs assistance while turning.

12. Count Number of Times Step Touch Measured Stool
Instruction: Place each foot alternately on the stool. Continue until each foot has touched the stool four times.
Score:
Grading:
4: Able to stand independently and safely and complete 8 steps in 20 seconds.
3: Able to stand independently and complete 8 steps in more than 20 seconds.
2: Able to complete 4 steps without aid with supervision.
1: Able to complete more than 2 steps – needs minimal assistance.
0: Needs assistance to keep from falling – unable to try.

13. Standing Unsupported One Foot in Front
Instruction: Place one foot directly in front of the other. If you feel that you cannot place your foot directly in front, try to step far enough ahead that the heel of your forward foot is ahead of the toes of the other foot. (DEMONSTRATE to subject.)
Score:
Grading:
4: Able to place foot tandem independently and hold 30 seconds.
3: Able to place foot ahead of the other independently and hold 30 seconds.
2: Able to take small step independently and hold 30 seconds.
1: Needs help to step but can hold 15 seconds.
0: Loses balance while stepping or standing.

14. Standing on One Leg
Score:
Instruction: Stand on one leg as long as you can without holding.
Grading:
4: Able to lift leg independently and hold more than 10 seconds.
3: Able to lift leg independently and hold 5 to 10 seconds.
2: Able to lift leg independently and hold at least 3 seconds.
1: Tries to lift leg, unable to hold 3 seconds but remains standing independently.
0: Unable to try or needs assistance to prevent fall.

Total Score: _____

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