International Journal of Allied Medical Sciences and Clinical Research (IJAMSCR)

ISSN:2347-6567

IJAMSCR | Volume 8 | Issue 3 | Jul - Sep - 2020
www.ijamscr.com

Research article | Medical research

Effect of sleep on novel motor task learning In Elderly individuals

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ABSTRACT

Purpose and objective:

To study the effect of sleep on novel motor task learning in elderly individuals.

Method:

68 elderly were divided randomly into Sleep group and No sleep group. Evaluation was done using Star excursion balance test (SEBT), Tandem walk test (TWT) and Dynamic Gait Index (DGI) before session. Sleep group subjects practiced novel task in evening at 8 pm and underwent retention testing next morning at 8 am. While in no sleep group they practiced the novel task in morning 8 am and underwent retention testing same day in evening at 8 pm. Novel task included 30 mins session of 3 virtual reality based games. Both groups were then analyzed using Wilcoxon Signed Rank W test within the group and Mann-Whitney U test between the two groups.

Outcome measures:

Primary outcome measures were SEBT, TWT and DGI. Secondary outcome was considered as Stanford Sleepiness Scale before the session.

Results:

Older adults in sleep group (n=32) showed increased performance in SEBT and step length, stride length components of TWT ($p<0.05$) as compared to no sleep group ($p>0.23$). However, participants in both groups showed improvement in base of support component of TWT- [sleep group ($p<0.05$) with (%change-38%) and no sleep group ($p=0.08$) with (%change-5.8%)]. DGI score also improved in both sleep group ($p<0.05$) with (%change-16.4%) and no sleep group ($p<0.05$) with (%change-7.1%).Hence, effect seen in group A was more than in group B ($p<0.05$)

Discussion: Present study demonstrates that older adults were able to perform novel tasks better after a night of sleep as compared to older adults who didn't sleep. It suggests that Sleep dependent offline learning can be applied to both simple and complex tasks. Offline learning refers to memory consolidation which takes place without any active participation of subject itself. It is described in terms with interference technique in which the consolidation of a primary task is disrupted by the immediate performance of a secondary task. If the period is lengthened then the extent of learning is lengthened as well Also, it is found that there is a positive correlation between sleep spindle density and offline motor learning and during different sleep states various neurophysiological changes take place. Therefore with better sleep learning over a novel task can be improved.

Conclusion: Sleep is effective in novel motor task learning in elderly individuals

Keywords*:* Sleep, Novel motor task learning, Elderly, Virtual Reality**.**

INTRODUCTION

Aging being a dynamic, progressive, and physiological process is accompanied by morphological and functional changes[1]. Old age causes a reduction in the functional reserve of organs and systems. This decline leads to changes in balance, postural control, depression, anxiety, and mobility. With age, they tend to lose dynamic and static balance control, because of the inability to counteract the external forces. If not managed properly, these destabilizing forces can lead to a fall. Risk of falls is noted mostly in people over 65 years with recurrent and multiple episodes leading to a decline in daily functions further. This may result in reduced social contact, increased dependency and increased mobility impairments. It is, therefore, necessary to tackle balance problems in the elderly. It is important to teach them techniques to manage balance effectively in the event of a fall. For this, effective motor learning is required.[2]Besides, it is seen that is a relation between age and decline in motor learning and overall motor performance. Some studies have also mentioned about a significant reduction in learning capacities in older adults[3, 4].

Motor learning is defined as the study of the acquisition and /or modification of movement for permanent change. While motor control focuses on understanding the control of movement already acquired, motor learning focuses on understanding the acquisition of movement. Forms of learning are the basis of re-acquisition of complex task post injury.[5]. Also, Humans prefer to practice actions which are similar to their habits and behaviour. Habits allow adequate decision making with flexible behaviour, hence forming a stimulus-response pairing. Planning on the other hand warrants more flexible and productive decision making[6].A study by Jiang and colleagues about Habitual attention in older and young adults suggest that habitual attention in older adults may be used to counter declines in controlled attention[7]. On the other hand, Associative forms of learning involve the association of ideas which helps the person to associate his relationships with stimulus. Procedural learning, a subset of associative learning, requires learning a task like a habit confined to only one specific aspect. Associative form of learning requires knowledge that can be consciously recalled along with awareness, while attention and reflection form the basis of declarative learning [5]. Moreover, a study by Eli Vakil and Dafna Agmon-Ashkenazi states that the learning rate of both young and old adults on the procedural tasks did not differ consistently, whether the measure was a number of errors/moves or time elapsed. However, there was one exception in the study in which the older group showed a steeper learning rate for procedural learning than the younger group[8].So while planning a motor learning strategy in older people it should be based on habituation and should be confined to one specific goal. Most common strategies to improve motor learning involve random order practice, mental imagery practice, videotaped based practice, feedback of knowledge over results etc.[9]. From rehabilitation point of view, not only traditional approaches but newer physiotherapeutic interventions should also be undertaken to tackle problems with everyday functioning to attain effective learning. It is always seen that newer modified activities are preferred over the same old daily activities. Also, older adults show a reduce adherence to daily monotonous exercises[10]. A new modified and more interactive exercise can get older adults more devoted to a rehabilitation program[11].

Word novel refers to new or not resembling something formerly known as used[12].New Motor skills can be learned efficiently if planned and organised. The longer the duration a task is carried out, faster is the acquisition of a new same skill-a phenomenon of learning to learn. This process of motor adaptation by the newer task can be explained by term "structure learning" Structured learning explains the ability of learning to learn [13]It infers that in spite of memory problems, older adults are able to retain themselves in a newer environment. Similarly, According to, Fitts and Posner (1967), for learning a new motor task, it is believed that an individual needs to follow the Cognitive ,Associative and Autonomous stages of learning[14].Thus for effective motor learning, the planned task should be to which the individual can associate himself easily. Likewise, it has been found that function-oriented exercises minimize the risk of falls in older adults on the whole improving balance, gait parameters, and the muscle strength of the lower limbs[15].

Nowadays, Modern newer interactive forms of training based on virtual reality (VR) are taking role in rehabilitation. VR has also shown to increase the role of motor stimulation during the modified experience, as users can move through and physically interact with virtual objects. Virtual environments can present combinations of stimuli that are not found in the natural world and the therapist can bring about similar changes which are not possible physically .A study by Rosenberg et al which studied the effect of virtual reality in older adults found out that virtual reality has positive effects on depression, mental health-related quality of life and cognitive performance[16]. A lab study showed that while energy expenditure was less in Wii balance exergame as compared to walking with a treadmill, enjoyment was rated much higher in older adults[16, 17] and, enjoyment has been found to be associated with increased adherence to exercise over time[18]. Also, virtual environment increases motivation and interaction between sensorimotor model making it more of an exploratory approach thus regaining active participation31. .A wide base of literature support using virtual reality for stroke or for improving pulmonary function in cerebral palsy kids.VR rehabilitation can be implemented through personal computers (PCs), mobile devices, video games, or specialized equipment. The Virtual reality headset is relatively small in size, which means that each patient can have a small virtual rehabilitation room in his or her home. So, to gain effective motor learning, virtual reality games could be used as a novel task to get beneficial changes. In short, VR can also be described in terms of I³: Interaction + Immersion + Imagination[19]. Therefore, an intervention to use virtual reality as a novel task to promote motor learning and achieve efficient recovery of function was decided.

Further, motor learning in older adults might also be influenced by sleep architecture. It is seen that Sleep plays a vital role in memory consolidation and motor learning. Sleep dependent memory consolidation requires the co-ordination of both type of memory that is processed and how well it is stored. Memory consolidation refers to the term in which unstable memory representation is converted into a form that is both more stable and effective[20].Offline learning refers to memory consolidation which takes place without any active participation of subject itself [21]. It is described in terms with interference technique in which the consolidation of a primary task is disrupted by the immediate performance of a secondary task. If the period is lengthened then the extent of learning is lengthened as well [22].

However, older people tend to have greater sleep disturbances that can create a negative impact on their quality of life, mood, and alertness. Elderly individuals sleep 36 per cent less than children at age. Even though the ability to sleep becomes more difficult, the need to sleep does not decrease with age. Literature suggests that exposure to partial and total sleep deprivation impairs primarily behavioural alertness and cognitive processing capabilities [23]. States of sleep are further divided into REM and NREM states. It is during these cycle where major metabolic events contain changes in brain electrophysiology[24]Also, with aging, as sleep disturbances increase impedance to executive functions might also increase[25]So accordingly, it can be stated that sleep might be considered as a beneficial factor for executive functions which can, in turn, be related to sleep increase cognitive ability.

Research has proved that sleep enhances the learning of both motor adaptation task and motor Sequence task in young adults[26]51As sleep disturbances increase with age, it may hinder physical and mental abilities of older individuals Older adults also develop behavioural and ecological changes which affect activities of daily living[27]. Sleep disturbances might also affect the learning capacity of the individual to adhere to a task. There are possibilities that sleep might affect the ability to learn a new task. Hence, this study was be conducted to find out the effect of sleep on performance of novel motor task learning in elderly individuals..

METHODS

Design

An experimental study was conducted. The sampling technique used was convenient sampling (chit method). 85 participants were screened out of which 69 were included in the study. Participants were recruited between august 2018 to march 2019. After baseline assessment according to criteria, participants were randomly allocated to either an experimental group (sleep group) or a control group (no sleep group).Study setting was Community-based including places like - individual residences, geriatric homes and community halls open till 9 pm.

Participants

68 Older individuals with age 65 years and above who could complete the Timed Up and Go Test and with MMSE score >/= 26 and above were included in the study. Individuals with known sleep disorders including sleep apnoea, restless leg syndrome, uncontrolled depression, and any history of psychiatric disorders. Any other neurologic disorders, orthopaedic problems any balance or gait deviations that make performing the task difficult vision and auditory issues .As per assessment by morningness-eveningness questionnaire extreme time sleepers were excluded[28]

Procedure

Institutional ethics committee approval was obtained prior to the commencement of study. Informed, written consent was taken from participants. Sleep quality was assessed by the Pittsburgh Sleep Quality Index[29] and subjects were asked to maintain regular sleep for a week prior. Sleepiness before the sessions was assessed by Stanford Sleepiness Scale.[30] Participants then underwent the Star excursion balance test, Tandem walk test and Dynamic Gait Index before the commencement of the session. Subjects were given manual instructions regarding the novel task and its application. Subjects in the sleep condition (group A) practiced novel task in the evening at 8 pm and underwent retention testing next morning at 8 am. At both times, tasks were performed under the therapist's supervision. While in no sleep condition (group B) subjects practiced the novel tasks in morning 8 am and underwent retention testing same day in the evening at 8 pm. At both times, tasks were performed under the therapist's supervision. They then undertook the session for 30 minutes with an allowance for rest intervals if needed. Each session included the performance of 3 novel tasks for 10 minutes each. The novel task consisted of VR games using VR glasses. The novel task included activities with weight shifts, squatting, tandem walking, walking with head turns and turning around while walking (Fig 3a,3b).Subjects were supervised by a physical therapist throughout the session. After completing the duration of 12 hours, subjects underwent retention testing. They were then reassessed using the same outcome measures.

Outcome measures

Primary outcome

Star Excursion Balance Test – it is a dynamic test that gives an idea about strength, flexibility, and proprioception. It was used in the study to assess the dynamic balance of subjects.

Technique - The goal of the SEBT is to maintain a single leg stance on one leg while reaching as far as possible with the contralateral leg in 8 different directions (Fig 1)[31]

Figure 1: Subject performing Star Excursion Balance Test

Tandem walk test – It requires individual to walk in a straight line with the front foot placed such that its heel touches the toe of the standing foot. It was used in the study to assess dynamic balance. The gait parameters measured were step length, stride length and base of support components (Fig2a,2b).[32]

Figure 2a: Subject performing Tandem Walk Test

Figure 2b: Parameters of Tandem Walk Test

Dynamic Gait Index – It was developed originally to assess the likelihood of falling in older adults. It is designed to test eight facets of gait. It consists of a four-point ordinal scale, ranging from 0-3. Where "0" indicates the lowest level of function and "3" the highest level of function. It was used in the study as a measure to assess dynamic balance in study subjects.[33]

Figure3a and 3b -Subject Undertaking Novel Task Training Using Virtual Reality

Secondary outcome

Stanford sleepiness Scale - The Stanford Sleepiness Scale was developed to assess the feeling of alertness throughout the day. It is a self-administered scale which is quick and easy to understand. It was used in the study to assess an individual's alertness before and after 12 hours of study duration.[30]

STATISTICAL ANALYSIS

The statistical analysis was done using Wilcoxon Signed Rank W test within the group and Mann-Whitney U test between the two groups.

The estimated sample size for the study was 68 and subjects were divided into two groups- Group A (sleep group)and Group B (no sleep group) After excluding the dropouts, the samples included in each group were 32 and the total samples studied were 64. All elderly individuals were 65 years of age, both males and females healthy elderly individuals were approached according to criteria and divided into groups. All participants were assessed based on SEBT, TWT and DGI scores and analyzed further.

RESULTS

The obtained results after analysis are plotted in the form of tables and graphs

Subject Characteristics- For both the groups there were no differences in respect to age and gender. Both the groups were matched with respect to sleeping conditions and functional mobility.(table and graph-1,2)

Performance characteristics

Primary Outcome

Star Excursion Balance Test

Older adults in sleep condition showed significant improvements in SEBT in all eight direction with greater degree of percentage change as compared to that of participants in no sleep condition($p<0.05$).(Table and graph 3-6).

Tandem Walk Test

Participants in sleep group showed increase significance in step length and stride length components of Tandem Walk test as compared to that of no sleep group($p<0.05$).Regarding improvements in base of support component there was significant change seen in both the groups, but percentage change seen in sleep group(38%) was more than that of other group(5.8%).).(Table and graph7-12)

Dynamic Gait Index

Participants in both group showed improvement in dynamic gait index scores with increase percentage change seen in sleep group (16.4%) as compared to that of no sleep group (7.1%)).(Table and graph 13,14).

Secondary Outcome

Standford sleepiness scale

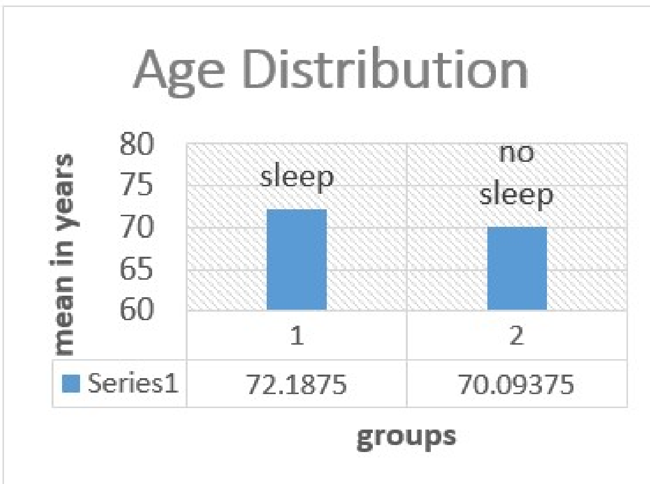
The Stanford Sleepiness Scale administered to ensure state of alertness before the sessions cancels out any negative effect of sleepiness which sleeps deprivation might have imposed[30].Hence, it can be quoted that continuous sleep before a session might be optimal than small sleep episodes during the day time

Table 1: Age distribution of subjects into groups

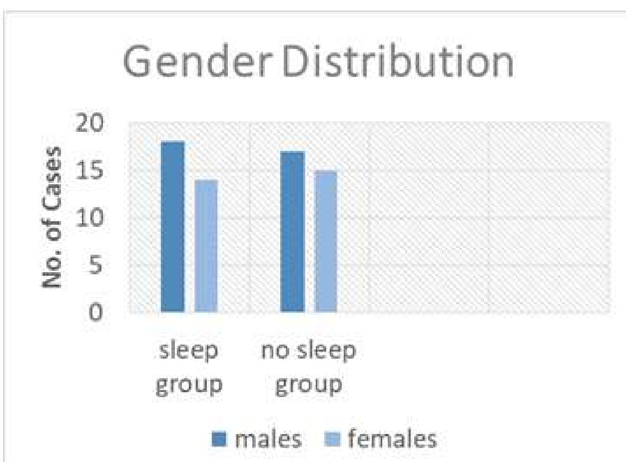
Age Distribution				
Age 65 years and above	**Group A (sleep group)**	**Group B (no sleep group)**	**P value**	**Result**
Mean	72.18	70.09	0.08	NS
SD	$\pm$ 5.07	$\pm$4.35		

Table 2: Gender distribution of subjects

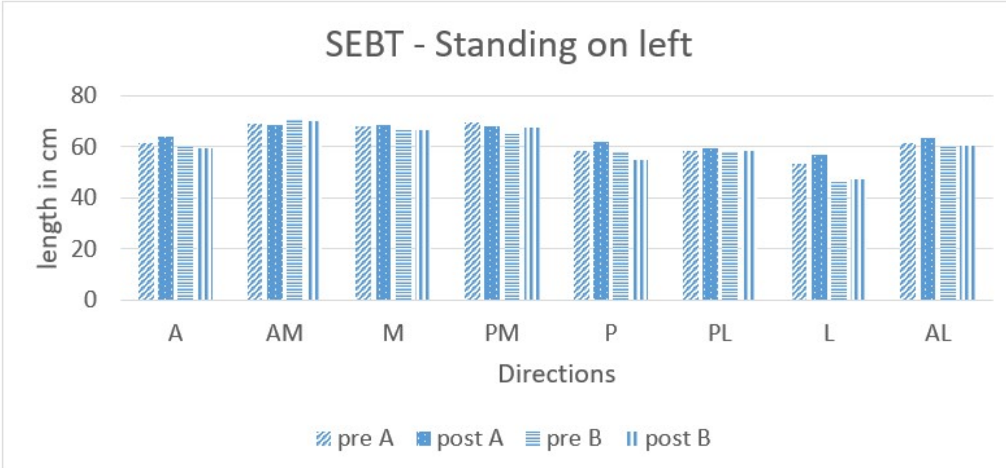
Gender Distribution		
Gender	**Group A (sleep Group)**	**Group B (no sleep group)**
Male	18	17
Female	14	15
Total	**32**	**32**



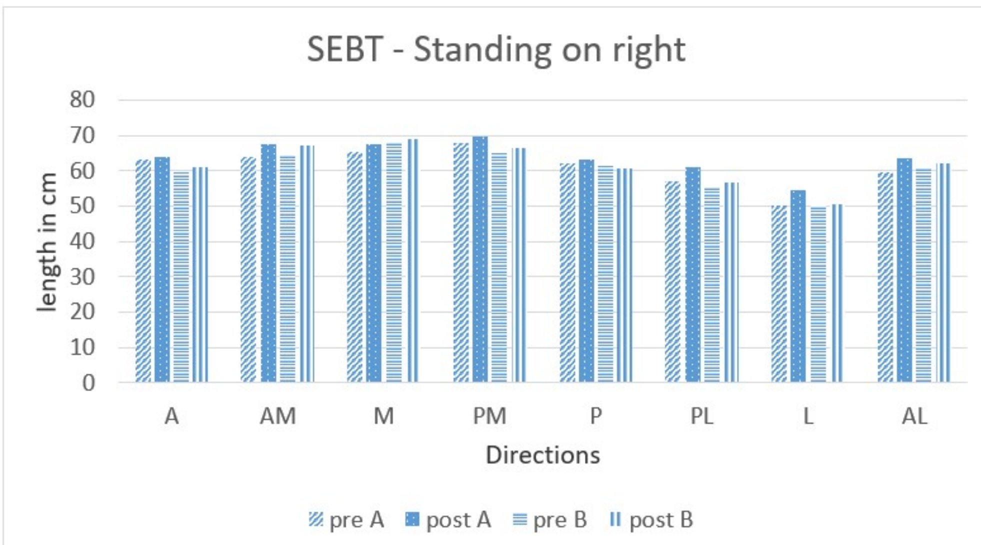
Graph 1: Age wise distribution of subjects



Graph 2: Gender distribution of subjects



Graph 3: SEBT– standing on left values pre and post training in group a and b



Graph 4: SEBT – standing on right values pre and post training in group a and b

Table 3: SEBT– standing on left values pre and post training in group a and b

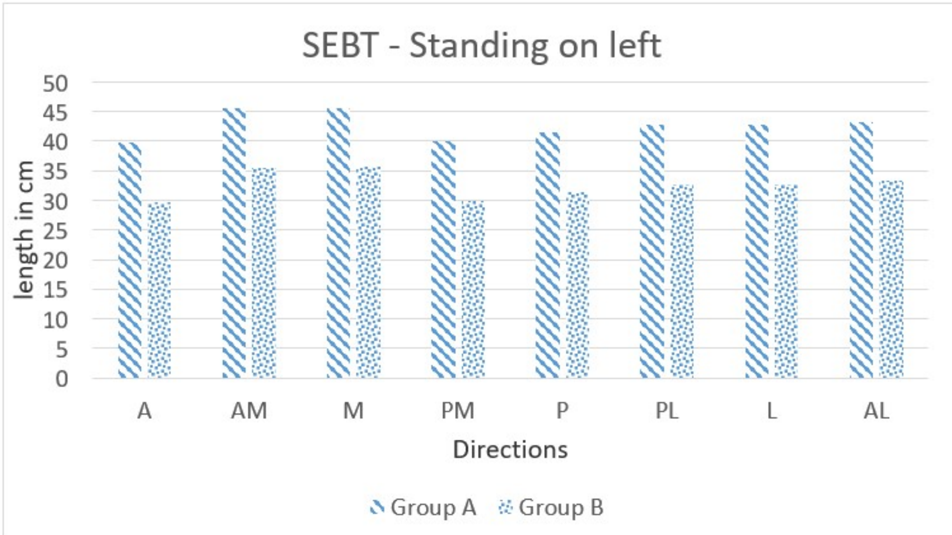
Star Excursion Balance Test – Standing On Left						
Anterior	**Median**		**Wilcoxon Signed Rank W**	**P-Value**	**% Change**	**Result**
	Pre	**Post**				
Group A	61.5	64	-4.581[a]	0.000	4.1	Sig
Group B	60	59.5	-.172[b]	0.863	0.0	NS
Anteromedial	**Median**		**Wilcoxon Signed Rank W**	**P-Value**	**% Change**	**Result**
	Pre	**Post**				
Group A	69	68.5	-3.428[a]	0.001	1.9	Sig
Group B	71	70	-2.059[b]	0.059	1.3	NS
Medial	**Median**		**Wilcoxon Signed Rank W**	**P-Value**	**% Change**	**Result**
	Pre	**Post**				
Group A	68	68.5	-2.831[a]	0.005	1.7	Sig
Group B	66.5	66.5	-.495[b]	0.621	0.1	NS
Posteromedial	**Median**		**Wilcoxon Signed Rank W**	**P-Value**	**% Change**	**Result**
	Pre	**Post**				

	Median Pre	Median Post	Wilcoxon Signed Rank W	P-Value	% Change	Result
Group A	69.5	68	-3.873[a]	0.000	3.4	Sig
Group B	65	67.5	-.553[b]	0.580	0.1	NS
Posterior	**Pre**	**Post**	**Wilcoxon Signed Rank W**	**P-Value**	**% Change**	**Result**
Group A	58.5	62	-4.369[a]	0.000	5.1	Sig
Group B	58	55	-.534[a]	0.594	0.5	NS
Posterolateral	**Pre**	**Post**	**Wilcoxon Signed Rank W**	**P-Value**	**% Change**	**Result**
Group A	58.5	59.5	-4.460[a]	0.000	5.8	Sig
Group B	58	58.5	-.763[a]	0.445	0.4	NS
Lateral	**Pre**	**Post**	**Wilcoxon Signed Rank W**	**P-Value**	**% Change**	**Result**
Group A	53.5	57	-3.816[a]	0.000	5.3	Sig
Group B	46.5	47.5	-.557[a]	0.577	0.4	NS
Anterolateral	**Pre**	**Post**	**Wilcoxon Signed Rank W**	**P-Value**	**% Change**	**Result**
Group A	61.5	63.5	-3.960[a]	0.000	3.6	Sig
Group B	60	60.5	-.353[b]	0.724	0.2	NS

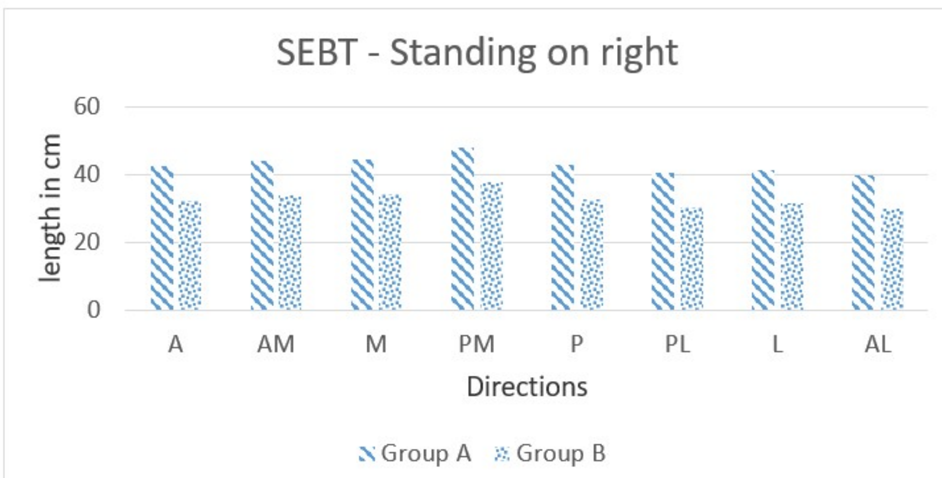
Table 4: SEBT– standing on right values pre and post training in group a and b

Star Excursion Balance Test – Standing on Right						
Anterior	**Median Pre**	**Median Post**	**Wilcoxon Signed Rank W**	**P-Value**	**% Change**	**Result**
Group A	63	64	-4.097[a]	0.000	2.8	Sig
Group B	60	61	-.811[a]	0.417	0.3	NS
Anteromedial	**Pre**	**Post**	**Wilcoxon Signed Rank W**	**P-Value**	**% Change**	**Result**
Group A	64	67.5	-4.079[a]	0.000	3.9	Sig
Group B	64.5	67	-.029[a]	0.977	0.4	NS
Medial	**Pre**	**Post**	**Wilcoxon Signed Rank W**	**P-Value**	**% Change**	**Result**
Group A	65.5	67.5	-3.940[a]	0.000	3.6	Sig
Group B	68	69	-1.167[b]	0.243	0.9	NS
Posteromedial	**Pre**	**Post**	**Wilcoxon Signed Rank W**	**P-Value**	**% Change**	**Result**
Group A	68	69.5	-4.033[a]	0.000	3.2	Sig
Group B	65	66.5	-.265[b]	0.791	0.7	NS
Posterior	**Pre**	**Post**	**Wilcoxon Signed Rank W**	**P-Value**	**% Change**	**Result**
Group A	62	63	-3.764[a]	0.000	4.3	Sig
Group B	61.5	60.5	-.637[b]	0.524	0.1	NS
Posterolateral	**Pre**	**Post**	**Wilcoxon Signed Rank W**	**P-Value**	**% Change**	**Result**
Group A	57	61	-3.935[a]	0.000	4.4	Sig
Group B	55.5	56.5	-.830[a]	0.407	1.7	NS
Lateral	**Pre**	**Post**	**Wilcoxon Signed Rank W**	**P-Value**	**% Change**	**Result**
Group A	50	54.5	-3.960[a]	0.000	5.4	Sig

Group B	50	50.5	-.938[a]	0.348	0.8	NS
Anterolateral	**Median**		**Wilcoxon Signed Rank W**	**P-Value**	**% Change**	**Result**
	Pre	**Post**				
Group A	59.5	63.5	-4.909[a]	0.000	4.9	Sig
Group B	61	62	-.053[a]	0.958	0.3	NS



Graph 5: Comparison between group a and group b in SEBT- standing on left



Graph 6: Comparison between group a and group b in SEBT- standing on right

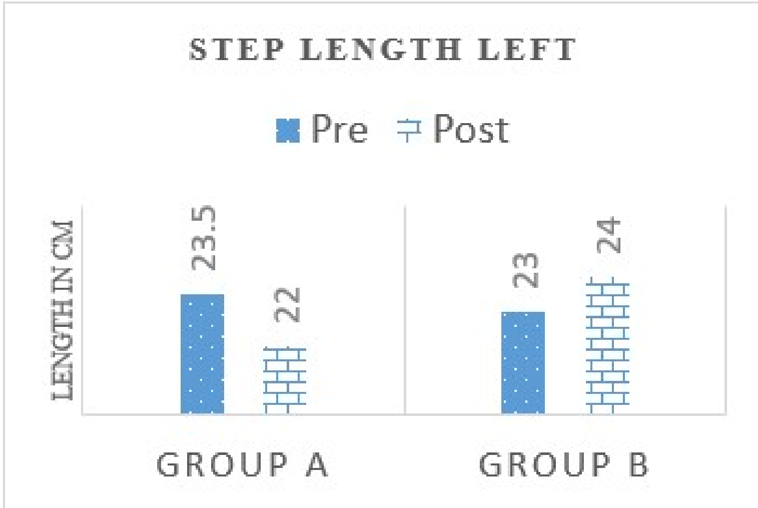
Table 5: Comparison between group a and group b in SEBT- standing on left

Star Excursion Balance Test – Standing on left						
	Group	**N**	**Mean Rank**	**Sum of Ranks**	**Mann-Whitney U**	**P-Value**
Anterior	Group A	32	39.67	1269.50	421.500	0.000
	Group B	32	29.67	949.50		
	Total	**64**				
Anteromedial	Group A	32	45.47	1455.00	417.000	0.000
	Group B	32	35.47	1135.00		
	Total	**64**				
Medial	Group A	32	45.67	1461.50	410.500	0.000
	Group B	32	35.67	1141.50		

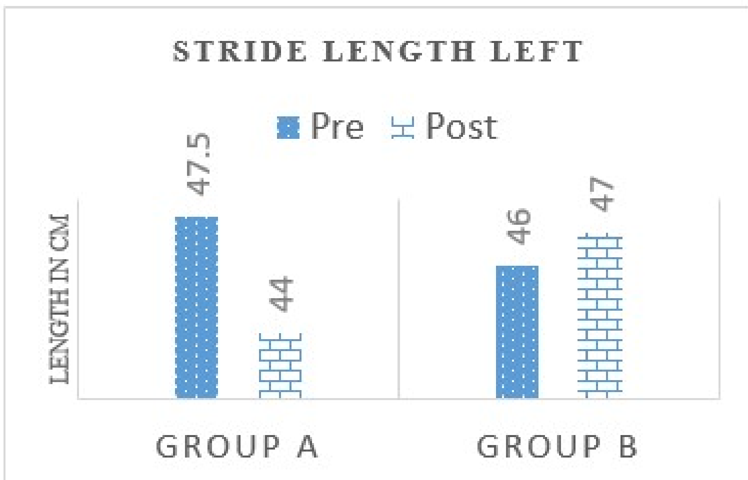
	Total	**64**				
Posteromedial	Group A	32	39.98	1279.50	431.500	0.000
	Group B	32	29.98	959.50		
	Total	**64**				
Posterior	Group A	32	41.42	1325.50	477.500	0.000
	Group B	32	31.42	1005.50		
	Total	**64**				
Posterolateral	Group A	32	42.73	1367.50	504.500	0.000
	Group B	32	32.73	1047.50		
	Total	**64**				
Lateral	Group A	32	42.70	1366.50	505.500	0.000
	Group B	32	32.70	1046.50		
	Total	**64**				
Anterolateral	Group A	32	43.27	1384.50	487.500	0.000
	Group B	32	33.27	1064.50		
	Total	**64**				

Table 6: Comparison between group a and group b in SEBT- standing on right

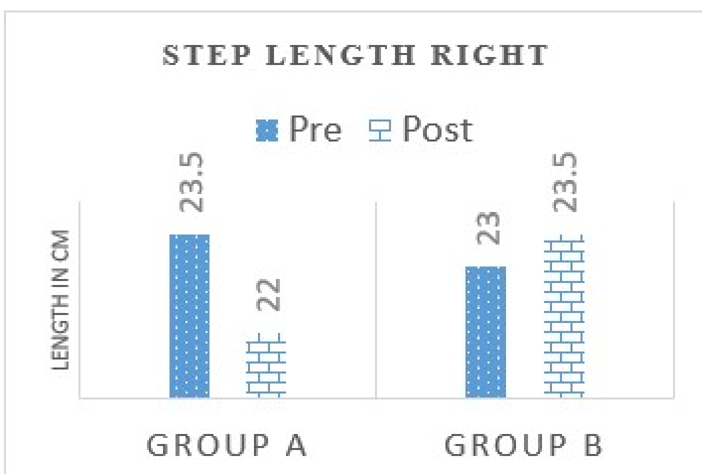
Star Excursion Balance Test – Standing on right						
	Group	**N**	**Mean Rank**	**Sum of Ranks**	**Mann-Whitney U**	**P-Value**
Anterior	Group A	32	42.47	1359.00	511.000	0.000
	Group B	32	32.47	1039.00		
	Total	**64**				
Anteromedial	Group A	32	44.00	1408.00	464.000	0.000
	Group B	32	34.00	1088.00		
	Total	**64**				
Medial	Group A	32	44.39	1420.50	451.500	0.000
	Group B	32	34.39	1100.50		
	Total	**64**				
Posteromedial	Group A	32	47.94	1534.00	338.000	0.000
	Group B	32	37.94	1214.00		
	Total	**64**				
Posterior	Group A	32	42.84	1371.00	501.000	0.000
	Group B	32	32.84	1051.00		
	Total	**64**				
Posterolateral	Group A	32	40.44	1294.00	446.000	0.000
	Group B	32	30.44	974.00		
	Total	**64**				
Lateral	Group A	32	41.34	1323.00	475.000	0.000
	Group B	32	31.34	1003.00		
	Total	**64**				
Anterolateral	Group A	32	39.78	1273.00	425.000	0.000
	Group B	32	29.78	953.00		
	Total	**64**				



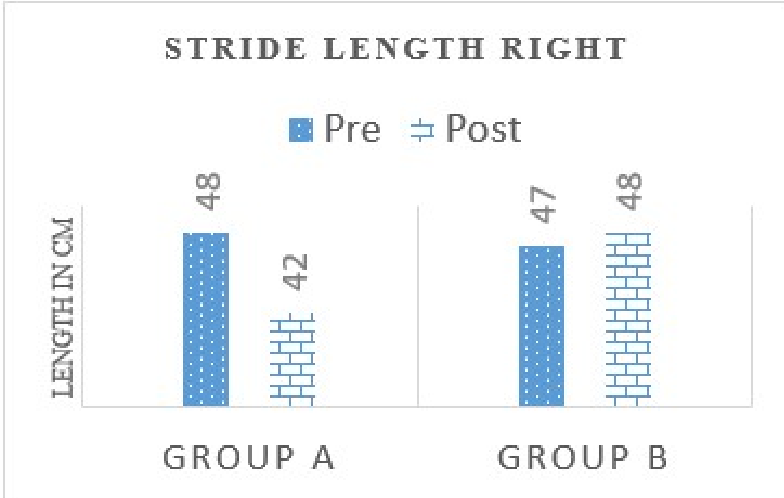
Graph 7: TWT- step length (left) pre and post values in group a and b



Graph 8: TWT- stride length (left) pre and post values in group a and b



Graph 9: TWT- step length (right) pre and post values in group a and b



Graph 10: TWT- stride length (right) pre and post values in group a and b

Table 7: TWT- step length (left) pre and post values in group a and b

Tandem Walk Test						
Step Length Lt	**Median**		**Wilcoxon Signed Rank**	**P-Value**	**% Change**	**Result**
	Pre	**Post**	**W**			
Group A	23.5	22	-3.524^{b}	0.000	6.2	Sig
Group B	23	24	$-.791^{b}$	0.429	1.2	NS

Table 8: TWT - stride length (left) pre and post values in group a and b

Tandem Walk Test						
Stride Length Lt	**Median**		**Wilcoxon Signed Rank**	**P-Value**	**% Change**	**Result**
	Pre	**Post**	**W**			
Group A	47.5	44	-4.692^{b}	0.000	7.5	Sig
Group B	46	47	$-.720^{b}$	0.472	1.2	NS

Table 9: TWT- step length (right) pre and post values in group a and b

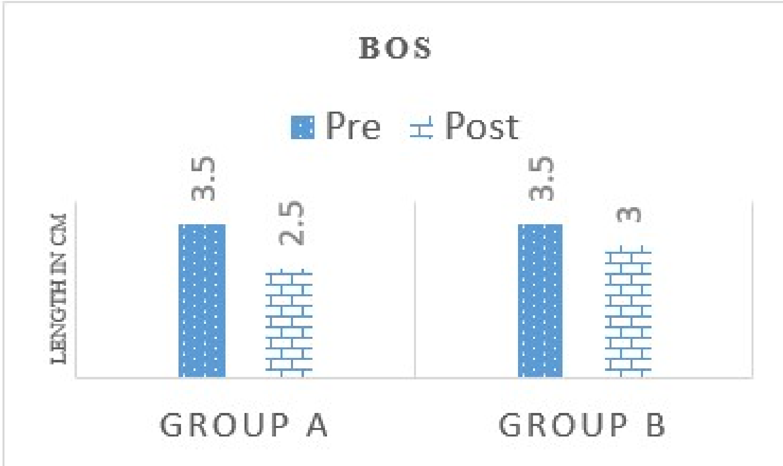
Tandem Walk Test						
Step Length Rt	**Median**		**Wilcoxon Signed Rank**	**P-Value**	**% Change**	**Result**
	Pre	Post	**W**			
Group A	23.5	22	-2.898^{b}	0.004	2.4	Sig
Group B	23	23.5	$-.920^{b}$	0.358	1.3	NS

Table 10: TWT - stride length (right) pre and post values in group a and b

Tandem Walk Test						
Stride Length Rt	**Median**		**Wilcoxon Signed Rank**	**P-Value**	**% Change**	**Result**
	Pre	Post	**W**			
Group A	48	42	-4.697^{b}	0.000	9.4	Sig
Group B	47	48	-1.193^{b}	0.233	1.3	NS

Table 11: TWT-base of support: pre and post values in group a and b

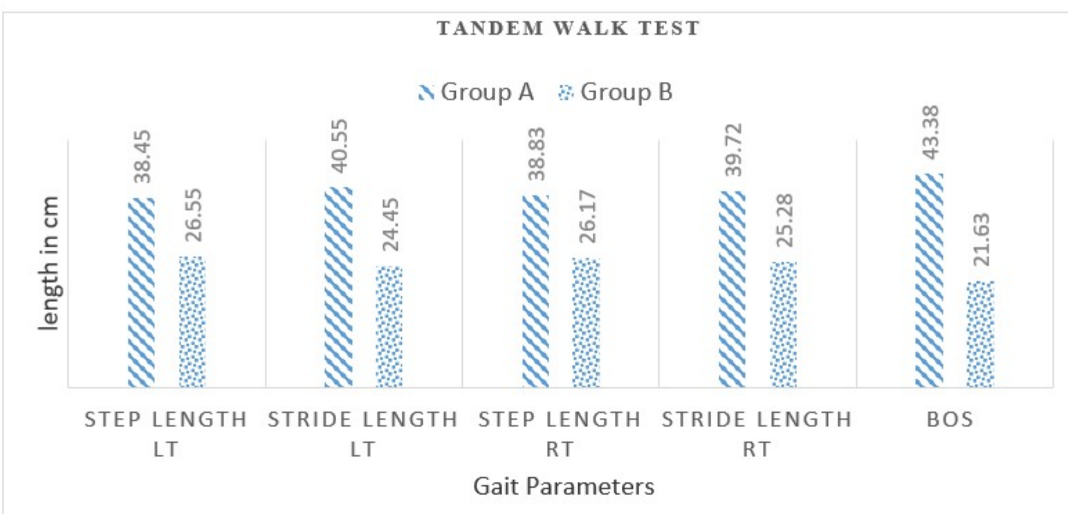
Tandem Walk Test						
BOS	**Median**		**Wilcoxon Signed Rank**	**P-Value**	**% Change**	**Result**
	Pre	**Post**	**W**			
Group A	3.5	2.5	-4.921^{b}	0.000	38.0	Sig
Group B	3.5	3	-2.642^{b}	0.008	5.8	Sig



Graph 11: TWT-base of support: pre and post values in group a and b

Table 12: Comparison between group a and group b in components of TWT

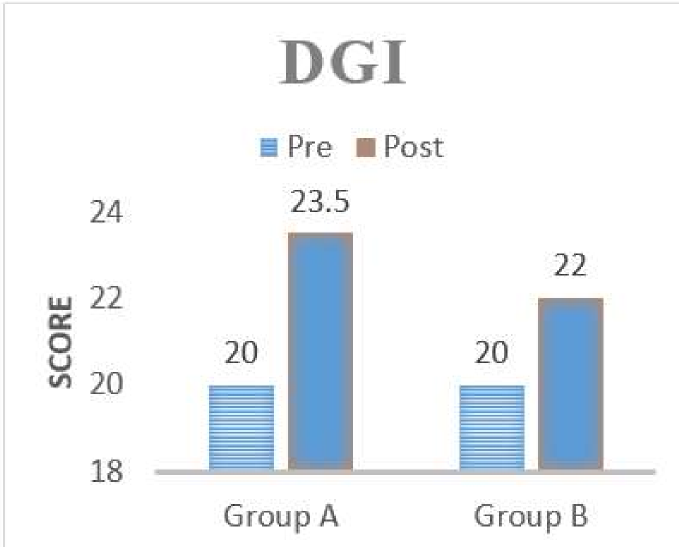
Tandem Walk Test						
	Group	**N**	**Mean Rank**	**Sum of Ranks**	**Mann-Whitney U**	**P-Value**
Step Length Lt	Group A	32	38.45	1230.50	321.500	0.009
	Group B	32	26.55	849.50		
	Total	**64**				
Stride Length Lt	Group A	32	40.55	1297.50	254.500	0.000
	Group B	32	24.45	782.50		
	Total	**64**				
Step Length Rt	Group A	32	38.83	1242.50	309.500	0.005
	Group B	32	26.17	837.50		
	Total	**64**				
Stride Length Rt	Group A	32	39.72	1271.00	281.000	0.001
	Group B	32	25.28	809.00		
	Total	**64**				
BOS	Group A	32	43.38	1388.00	164.000	0.000
	Group B	32	21.63	692.00		
	Total	**64**				



Graph 12: Comparison between group a and group b in components of TWT

Table 13: DGI score pre and post training in group a and b

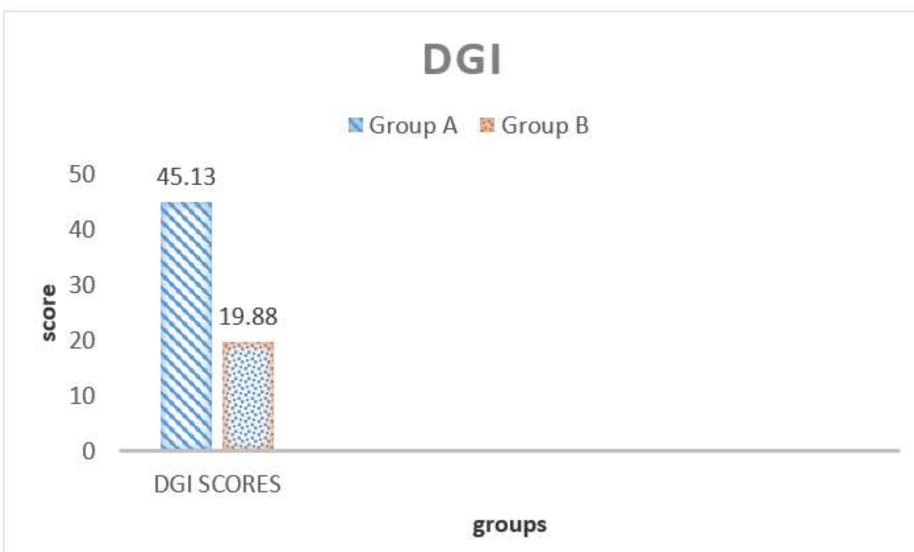
DGI	Median		Wilcoxon Signed Rank W	P-Value	% Change	Result
	Pre	Post				
Group A	20	23.5	-4.985[a]	0.000	16.4	Sig
Group B	20	22	-4.832[a]	0.000	7.1	Sig



Graph 13: DGI score pre and post training in group a and b

Table 14: Comparison between group a and group b in DGI scores

	Group	N	Mean Rank	Sum of Ranks	Mann-Whitney U	P-Value
DGI	Group A	32	45.13	1444.00	108.000	0.000
	Group B	32	19.88	636.00		
	Total	**64**				



Graph 14: Comparison between group a and group b in DGI scores

DISCUSSION

The main purpose of the study was to find out the effect of sleep on novel motor task learning in elderly individuals. Findings from SEBT values in no sleep group confirms the result of the study done June J. Pilcher and colleagues that sleep deprivation strongly impairs human functioning. Even previously done studies suggest that exposure to partial and total sleep deprivation impairs primarily behavioural alertness and cognitive processing capabilities [23]

Improvement in BOS component of TWT in no sleep condition can be explained with work of Lowry K A and colleagues, who studied Age-Related Differences in Locomotor Strategies during Adaptive Walking. They stated that adults tend to preserve mediolateral (ML) smoothness at the expense of anteroposterior (AP) smoothness. Study inferred that older adults prioritized ML control over forward progression during adaptive walking challenges[34]. So accordingly it can be concluded that older adults while performing the TWT in the no sleep group might have preferred managing the BOS component easily rather than resolving the anterior-posterior components.

Also, in no sleep group a significant improvement was seen in DGI scores. DGI includes components which are similar to daily walking. Walking doesn't require any conscious effort. Also, walking is an automated movement might have been easy to learn for the subjects even in no sleep group. This can be reasoned out with the theory of Ericsson, which states the premature transition to the autonomous stage of learning.[35] Even, Anderson's Adaptive Control of Thought theory, states- as learning occurs, a transition from declarative memory to procedural memory takes place.Fiery Cushman and Adam Morris,quote that humans use habitual control to select a goal. Once selected they can then effectively plan and improve their performance.[36]It might be, because of this reason the DGI score improved even in no sleep group. Considering this relevance, we can conclude that as people were priorly used to the components of DGI it might have been possible that they were able to improve their performance in spite being in the no sleep condition.

It can be stated that learning effect was seen in sleep group as they demonstrated a significant change in SEBT values. A study done by Kuriyama and colleagues mentions about complexity theory which states that sleep enhances learning the tasks that are more complex. [37] Therefore, the present study can also confirm that sleep dependent learning is not limited to simple motor tasks but also extends to novel more complex motor tasks, as SEBT scores in no sleep group were not significant. SEBT being a complex activity to perform might have been difficult to perform.

Findings from TWT suggest that Sleep was effective to get the learning effect post novel task training. These results can be supported with findings of AL Sharman and colleagues which states that sleep enhances learning a functional motor task in middle-aged and older adults.[21] Also, subjects in sleep group subjects showed a significant difference in DGI scores. Hence, it can be concluded that the learning effect was seen in subjects in the sleep group. As mentioned earlier, this change might be because of the premature transition towards the autonomous stage of learning.[35]Also, Elmar Kal and colleagues in their systemic review concluded that while comparison between implicit and explicit learning, found that comparisons leaned more toward a greater degree of movement automaticity after implicit learning than explicit learning.[38]

However, the effect seen in sleep group is greater than no sleep group. With reference to gait variability in older adults[34], present study findings can be used to quote that sleep improves novel motor skill learning which indirectly can imply that this technique can also be used in a way to improve or modify or manage the coping strategies used by older adults.

Ericsson in his study also proposed that a premature shift to the autonomous stage of learning can lead to arrested development as the performance stabilizes in a nonmaximal state[35]. From this, we can say that this arrested performance can be overcome by sleep. Hence, it can be concluded that sleep enhances the learning of novel motor tasks in elderly individuals.

The current study also can suggest that sleep quality and sleep dependent motor learning might have a relation with each other. Sleep quality was assessed by the Pittsburgh Sleep Quality Index and subjects were asked to maintain regular sleep for a week prior[21,29]. Therefore after ruling out sleep difficulties and ensuring efficient sleep patterns by addressing Pittsburgh Sleep Quality Index, it can be concluded that with better sleep and fewer awakenings there learning over a task can be improved. Also, the Stanford Sleepiness Scale 64administered to ensure state of alertness before the sessions cancel out any negative effect of sleepiness which sleeps deprivation might have imposed.[30] It has already been proved that motor performance is not enhanced by day time naps in older adults[39] Hence, it can quote that continuous sleep before a session might be optimal than small sleep episodes during the day time. Also, it is found that there is a positive correlation between sleep spindle density and offline motor learning and sleep duration having an association with specific motor task learning but not with nonspecific learning.[22] Hence, we can conclude that with enough sleep duration and quality effective novel motor task training can be achieved.

Hence, in the study presented above it can be concluded that sleep enhances the learning of novel motor tasks in elderly individuals.

CONCLUSION

Present study states that sleep is effective in novel motor task learning in elderly individuals. It should be seen that significant importance is given to adequate sleep before physical therapy sessions to ensure effective motor learning. Even, during rehabilitation, timing of the session should be plan appropriately to facilitate the learning process. Also, it is necessary to address sleep disorders on a priority basis in the diseased population, because if left unnoticed it might cause hindrance in achieving the goal.

Limitations

Lifestyles were not taken into consideration.

Future Scope

A correlation between the quality of sleep and the extent of motor task learning achieved can be found out. A research can be done to find out the effect of sleep on novel motor task learning in different populations, especially following a neurological deficit or in people with neurological disorder. A study can be proposed to compare the effect of sleep on novel motor task learning in physically active older adults versus that in their sedentary counterparts**.**

REFERENCES

1. Lopes K, Costa D, Santos L, Castro D, Bastone A. Prevalência do medo de cair em uma população de idosos da comunidade e sua correlação com mobilidade, equilíbrio dinâmico, risco e histórico de quedas. Rev Bras Fisioter. 2009;13(3):223-9. doi: 10.1590/S1413-35552009005000026.
2. Kamińska Magdalena Sylwia, Miller Agnieszka, Rotter Iwona, Szylińska Aleksandra, Grochans Elżbieta. The effectiveness of virtual reality training in reducing the risk of falls among elderly people. Clin Interv Aging. 2018;13:2329-38. doi: 10.2147/CIA.S183502, PMID 30532523.
3. Harrington DL, Haaland KY. Skill learning in the elderly: diminished implicit and explicit memory for A motor sequence. Psychol Aging. 1992;7(3):425-34. doi: 10.1037//0882-7974.7.3.425, PMID 1388864.
4. Ehsani Fatemeh, Abdollahi Iraj, Bandpei Mohammad Ali Mohseni, Zahiri Nahid, Jaberzadeh Shapour. Motor learning and movement performance: older versus younger AdultsBasic and clinical neuroscience. Vol. 6. Number 4; October 2015.
5. Shumway-Cook Anne CHAPTER 4. Physiological basis of motor learning and recovery of function, Pg No. In: Motor control: translating research into clinical practice/Anne Shumway cook and Marjorie H. Woollacott. 4th ed; 1947. p. 85-9.
6. Cushman Fiery, Adam Morris. Habitual control of goal selection in humans. PNAS. November 10, 2015;112(45):13817-22.
7. Jiang Yuhong V, Koutstaal Wilma, Twedell Emily L. Habitual attention in older and young adults. Psychol Aging. October 2016;31(8):970-80. doi: 10.1037/pag0000139, PMID 27831723.
8. Vakil Eli, Agmon-Ashkenazi Dafna. Baseline performance and learning rate of procedural and declarative memory tasks: younger versus older adults journal of gerontology: psychological Sciences 1997. Vol. 52b(5). p. 229-P234.
9. Taylor Jordan A, Ivry Richard B. The role of strategies in motor learning. Ann N Y Acad Sci. 2012 March;1251:1-12. doi: 10.1111/j.1749-6632.2011.06430.x, PMID 22329960.
10. Rivera-Torres Solymar, Fahey Thomas D, Rivera Miguel A. Adherence to exercise programs in older adults: informative report. Gerontol Geriatr Med. 2019;5:2333721418823604. doi: 10.1177/2333721418823604, PMID 30733977.
11. Ofli Ferda, Kurillo Gregorij, Obdržálek Štěpán, Bajcsy Ruzena, Jimison Holly Brugge, Pavel Misha. Design and evaluation of an interactive exercise coaching system for older adults: lessons learned. IEEE J Biomed Health Inform. 2016 January;20(1):201-12. doi: 10.1109/JBHI.2015.2391671, PMID 25594988.
12. Updated ND25December. Merriam-Webster since 1828; 2017. Novel. Web. 3 Jan. 2018. Available from: Merriam-Webster.Com.
13. Mitry Kobark D, Mehring Carsten. Adaptation paths to novel motor task S Are shaped by prior structure learning. Behavioral/systems/cognitive. J Neurosci. July 18 2012;32(29):9898-908.
14. Shumway-Cook Anne, 1947. Motor control: translating research into clinical practice/Anne Shumway cook and Marjorie H. Woollacott. — CHAPTER 2. Motor learning and recovery of function, Pg No: 30,31. 4th ed.
15. Żak Marek, Swine Christian, Grodzicki Tomasz. Combined effects of functionally oriented exercise regimens and nutritional supplementation on both the institutionalised and free-living frail elderly (double-blind, randomised clinical trial). BMC Public Health. 2009;9:39. doi: 10.1186/1471-2458-9-39, PMID 19175935.
16. Le Graves Ridgers Nd, Williams K, Stratton G, Atkinson G. Cable Nt. The physiological cost and enjoyment of Wii fit in adolescents, young adults, and older adults. J Phys Act Health. 2010;7. PMID 393401.
17. Agmon Maayan. Pt, Phd, ma, Ba; Cynthia K. Perry, PhD, Arnp; Elizabeth Phelan. Md, Ms: George Demiris, Phd; Huong Q. Nguyen, Phd A Pilot Study Of Wii Fit Exergames To Improve Balance In Older Adults (J Geriatr Phys Ther 2011;34:161-167.

18. Huberty Jennifer L, Ransdell Lynda B, Sidman Cara, Flohr Judith A, Shultz Barry, Grosshans Onie, Durrant Lynne, Et Al. Explaining long-term exercise adherence in women who complete a structured exercise program. Res Q Exerc Sport. 2008;79(3):374-84. doi: 10.1080/02701367.2008.10599501, PMID 18816949.
19. Bohil Corey J, Alicea Bradly, Frank A, Biocca. Virtual reality in neuroscience research and therapy nature reviews. Neuroscience. Vol. 12(December); 2011. p. 752-62.
20. Stickgold Robert, Walker Matthew P. Sleep-dependent memory consolidation and reconsolidation. Sleep Med. 2007 June;8(4):331-43. doi: 10.1016/j.sleep.2007.03.011, PMID 17470412.
21. Al-Sharman Alham, Siengsukon Catherine F. Performance of A functional motor task in enhanced by sleep in middle-aged and older adults, Jnpt. J Neurol Phys Ther. 2014;38(3):161-9. doi: 10.1097/NPT.0000000000000048, PMID 24866594.
22. Walker Matthew P, Brakefield Tiffany, Seidman Joshua, Alexandra Morgan J, Hobson Allan, Stickgold Robert. Sleep and time course of motor skill learning, Csh press. Learn Mem. 2003;10(4):275-84. doi: 10.1101/lm.58503.
23. Lo June C, Groeger John A, Santhi NayantaraEtAl, Arbon Emma L, Lazar Alpar S, Hasan Sibah, von Schantz Malcolm, Archer Simon N, Dijk Derk-Jan. Effects of partial and acute total sleep deprivation on performance across cognitive domains, individuals and circadian phase. PLOS ONE. 2012;7(9): E459. doi: 10.1371/journal.pone.0045987, PMID 23029352.
24. Hobson JAllan, Pace-Schott Edward F. The cognitive neuroscience of sleep:neuronal systems, consciousness and learning. Nat Rev Neurosci. 2002;3(9):679-93. doi: 10.1038/nrn915, PMID 12209117.
25. Titz Cora, Karbach Julia. Working memory and executive functions: effects of training on academic achievement. Psychol Res. 2014;78(6):852-68. doi: 10.1007/s00426-013-0537-1, PMID 24389706.
26. Tucker Matthew A, Nguyen Nam, Stick Gold Robert. Experience playing A musical instrument and overnight sleep enhance performance on A sequential typing task Plosone11 (7). p. E0159608.
27. Rodriguez Juan Carlos, Dzierzewski Joseph M, Alessi Cathy A. Sleep problems in the elderly. Med Clin North Am. 2015 March;99(2):431-9. doi: 10.1016/j.mcna.2014.11.013, PMID 25700593.
28. Valériemongrain Suzie Lavoie, Brahimselmaoui Jean Paquet, Dumont Marie. Phase relationships between sleep-wake cycle and underlying circadian rhythms in morningness-eveningness. J Biologicalrhythms. June 2004;19(3):248-57.
29. Buysse Daniel J, Reynolds Charles F Iii, Monk Timothy H, Berman Susan R, Kupfer David J. The Pittsburgh Sleep Quality Index: A new instrument for psychiatric practice and research. Psychiatry Res. 1989;28(2):193-213. doi: 10.1016/0165-1781(89)90047-4, PMID 2748771.
30. Herscovitch Joel, Broughton Roger. Sensitivity of the Stanford sleepiness scale to the effects of cumulative partial sleep deprivation and recovery oversleeping. Sleep. 1981;4(1):83-91. doi: 10.1093/sleep/4.1.83, PMID 7232973.
31. Kinzey SJ, Armstrong CW. The reliability of the Starexcursion test in assessing dynamic balance. J Orthop Sports Phys Ther. 1998;27(5):356-60. doi: 10.2519/jospt.1998.27.5.356.
32. Robertson Marc, Gregory Robert. Concurrent validation of the tandem walk test As A measure of dynamic walking balance in A healthy population. Phys Ther Rehabil: Ssn 2055. 2017;4(1):(Article 12). doi: 10.7243/2055-2386-4-12.
33. Jonsdottir Johanna, Cattaneo D. Reliability and validity of Dgi in persons with chronic stroke. Source PubMed J Apmr. 2007;08:109.
34. Lowry Kristin A, Sebastian Katherine, Perera Subashan, Van Swearingen Jessie, Smiley-Oyen Ann L. Age-related differences in locomotor strategies during adaptive walking. J Mot Behav. 2017 Juil–Aug;49(4):435-40. doi: 10.1080/00222895.2016.1241742, PMID 27870605.
35. Ericsson KA. Attaining excellence through deliberate practice: insights from the study of expert performance. In: Ferrari M, editor, The pursuit of excellence through education. Mahwah, Nj: Erlbaum; 2002. P. 21-56.
36. Anderson JR. Acquisition of cognitive skill. Psychol Rev. 1982;89(4):369-406. doi: 10.1037/0033-295X.89.4.369.
37. Kuriyama Kenichi, Stickgold Robert, Walker Matthew P. Sleep-dependent learning and Motorskill complexity. Learn Mem. 2004;11(6):705-13. doi: 10.1101/lm.76304, PMID 15576888.
38. Kal Elmar, Prosée Rens, Winters Marinus, van der Kamp John. Does implicit motor learning lead to greater automatization of motor skills compared to explicit motor learning? A systematic review. PLOS ONE. 2018;13(9):e0203591. doi: 10.1371/journal.pone.0203591, PMID 30183763.
39. Backhaus Winifried, Braass Hanna, Renné Thomas, Gerloff Christian, Hummel FC. Motor performance is not enhanced by daytime naps in older adults. Front Aging Neurosci. 2016;8:125. doi: 10.3389/fnagi.2016.00125.

How to cite this article: Dr Richa N Shah, Dr Snehal Joshi. Effect of sleep on novel motor task learning In Elderly individuals. Int J of Allied Med Sci and Clin Res 2020;8(3):587-603.
Source of Support: Nil. **Conflict of Interest:** None declared.