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The Effectiveness of Balance Intervention In Normal Pre-Teen Urban School Children Using Balance Master

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ABSTRACT: Postural control is developed by interaction individuals with environment. Maturity of postural control is achieved by 7-10yrs of age. The level of physical activity in children is declining slowly, which causes increase in 'sitting time' over in physical activities. Specially tailored intervention could provide an insight to influence environmental stimulation in order to improve balance. Study included assessing balance using Balance Master and timed up and down stairs test and compare balance before and after 4 weeks of training with structured balance program along with carry over effect after 26 weeks. And study the effectiveness of balance training. Healthy pre-teen children between age 9-12yrs (n=30) in each group (total 60) from schools of Mumbai were included in the study. MCTSIB on Firm and foam surface (EO & EC) Unilateral stance on firm and foam surface (EO and EC) timed up and down stairs test checked for children at baseline, after 4 week of intervention and after 26weeks of training for both groups.

Repeated ANOVA showed significant difference in pre, post and carry over values of sway velocities in experimental group ($p<0.05$) whereas no significant change in values with control group in sway velocities for MCTSIB and Unilateral stance when checked within the group pointing towards change in performance. Analysis of data showed significant difference in sway velocities for experimental group as compared to controlled group in terms of reduction in sway velocities immediately after 4 weeks of training. However, sway velocities which were markedly low after 4weeks of training returned more or less to the baseline when assessed after 26weeks. Significant improvement if timed up and down stairs test confirms functional improvement in experimental group.

Conclusion: Balance training improved the postural control &balance responses in children.

KEYWORDS : Balance Training, effects of balance Training, Urban schoolchildren, Neuroplasticity, Environmental factors and neuroplasticity, repetition and neuroplasticity

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I. INTRODUCTION

Balance is defined as ability to maintain body's centre of gravity (COG) over base of support (BOS). [1] Among the higher organism's human species is uniquely gifted with the ability to assume erect posture. The latter facilitates standing, walking and running on different surfaces and bases of support. Building blocks of these unique mechanisms are forged in fetal life. A fetus is able to move arms, kick & rotate the body during intrauterine life. After birth he/she achieves milestones like head holding, rolling, crawling, sitting, standing and walking by the age of one year. [2]Maturation of synapses as well as visual, somatosensory, vestibular-cochoclear systems is genetically timed. In addition, there is an influence of environmental factors. The contribution of environment is referred to as "experience-dependent maturation". This process of maturity of the nervous system facilitates adaptation of human organisms to their own unique environment. Highly coordinated movements develop gradually from simpler components, i.e. gross to finer movement patterns.

A movement is an essential characteristic of all living organisms. Human beings have an additional ability to perform running, hopping and skipping. These activities continuously challenge balance systems. Balance develops through the interaction of somatosensory, visual, vestibular and musculo-skeletal systems.Postural control develops from further interaction of an individual with environment. Long term practice improves performance and skills are learnt.

Postural stability is necessary in all daily activities.Researchers propose that co-ordination of postural responses to perturbation commences as early as 1.5 years of age. Nevertheless, it is apparent only at the age of 3yrs. An apparent regression in children is noticed from age 4-6years, maturity of postural balance is completed by 7-10yrs of age. [1]To carry out the task acquisition of control over speed, quality, force and strength of actions, sequence and timing of muscle activity to ensure smooth, efficient & purposeful movements are essential for chain responses. [4]

As a result, balance responses are context & task dependent and are triggered by availability and accuracy of specific sensory inputs. It is evident from research that balance control in children is not only age dependent process attained with maturation but is also associated with task or environmental constraint [5] The developing brain is a dynamic, responsive, and to some extent self-organizing organ. Neurogenesis is extremely dynamic process and is up-down regulated by various endocrinal, environmental, genetic & pharmacological factors. Neurogenesis occurs in granulate neurons in hippocampus, neocortex & striatum. Neuronal progenitors in hippocampus give rise to new neurons that make synaptic connections with other cells; these new neurons are believed to participate in hippocampal function and in mechanism related to adaptive plasticity.Neural development is an active, reciprocal process. [11] Even though there is matured neural networking between various systems by the age of 10 there is still a scope for development in these children.

It has been observed that the level of physical activity in children has alarmingly declined in recent years. Moreover, with, the advent of television, Internet & smart phones, the children in age group of 6.5 to 13 years prefer to spend time in watching television, "exploitation/explosion" of internet as well as smart phones barring a few exceptions. [6] Time spent in sitting in the crowded classrooms where over 70children are accommodated in a section, is more than the time spent in sports /physical activities. This is evident from the growing trend seen towards cutting down on number of periods of Physical Education per week, and participation in sports in the school [7].

Thus a specifically tailored intervention could provide an insight into the influence of environmental stimulation, which may advance interaction between fully matured visual, vestibular and somatosensory systemon postural control and balance in urban children aged 9 to 12 years. It has been suggested that through specific balance training program there is an improvement in balance as well as postural control. [8]

II. METHODOLOGY

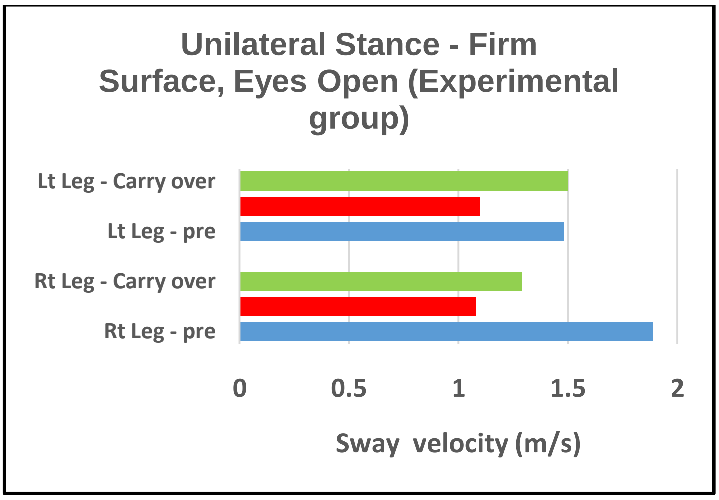
After approval from the Ethics Committee, the purpose of the study was explained to the school authorities and parents of the children of both the schools.Written assents were received from parents and school authorities of both the schools. 120 children were screened from. (60 from each school) 30 from each school were recruited in the study based on inclusion & exclusion criteria.Healthy pre-teen children in 9-12yrs age group,walking independently without walking aid and showed willingness to participate were included in the study after consenting their parents. Study excluded children with neurological, auditory and visual impairments.Children with congenital disorders and deformities, musculoskeletal injuries. Also children undergoing specialized training (dancing, swimming, sports coaching, etc.All subjects were tested for their balance on force platform with eyes open (EO) and eyes closed (EC) and on firm and foam surfaces for MCTSIB and Unilateral Stance Timed Up & Down Stairs Test assessment done for all the children. An average of three trials of the performance on above mentioned activities was observed & documented.An interval of 15 secs was given between each trial, and adequate rest was given between each test.A structured balance training program of 45mins 3days per week was conducted for the children from one school (Group A) during physical training period in school. The level of difficulty was increased per week to ensure that each child was exposed to a new set of environment and challenging tasks. Balance of children from experimental group was reassessed immediately after training.After 26weeks reassessment of said tests was carried out for the both groups.(diagram 1)

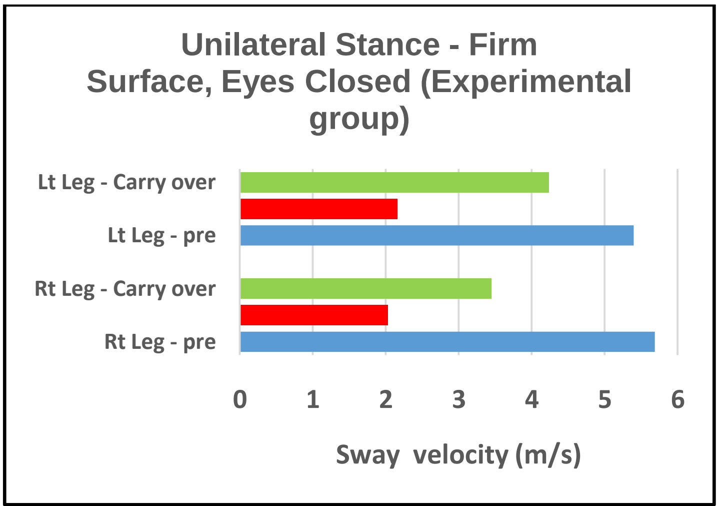
III. RESULTS

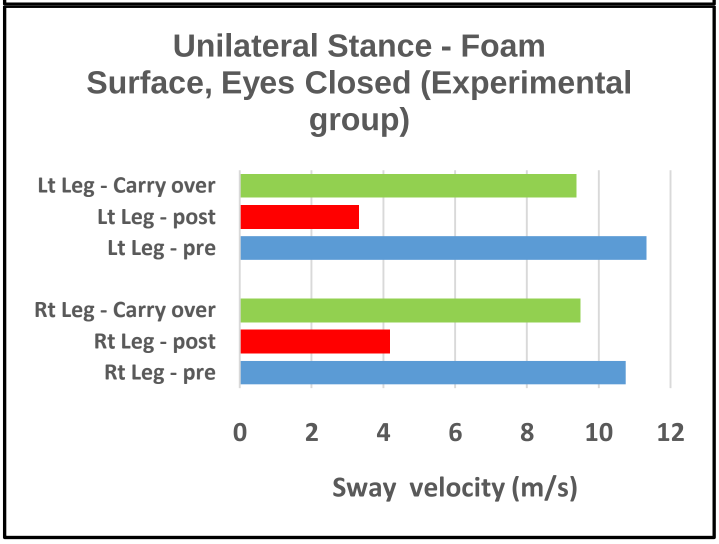
The data passed normality tests. The data was analyzed using SPSS-16 software for windows. Normality was checked using Kolmogorov Smirnhov test**.**

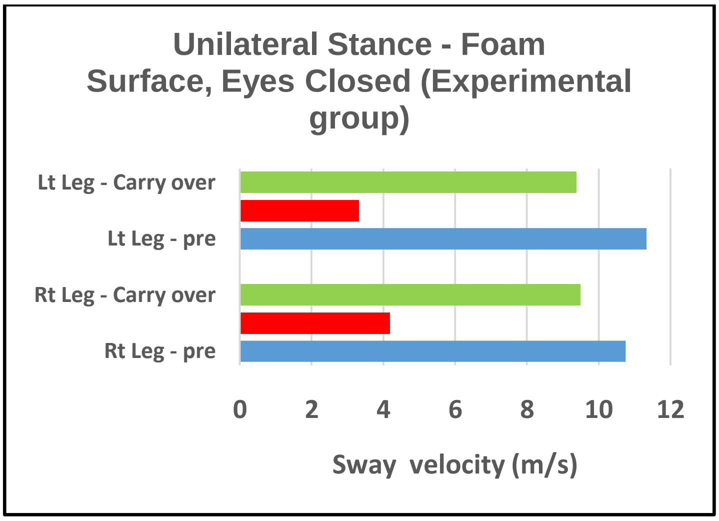
The parametric tests were used for statistical analysis**.** Repeated measures ANOVA test was usedfor comparison within the experimental group. Paired t test used for comparison of means of variables recorded for control group (pre &post). The significant findings were defined as those with a "p" value less than 0.05.

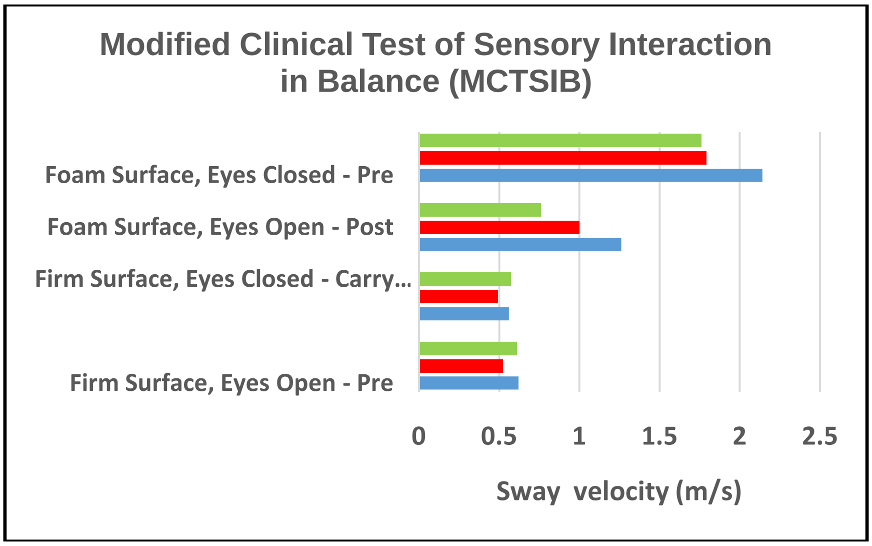
For distribution of age, gender & height in both the groups, statistically insignificant difference ($p=0.403$) was noted between both the groups when tested with Unpaired t test, $p>0.05$Children consisting of the mean age 10.53 ± 1.106 in experimental group & the mean age 10.30 ± 0.877 in control group, comprising of 30 subjects in each group. Group A consisted of 19 boys& 11girls Group B consisted of 10 boys & 20 girls. Analysis of the data in MCTSIB & unilateral stance when treated with repeated ANNOVA test for pre-post and carry over revealed significant difference in the performance in the sway velocity in experimental group ($p<0.05$). (Diagram 6) However, when the children were tested on firm surface with "eyes open & eyes closed" conditions, (diagram 2,3,4,5) the results were not significant. ($p=0.184$ for eyes open & $p=0.194$ for eyes closed). In intragroup analysis for controlled group data was not significant indicating no change in performance nevertheless experimental group showed significant difference in post training data analysis. This result was seen for MCTSIB and Unilateral stance with EO and EC. Effectiveness of training was more significant for EC than on EO, and more for foam surfaces vs firm surface when tested using force platforms. Similar results obtained for TUDS, significant change seen in pre-post values for comparison of control and experimental group (p=0.05) and for controlled group there was no change(p=0.870). In pre(21secs),post(19 secs) and carry over(19.17secs) data for experimental group there was change in TUDS scored which was lesser than post training but statistically significant confirming change in performance over a period of time.

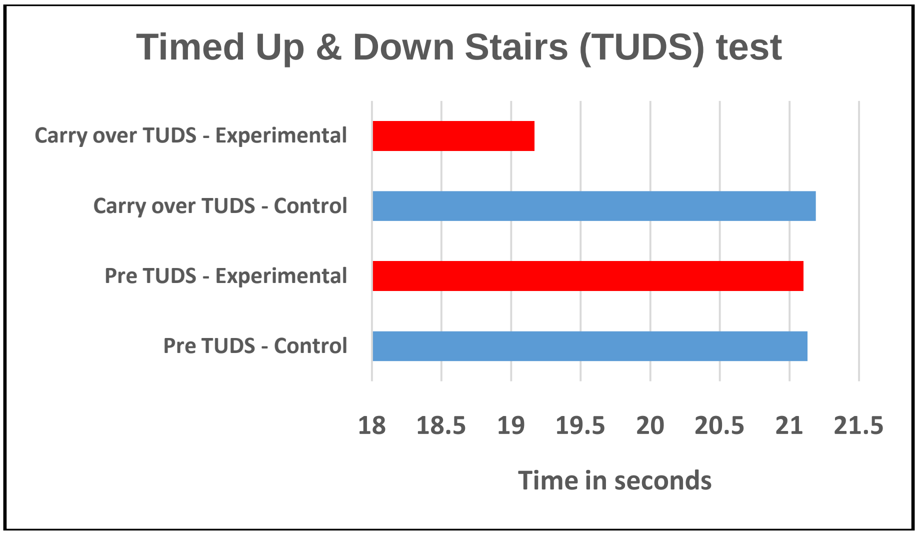







Unilateral Stance - Foam Surface, Eyes Closed (Experimental group)
Lt Leg - Carry over
Lt Leg - pre
Rt Leg - Carry over
Rt Leg - pre
0
2
4
6
8
10
12
Sway velocity (m/s)


Modified Clinical Test of Sensory Interaction in Balance (MCTSIB)
Foam Surface, Eyes Closed - Pre
Foam Surface, Eyes Open - Post
Firm Surface, Eyes Closed - Carry...
Firm Surface, Eyes Open - Pre
0
0.5
1
1.5
2
2.5
Sway velocity (m/s)


Timed Up & Down Stairs (TUDS) test
Carry over TUDS - Experimental
Carry over TUDS - Control
Pre TUDS - Experimental
Pre TUDS - Control
18
18.5
19
19.5
20
20.5
21
21.5
Time in seconds

IV. DISCUSSION

The study intended to study the effectiveness of balance training in enhancing the balance performance of the urban school children. All the children were assessed for baseline parameters prior to the intervention on force plate. The children in experimental group were subjected to the structured balance interventional program for four weeks. Assessment was carried out at the end of 4 weeks & the re-assessment followed after 26 weeks to check whether the effect of the intervention persisted even after the cessation of the exercise program.

The data in MCTSIB & unilateral stancerevealed significant difference in the performance in the sway velocity in experimental group ($p<0.05$). However, when the children were tested on firm surface with "eyes open & eyes closed" conditions, the results were not significant, because the children are used to playing on hard & soft surfaces most of the time. The children in lower socioeconomic strata do not use footwear during the play. Therefore,the sensory system integration is the possible cause for these insignificant results.Bon Ferroni analysis showed, significant "$f_{pre, post}$" value (<0.05) thus indicating definite improvement in performance and in turn reduction in sway velocity after the intervention. "$f_{post\text{-}carry\ over}$" (<0.05), too. These results point towards the change in performance of children after 4 weeks of the intervention. However, sway velocities which were markedly low after 4 weeks returned more or less to the baseline when assessed after 26 weeks. "$f_{pre\ –carryover}$" (>0.05).These results are in tandem with the results of Taubert et al 2010.[46,47]

The significant difference in "timed up and down stairs" test ($P<0.05$) confirmed functional improvement in terms of speed. Clinically too, the children in experimental group demonstrated qualitative improvement in terms of smoothness & agility.

The "Sway velocity" of the children in control group showed non significant results ($p>0.05$) indicate no change, in their performance, though chronologically they advanced in their ages. These non significant results could be due to deficient stimuli available through the systems mentioned above. This lack of "stimulus-response" may affect the ability to develop new connections & the maturity in the CNS. This is apparent from the results in the said tables and in line with the results obtained by J.F. Stins et al [57].

Comparison of baseline data of both the groups was not significant, indicating both groups are compatible. There was no significant difference ($p>0.05$), in baseline values of sway velocities of both the groups. This fact indicates that participants from both the groups were at same level of age appropriate neurological development.

The carry over data, collected after 26 weeks for the experimental & control group, provided evidence regarding statistically significant difference ($p<0.05$) in the conditions of eyes open on both firm & foam surfaces 26 weeks after the intervention. The experimental group showed better balance than the children in control group, though the comparison between both groups was non significant at baseline.

The findings in unilateral stance, where sway velocities were not significant at baseline in all conditions except on foam surface –Eyes closed. The findings in the last condition indicated significant values.

Comparison of the rest of the conditions demonstrated significant values after 26 weeks in the experimental group.

It was observed, that children in the control group swayed more than that of experimental group Most of the children in the latter group, showed qualitative improvement, when evaluated clinically.

Significant difference ($p<0.05$) between the two groups as depicted timed up and down stairs test. The mean time taken by participants of experimental group for completing task was 21.10 at base line and 19.16 after 26 weeks; whereas the control group had a mean value of 21.13 and 21.19 respectively. These findings confirm the functional improvement in children from experimental group.

A stepwise sequence of neurodevelopment is genetically predetermined and not exchangeable by environmental factors at birth. However, as the child grows, environmental factors begin to contribute to the development & allow the child to master the activities & functional independence through, cognitive, perceptual, somatosensory & vestibular influences.

Brain plasticity continues throughout adult life & gives an opportunity for individual to work on developing new skills and abilities, at all ages. Stress, difficulty in task, enriched environmental stimuli & practices are the few factors affecting plasticity [49,]. Changes in the strength of synapses and reorganization of neuronal circuits also play important roles in brain plasticity. Synaptic plasticity refers to changes in the strength of neurotransmission induced by activity experienced by the synapse in the past. Changes in the frequency or strength of activation across synapses can result in long-term increase or decrease in their number, referred to long-term potentiation (LTP)[50,51] .These activity- dependent changes occur in all excitatory synapses mediated by changes in the release of neurotransmitters from presynaptic terminals as well as changes in the number of excitatory receptors on postsynaptic neurons. Rapid repetitive presynaptic stimulation via neurotransmitters at the synapses of pyramidal neurons in the hippocampus produced LTP. This in turn increases cortical plasticity. A burst in synapse production begins in the occipital cortex in the early postnatal period, rising to a density that is approximately twice of that in the adult brain by age of 2 years, then falling to adult levels by early adolescence[52].Similar waves of synaptogenesis occur in parietal-temporal and then frontal regions.

Other form of plasticity is prominent in the cerebellum. LTP is associated with memory formation in the hippocampus, and LTP and LTD form the basis for activity-dependent reorganization and stabilization of developing neuronal networks in sensory-motor cortex (53(54)(55)

This supports the hypothesis that a prolonged period of overproduction and pruning of synapses in children and young adults contributes to their capacity for plasticity and learning.

Study by **Jen Bo Nielsen 2008**[12], suggests that repeated training of the task over several days or weeks leads to more or less long lasting expansion of the cortical representation.This in turn, may perhaps lead to the structural reorganization of the cortical networks activated by unmasking of cortical regions which were engaged in performing other tasks before commencement of the practice. The picture emerging is consistent with the view that skill acquisition may recruit a large amount of cortical resources which, after the task is well learned, is performed by smaller cortical regions, the release of cortical resources after the task is learned would leave these areas available for engagement in new learning tasks.

Several repetitions & practice of a movement result in encoding of elementary motor memories in the primary motor cortex & other cortical areas. Kinematic details of practiced movement form a memory of movement.Extensive practice results into the representation in the cortex. This representation forms a permanent pattern in the cortex, thus becoming a part of a long term memory.

The results obtained through the structured balance training protocol signify the importance of the physical activity in different environmental conditions. The protocol, when implemented, not only improves physical strength, agility n flexibility but adds to the co-ordination as well as quality to a movement &greater efficiency in day to day functions .[21,24,26]

Significant values observed in the current study, confirm the hypothesis that there is a significant improvement in the performance of children following balance training. The balance training program in this study was designed in such a way that the intensity, difficulty & complexity of the tasks were progressively increased in successive weeks. [30].

The exercise protocol achieved two goals. The first goal was to provide constantly changing environmental stimulus to the children, to take away monotony of the repetitive activities. Fresh and challenging tasks were presented as part of fun and play. Second goal was that of increasing complexity to which the subjects were exposed to. Sufficient time was given to get accustomed to the training & master the newer skills while maintaining balance.

Different surfaces used during training, confronted the subjects as the confounding factors. Intrinsic constraints of each surface demands different movement dynamics in order to maintain upright posture & balance.

Alteration of sensory inputs from the said systems sends the feedback information directly to the motor cortex, association areas of the brain & indirectly via spinocerebellar tracts which relay in basal ganglia & brainstem. The sensations are mapped to the action & ensure anticipatory and adaptive responses of postural control.[9]

Most of the functional activities of daily living involve multi tasking. **Ehrenfield 2003**[22] and **Nicolas Vullerme 2006**[22] found similarities in the performance of a balance when presented with concurrent cognitive task. The subjects either lost balance or became stiff & discontinued their activity. Similar findings were noted in another study. However, balance, cognitive training and practice of the assigned activities, subjects were able to perform with greater efficiency indicating that practice has a definite effect on postural control[33,36,44].

The structured training protocol of the present study ensured that all sensory systems concerned with equilibrium i.e. somatosensory, visual, auditory, vestibular, cognition& attention contributed equally to stimulate balance & postural alignment.

The outcome of the study stands well supported by the research being carried out by in other authors as well [14, 15, 33, 36, and 44].

V. LIMITATIONS OF THE STUDY

This study included schools in same geographical area BMI of children was not considered. Dominance of lower extremity was not considered.
Socioeconomic status of families of the children was not considered
Psychological and family background of children was not considered.

VI. CONCLUSION

Structured Exercise program to develop balance & postural control in urban school children between the ages of 9 to12 years for 4 weeks enhanced their postural control & balance responses as compared to the children who did not undergo such training, when tested on force platform. However, the results of the carry-over tests indicated decline in the values when tested on force platform. These findings indicate lack of constant practice would lead to decline in balance, not allowing the representation in the cortex all the way through hippocampal & thalamic pathways to form a long term memory.

Abbreviations
EO- eyes open
EC- eyes closed
TUDS- timed up and down stair test
MCTSIB- modified clinical test of sensory interaction in balance
US- unilateral stance

REFERENCES

[1]. Shumway Cook ,Marjorie Woollacott (1985),Motor control 2007.
[2]. Development and assessment of pediatrics 1987 . K .S. Holt , second edition
[3]. The human nervous system, Murray Barr and John A Kiernan.
[4]. Illingworth. Development and assessment of pediatrics 1987. K .S. Holt , second edition
[5]. V. Hatzitaki, Perceptual-Motor Contributions to static & dynamic balance control in children. Journal of motor behavior 2002;34(2)
[6]. Tovio Jurmiae, Growth of Physical Activity in childhood in pre-pubertal children ,2001 ; chap 1:18-10
[7]. Andrew P. Hills, Neil A. King 1, 2 Timothy P. The Contribution of physical activity and Sedentary Behaviours to the Growth & Development of children & adolescents implications for overweight and obesity; sports med 2007 ;37 (6)
[8]. Taube w, Strang A , Hieronymus M , Haworth J, Walsh M. Balance Training alters postural dynamics uniquely for stance on compliant vs. non compliant surfaces , Physical D,16;285-317
[9]. William f. Ganong , review of medical physiology 2003 ; 21st edition 205-20
[10]. Sanes JL & Donoghue JP (2000), Plasticity & primary motor cortex, Annual Review of Neuosciences, 23 , 393-415.
[11]. Neural Plasticity and Cognitive Development Joan Stiles. Department of Cognitive Science University of California, San Diego DEVELOPMENTAL NEUROPSYCHOLOGY, 18(2), 237–272
[12]. The Olympic Brain, Does corticospinal plasticity play a role in acquisition of skills required for high perfomrmance sports? Jen Bo Neilsen ,Journal Of Physiology,2008,pp 65-70.
[13]. Central Vestibular Pathways: Eye, Head, and Body Reflexes, Purves D, Augustine GJ, Fitzpatrick D, et al., editors.Sunderland (MA): Sinauer Associates; 2001. Neuroscience. 2nd edition
[14]. Journal of applied physiology ,2006 Motor training induces experience-specific patterns of plasticity across motorcortex and spinal cord DeAnna L. Adkins,1,2 Jeffery Boychuk,1,2 Michael S. Remple,3,4 and Jeffrey A. Kleim1,2
[15]. Skill learning induced plasticity of motor cortical representation is time and age-dependent, Kelly A. Tennanta,1,*, DeAnna L. Adkinsb, Matthew D. Scalcoc, Nicole A. Donlanc, Aaron L. Neurobiol Learn Mem. 2012 October ; 98(3): 291–302. doi:10.1016/j.nlm.2012.09.004
[16]. Changes in Posture Control Across the Life Span-**A** Systems Approach,PHYS THER. 1990; 70:799-807. Anne shumway cook, woollacott
[17]. Development of Locomotor Balance Control in Healthy Children CHRISTINE ASSAIANTE Neuroscience and Biobehavioral Reviews, Vol. 22, No. 4, pp. 527–532, 1998
[18]. Andrew P. Hills ,the contribution of Physical activity and sedentary behaviors in young children. Lancet 2004; 363 (9415),1162.3
[19]. Australian Bureau Of Statistics (ABC). Children's participation in cultural & leisure activities,Australia, 2001cat no.4910[19]
[20]. Child PhysicalActivity, Dec 2010, National Obesity Observatory, United Kingdom.
[21]. Effects of physical activity on children's executive function: contribution to experimental research on aerobic exercises. John R. Best. Dev Rev. 2010 December; 30(4): 331–551.
[22]. How performing amental arithametic task modify the regulation of foot pressure during bipedal quite standing Vuillerme and Vincent, Exp Brain Res (2006) 169: 130–134
[23]. Ehrenfried T, Guerraz M, Thilo KV, Yardley L, Gresty MA (2003) Posture and mental task performance when viewing a moving visual field. Cogn Brain Res 17:140-153.
[24]. Can balance training promote balance and strength in pre-pubertal children URS Granacher , Thomas Mehlbauer VOLUME 25 | NUMBER 6 | JUNE 2011Journal of Strength and Conditioning Research
[25]. Marjorie Woollacott & Anne Shumway cook, July 2001, Attention and the control of posture & gait : a review of an emerging area of research. Gait and Posture 16 (2002) 1–14
[26]. Gait & Posture 27 (2008) 347–351 The effects of a concurrent cognitive task on the postural control of young children with and without developmental coordination disorderYocheved Laufer a, Tal Ashkenazi
[27]. Postural Control and Age 1993, Vol. 113, No. 2 , Pages 119-122, Malta Hytonen, IImari Pyykko, Heikki Aalto & Jukka Strack
[28]. Exp Brain Res.2005, Nov 167(1) 119-27, Children use different anticipatory control strategies than adults to circumwent an obstacle in travel path, Vallis CA, Mc Fadyen BJ.
[29]. Standing stability in children- and young adults. Influence of proprioceptive, visual and vestibular systems in age- and sex dependent changes].Steindl R, Ulmer H, Scholtz AW2004 May;52(5):423-30.[
[30]. Age-related changes in posture control are differentially affected by postural and cognitive task complexity.(PMID:20021408)Bernard-Demanze L, Dumitrescu M, Jimeno P, Borel L, Lacour M[2009, 2(2):139-149]
[31]. Maturation of postural sway in young children. Riach CL, Hayes KC. 1987Oct;29(5):650-8.Developmental medicine & child neurology
[32]. Perceptual motor skills, Vestibular system in performance of standing balance of children and young adults under altered sensory conditions. Cherng RJ, Chen JJ, Su FC. 2001 Jun;92(3 Pt 2):1167-79.
[33]. National obesity observatory, determinants of obesity, child physical activity, December 2010.
[34]. Child Care Health Dev. 2009 Jul;35(4):551-60. doi: 10.1111/j.1365-2214.2009.00974.x.Dual-task study of cognitive and postural interference: a preliminary investigation of the automatization deficit hypothesis of developmental co-ordination disorder.Tsai CL, Pan CY, Cherng RJ, Wu SK
[35]. Dev Psychol. 2008 May;44(3):747-57. doi: 10.1037/0012-1649.44.3.747.Age differences between children and young adults in the dynamics of dual-task prioritization: body (balance) versus mind (memory). Schaefer S, Krampe RT, Lindenberger U, Baltes PB

[36]. Journal of NeuroEngineering andRehabilitation2005The development of postural strategies in children: a factorial design study Maurizio Schmid, Silvia Conforto, Luisa Lopez, Paolo Renzi3 andTommaso D'Alessio

[37]. Human Movement ScienceVolume 14, Issue 1, June 1995,Pages 13 An ontogenetic model for the sensorymotor organization of balance control in humansC. AssaianteB. Amblard

[38]. What is posture & how its is controlled ? UK ,Latash M, Hadders-Algra M,2008

[39]. Normative Value for unipedal stance test with eyes open & eyes close, Journal of Geriatric physiotherapy ,2007, Barbara A, Spinger

[40]. Reviews of tests of standing balance abilities , 1989, Brain injury, Newton R.

[41]. One Leg Standing Balance & functional status in an elderly community dwelling population in Northeast , Aging & Clini Exp rev, 2002.

[42]. Changes in Postural Stability in Women Aged 20 to 80 Years Nancy Low Choy, Sandra Brauer and Jennifer Nitz, journal of gerontology, 2002.

[43]. Construct Validity of the Assessment of Balance in Children Who AreDeveloping Typically and in Children With Hearing Impairments Alexandra De Kegel, Inge Dhooge, Wim Peersman,December 2010 ptjournal.apta.org

[44]. Locomotor tests predict community mobility in children and youth with cerebral palsy , Adapted Physical Activity Quaretly, july 2012, Ferland C, Moffet H.

[45]. Timed up & down stairs test: Preliminary reliability and validity of a mew measure of functional mobility, Christopher A Zaino, Victoria Marchese, 2004, Pediatric Physical Therapy.16' 19-98

[46]. Long term effects of motor training on a resting network & underlying brain strucutes. Macro Taubert, Cabreile Lohmann, Neuroimage, 2011,(57), 1492-1498

[47]. Dynamic properties of human brain structures: learning and related changes in cortical areas and associated fiber connection. Tauber M, Draganski B, Muller K, Journal of Neurosciences, 2010, 11670-11677 \

[48]. MRI of normal brain maturation. B A Holland, D K Haas, D Norman, M Brant-Zawadzki and T H Newton. American Journal of Neuroradiology, 1986, 7,201-208

[49]. Plastic & functional effects of exercises on the brain: Original ways to enhance cognition through sports practice, International quarterly sports sciences. 2012, 1.David Moreau, Anni Dannay.

[50]. Plasticity in the developing brain: Implication for rehabilitation. Michael V. Johnson, Developmental disabilities research reviews, 2009(15), 94-101

[51]. Crair MC, Malenka RC. 1995. A critical period for long-term potentiation at thalamocortical synapses. Nature 375:325–328

[52]. Huttenlocher PR, de Court. 1987. The development of synapses in striate cortex of man.Hum Neurobiol 6:1–9.

[53]. Feldman DE, Nicoll RA, Malenka RC. 1999.Synaptic plasticity at thalamocortical synapses in developing rat somatosensory cortex: LTP,LTD, and silent synapses. J Neurobiol 41:92–101.

[54]. Trachtenberg JT, Chen BE, Knott GW, et al.2002. Long-term in vivo imaging of experience-dependent synaptic plasticity in adult cortex. Nature 420:788–794.

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