Original Article

ASSESSMENT OF ANTIGRAVITY AND POSTURAL CONTROL IN HEALTHY CHILDREN IN IBADAN, NIGERIA

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ABSTRACT

Objective: This study determined the relationship between antigravity and postural control in apparently healthy children.

Methodology: Two hundred and fifty subjects (125 males and 125 females), aged 4-12 years participated in the study. The participants were divided into 9 groups based on their chronological age with a minimum of 10 males and 10 females in each group. A non-probability sample of convenience was used to choose schools in Ibadan North Municipality and simple random sampling method was used to recruit participants from the schools. Antigravity and postural indices were assessed qualitatively and quantitatively. Analysis of data was performed using descriptive statistics of mean and standard deviation and inferential statistics of Pearson product moment correlation co-efficient (r), independent t-test and ANOVA and the level of significance was set at 0.05.

Results: A relationship between antigravity and postural control in healthy children was established at six years of age. Antigravity control was more related to static balance than dynamic balance in late childhood while supine flexion rather than prone extension was more related to quality of postural control in late childhood. There was no significant gender difference in antigravity control, however there were significant ($P<0.05$) gender differences in postural control at ages 5, 8, 9, 10 and 12 years. No significant ($P>0.05$) difference was observed in each of prone extension quality, supine flexion quality and supine flexion quantity in late childhood (7-12 years of age) and no significant difference was observed in prone extension quantity amongst children 5-12 years of age. In postural control, no significant age differences were observed in each of quality of static and dynamic balance amongst children aged 6-12 years. Quantity of static balance right did not differ significantly amongst children aged 10-12 years, also quantity of static balance left did not differ significantly in children aged 8-12 years.

Conclusion: A relationship between antigravity and postural control is established at six years of age and that antigravity control is more related to static balance than to dynamic balance and supine flexion rather than prone extension posture is more related to quality of postural control.

KEY WORDS: Antigravity, Postural Control, Healthy Children.

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INTRODUCTION

The transition from helplessness and physical dependence to independence during the first year after birth is of great importance to the child and family.[1-3] Such transition involves maturation of various body components including musculoskeletal and other locomotor

factors. Sellers defined antigravity control as the ability to maintain static prone extension and supine flexion postures and defined postural control as the ability to maintain static and dynamic balance postures.[4] Posture is a bearing of the body that is assumed for a special purpose.[5,6] Postural control is an inter-relationship between two types of motor control: mobility and stability, whereby non-directive, non-purposeful movement of all body parts precedes stability and then controlled mobility in child motor development.[6,7-11]

The development of antigravity muscular control is critical to the normal development of children and clinicians and other health professionals can use the antigravity postures to determine the integration of the tonic labyrinthine reflex, the vestibular system and postural control. It is believed that as the infant gains control over the body and is able to resist the force of gravity, new worlds open up for exploration and the baby is less dependent on parents to be held and carried.[1,12] Some clinical conditions which cause impaired postural control in children include cerebral palsy, meningitis and encephalitis.[11,13] These conditions which occur as a result of upper motor neuron lesions vary in their level of presentation of postural constraints depending on the area of the brain that is affected.[14] It has been reported that children with balance and co-ordination problems often have difficulty controlling posture in static and dynamic situations. Literature shows that a paucity of research exists on the supine flexion posture.[3,11,15]

In healthy children, activities like rolling, creeping and crawling involve movement patterns such as prone extension and supine flexion. These activities are of relevance to clinicians in the treatment of children with balance and co-ordination problems. Knowledge is needed on the relationship between antigravity control and postural control in children in order to make appropriate assessments, treatment plans and reassessments in children with balance and co-ordination problems. We were therefore prompted to carry out this study. The outcome of this study may alert clinicians and other health professionals on the usefulness of assessing antigravity postures as an important element in the normal motor development of children. The study may also contribute to the existing pool of knowledge in paediatric neurology and stimulate further research.

METHODOLOGY

Participants: Two hundred and fifty (250) participants of ages 4 to 12 years old consisting of a minimum of 10 males and 10 females in each age level attending public and private primary and secondary schools in Ibadan North Municipality took part in this study.

Inclusion Criteria: Participants who had absence of previous or current history of back pain, spinal disease, motor development delay, neurological disorders, postural abnormalities such as scoliosis, kyphosis, barrel chest and pigeon chest, limb discrepancy, recent injuries to the back, lower and upper extremities were excluded. Each subject was assessed by a medical practitioner before inclusion in the study.

Research Design: An evaluation type of survey research design which involved the assessment of quality and quantity of antigravity and postural control in healthy children.

Sampling Technique: A non-probability sample of convenience technique was used to choose public and private primary and secondary schools in Ibadan North Municipality. Simple random sampling was used to recruit participants from the schools by picking names from the registers.

Procedure: Informed consent was obtained from the school authorities, parents of participants and local education authority. Only participants who and whose parents agreed to participate were recruited into the study. Ethical approval for the study was sought and obtained from the Joint University of Ibadan (UI)/University College Hospital (UCH) Institutional Review Committee before commencement of the study.

The ages of participants were recorded in years as age at their last birthdays and participants were assigned into 9 age levels depend-

Table-I: Physical characteristics of male and female participants

Gender	*Age (years)*	*Weight (kg)*	*Height (cm)*
Male			
Range	8	33	65
Mean	7.98	24.06	125.10
SD	2.58	6.41	13.99
Female			
Range	8	37.00	66.00
Mean	8.02	24.19	125.21
SD	2.61	7.42	15.29

ing on their chronological ages from ages 4 to 12 years. Age level 1 constituted 4-year-olds, age level 2 constituted 5-year-olds and age level 3 constituted 6-year-olds and so on to year 12. Each participant's weight was measured and recorded in kilograms to the nearest whole number and height was measured and recorded in centimeters to the nearest whole number. Antigravity control (prone extension, supine flexion) and postural control (static and dynamic balance) test procedures were explained and demonstrated to the subjects by the investigators prior to testing. Each participant was allowed a practice trial before being tested properly on each test. The quantitative and qualitative performances of the participants during each test were recorded. All tests and method used in this study follow that of Sellers.[4]

Statistical Analysis: All data were analyzed using computer software-Statistical package for the Social Sciences (SPSS.11.0) and significance level was put at P<0.05.

RESULTS

Physical characteristics of participants: Table-I shows physical characteristics of male and female partcipants. Results showed that there was a significant difference in weight and height across the 9 age levels (p<0.05) (Table-II).

Correlation between antigravity and postural control test scores of subjects: There was no significant correlation between indices of antigravity control and postural control for age 4 and 5 years (P>0.05). Ages 6, 7, 8, 9, 10, 11 and 12 years, showed significant correlation (P<0.05) between the indices of antigravity and postural control.

Comparison of antigravity control test scores of male and female participants: There was no significant difference in quantitative and qualitative antigravity control test scores between male and female participants in each age level (P>0.05). Table-III

Comparison of postural control test scores of male and female participants: There was no significant difference (P>0.05) in both quantitative and qualitative postural control scores between male and female participants in ages 4, 6, 7 & 11 years (P>0.05). However, for ages 5, the male participants obtained a significantly higher DB scores than female participants (P<0.05) and for ages 9 & 12 years, male participants obtained significantly higher DBQ scores P<0.05) while for ages 8 & 10 years, the female participants obtained significantly higher SBR scores than male participants (P<0.05). Table-IV.

Comparison of antigravity and postural control test scores of participants across the age levels: There was a significant difference in all the test

Table-II: Physical characteristics of participants by age

Age (yrs)	*4 n=28*	*5 n=26*	*6 n=30*	*7 n=27*	*8 n=30*	*9 n=26*	*10 n=29*	*11 n=24*	*12 n=30*	*P-value*
Wt	15.65±	18.89±	19.03±	21.96±	23.43±	26.35±	27.28±	31.63±	33.37±	0.01
(kg)	2.42	2.18	2.21	2.41	3.06	3.72	3.57	7.28	6.42	
Ht	102.11±	110.96±	115.00±	122.41±	126.47±	133.58±	133.72±	139.96±	142.83±	0.01
(cm)	6.56	5.17	5.29	4.82	7.46	6.08	6.63	7.01	10.22	

Key: Wt (weight), Ht (height). Results are presented as mean ± SD (standard deviation).

Table III: Comparison of antigravity control scores of male and female participants using independent t-test.

Age (yrs)		*PE*	*PEQ*	*SF*	*SFQ*
4 (n=28)	M	13.79±6.36	1.36±0.75	12.50±7.20	1.5±0.94
	F	13.21±7.05	1.29±0.73	15.93±4.36	1.71±0.73
	T	0.23	0.26	1.53	0.45
	P	0.82	0.80	0.14	0.66
5 (n=26)	M	14.77±7.27	1.54±1.23	15.00±7.05	2.00±1.08
	F	18.77±3.00	2.0±0.58	16.69±4.54	2.00±0.82
	T	1.83	1.25	0.73	0.00
	P	0.08	0.22	0.47	1.00
6 (n=30)	M	18.86±1.99	2.36±0.63	18.64±1.99	2.36±0.50
	F	18.36±2.58	2.25±0.58	18.69±4.48	2.19±0.91
	T	0.57	0.49	0.03	0.62
	P	0.58	0.63	0.97	0.54
7 (n=27)	M	20.00±0.00	2.33±0.49	19.53±1.55	2.6±0.63
	F	16.33±5.66	2.17±0.72	19.08±1.93	2.42±0.79
	T	0.60	0.72	0.67	0.67
	P	0.52	0.48	0.51	0.51
8 (n=30)	M	17.06±5.32	2.44±0.73	18.25±3.33	2.19±0.75
	F	18.00±4.62	2.29±0.91	19.57±1.60	2.36±0.75
	T	0.51	0.51	1.29	0.62
	P	0.61	0.62	0.21	0.54
9 (n=26)	M	18.17±4.99	2.42±0.90	18.83±3.46	2.67±0.65
	F	18.14±5.35	2.29±0.47	19.57±1.60	2.50±0.86
	T	0.01	0.48	0.72	0.55
	P	0.99	0.64	0.48	0.59
10 (n=29)	M	19.13±3.36	2.40±0.63	19.00±2.65	2.60±0.51
	F	19.29±1.86	2.36±0.50	19.36±1.91	2.43±0.76
	T	0.15	0.20	0.41	0.72
	P	0.88	0.84	0.68	0.48
11 (n=24)	M	17.73±3.19	2.64±0.51	20.0±0.00	2.91±0.30
	F	19.31±1.11	2.54±0.52	19.15±2.51	2.62±0.51
	T	1.67	0.47	0.49	1.68
	P	0.11	0.65	0.68	0.11
12 (n=30)	M	19.53±0.99	2.67±0.49	19.8±0.56	2.80±0.41
	F	19.60±0.83	2.40±0.51	20.0±0.00	2.73±0.46
	T	0.2	1.47	1.21	0.42
	P	0.84	0.15	0.25	0.68

Key: PE=prone extension quantity, PEQ=prone extension quality, SF=supine flexion quantity, SFQ=supine flexion quality, m=male, f=female, t=t-value, p=probability level.

scores across the different age levels.

DISCUSSION

Equal number of male and female participants took part in this study. The result showed that there was a significant difference in weight and height of participants and their corresponding ages. This is expected as children in normal population are known to in-

Table IV: Comparison of postural control scores of male and female participants using independent t-test.

Age (yrs)		*SBL*	*SBR*	*SBQ*	*DB*	*DBQ*
4 (n=28)	M	8.14±8.22	11.07±10.25	1.77±0.80	0.64±0.63	1.57±0.94
	F	11.71±11.50	11.86±9.95	1.86±0.77	0.71±0.83	1.64±0.84
	T	0.94	0.21	0.24	0.26	0.21
	P	0.36	0.84	0.81	0.79	0.83
5 (n=26)	M	10.77±7.29	9.77±8.81	1.62±0.65	0.39±0.51	1.69±0.75
	F	16.77±11.78	11.46±6.23	1.85±0.69	0.07±0.28	2.15±0.80
	T	1.56	0.57	0.88	1.92	1.52
	P	0.13	0.53	0.39	0.05*	0.14
6 (n=30)	M	20.57±8.84	19.86±10.23	1.93±0.73	0.36±0.63	2.36±0.75
	F	20.56±10.07	15.25±9.73	2.25±0.58	0.25±0.45	1.88±0.72
	T	0.003	1.26	1.35	0.54	1.80
	P	0.99	0.22	0.19	0.59	0.08
7 (n=27)	M	21.53±8.48	21.60±11.33	2.20±0.56	0.00±0.00	2.40±0.74
	F	17.92±9.12	18.50±10.86	2.00±0.85	0.50±0.91	2.50±0.52
	T	1.07	0.72	0.73	0.80	0.40
	P	0.30	0.48	0.47	0.51	0.70
8 (n=30)	M	21.56±10.05	17.83±10.19	2.50±0.82	0.00±0.00	2.38±0.62
	F	23.14±9.18	25.93±7.14	2.36±0.84	0.13±0.34	2.43±0.65
	T	0.45	2.49	0.47	0.52	0.23
	P	0.66	0.02*	0.64	0.73	0.82
9 (n=26)	M	25.67±9.14	19.42±11.33	2.67±0.65	0.00±0.00	283±0.39
	F	23.43±9.30	20.36±9.68	2.50±0.94	0.21±0.58	2.14±0.86
	T	0.62	0.23	0.52	0.63	2.55
	p	0.54	0.82	0.61	0.48	0.02*
10 (n=29)	M	27.40±6.65	19/60±11.43	2.53±0.64	0.00±0.00	2.20±0.68
	F	21.50±9.48	28.14±3.78	2.36±0.84	0.29±0.83	2.57±0.51
	T	1.95	2.66	0.64	0.92	1.66
	p	0.06	0.01*	0.53	0.57	0.11
11 (n=24)	M	28.18±3.16	28.27±2.61	2.64±0.51	0.00v0.00	2.55±0.52
	F	23.85±8.59	26.62±5.98	2.92±0.28	0.00±0.00	2.39±0.65
	T	1.58	0.85	1.76	1.41	0.66
	p	0.13	0.40	0.09	0.83	0.52
12 (n=30)	M	30.00±0.00	29.00±2.80	2.87±0.35	0.07±0.26	2.66±0.49
	F	24.00±9.49	26.07±5.85	2.67±0.62	0.27v0.80	1.93±0.80
	T	-	1.75	1.09	0.92	3.03
	p	-	0.09	0.29	0.37	0.01*

Key: SBR=static balance right quantity, SBL=static balance left quantity, SBQ=static balance quality, DB=dynamic balance quantity, DBQ=dynamic balance quality, m=male, f=female, t=t-value, p=probability level.

crease in weight and height as age increases. It has been shown that there is a steady rate of increase in weight and height up to the time of adolescence.[3]

The study of the relationship between indices of antigravity and postural control among the participants showed that in children aged 4 and 5 years, there was no significant rela-

tionship between the indices and is in contrast to the finding of Sellers[4] who noted a significant relationship between antigravity and postural control in participants of same ages. This could be due to differences in races and other inherent biological factors. The implication of the non-significance between antigravity and postural control in children aged 4 and 5 years is that development or establishment of antigravity control does not occur at the same rate as postural control in children aged 4 and 5 years. A significant relationship between indices of antigravity and postural control in participants from 6 to 12 years of age was observed in this study. This could be explained to imply that at age 6 years and above, both antigravity and postural control mechanisms have become equally established.[3,13,16]

Amongst children aged six years, there was a relationship between prone extension quantity and quantity of static balance on the left leg; and between quantity of supine flexion and quantity of static balance on the right leg and for children aged 7 to 12 years, and quantity of antigravity control was related more to static balance indices than dynamic balance indices. It could be inferred from this that improvement of antigravity control would improve static balance much more than dynamic balance in late childhood. Tecklin[3] described late childhood as the period between ages of 7 to 12 years. It was also observed in this study that amongst participants of 7 to 12 years of age, supine flexion quantity, supine flexion quality and prone extension quantity were more related to the quality of performance of static and dynamic balance than the length of time for which they were able to execute the test (that is quantitative static and dynamic balance). This finding is in agreement with that of Sellers who found a significant relationship between quantity of supine flexion and each quality and quantity of static and dynamic balance and a significant relationship between each of quantity and quality of prone extension and quality of dynamic balance.[4]

It is known that muscular and motor development and management and quality of movement patterns are more important than quantity of movement patterns. Therefore, assessing the supine flexion muscles may be more important in assessing quality of postural control than the prone extensor muscles, since quality of supine flexion rather than quality of prone extension was related to quality of postural control.

Our results showed that there were no significant differences in both quality and quantity of antigravity postures between male and female participants in each age level. This implies that gender has no significant effect on antigravity control among the participants. This finding corroborates the finding of Harris[17] who reported no significant difference in quality and quantity of prone extension in both sexes. Amongst the 4 and 5-year old participants, girls had slightly higher but not statistical significant mean qualitative scores of prone extension than boys. From 6 to 12 years, males had better mean qualitative prone extension and supine flexion scores than females however, there was no difference in mean quantitative prone extension and supine flexion scores between male and female participants. Significant gender differences in quantitative scores of static balance in ages 8 and 10 years, qualitative scores of dynamic balance in ages 9 and 12 years and quantitative scores of dynamic balance in ages five years were observed in this study. This could be interpreted to mean that gender has a significant effect on quantity and quality of postural control in certain ages. Girls had significantly better scores than boys in quantity of dynamic balance in age five years. Also, we observed that girls had significantly better quantitative static balance scores than boys in age 8 and 10 years. This could probably be due to the involvement of girls of these ages in traditional games involving one leg stance. In ages 9 and 12 years, boys performed better than girls in qualitative dynamic balance. Boys are thought to be more exuberant than girls at these ages.

Our results revealed significant differences in the prone extension and supine flexion scores across the nine age levels. For prone ex-

tension quantity, there was no significant difference in scores of children aged 5 to 12 years as only the scores of four years old participants differed significantly from scores of all other ages. It was observed during the study that, it was difficult for the four years old subjects to attain the maximum duration for the prone extension test as their hands and legs kept touching the floor.

For prone extension quality and supine flexion quantity and quality, there was no significant difference in the performances of children aged 7 to 12 years. It could mean that the quality of performance of prone extension and quality and duration of maintenance of supine flexion do not follow a linear trend with increase in age amongst children ages 7 to 12 years.

For quantity of prone extension, there was no significant difference in performance of children aged 5 to 12 years, suggesting that quantity of prone extension does not follow a linear trend with increase in age amongst children of ages 5 to 12 years. It could also be interpreted to mean that age has more influence on quality of prone extension than on quantity of prone extension since increase in age has a linear trend with prone extension quality from 4 to 7 years of age, whereas increase in age has a linear trend with prone extension quantity only between ages 4 and 5 years.

This study reported significant differences in static balance and dynamic balance scores across the 9 age levels. It was observed that quality of performance of static and dynamic balance did not follow a linear trend with increase in age amongst children of age 6 to 12 years. According to Smith *et al*.,[18] postural control is the ability to assume and maintain a position and therefore movement and posture are intimately related as movement begins from a posture and ends in a posture. It could therefore be said that the ability to assume and maintain the static and dynamic balance position are equally established in children 6 years and above.

It was observed that quantity of static balance on the right leg did not differ significantly in children of ages 10 to 12 years, whereas quantity of static balance on the left leg did differ significantly in children of ages 8 to 12 years. This could imply that static balance on the left leg becomes established at an earlier age than static balance on the right leg. This trend is also reflected in the fact that most of the participants were right handed and preferred starting the static balance test on the left leg first rather than on the right leg.

In conclusion, the relationship between antigravity and postural control in apparently healthy children is established at six years of age. Antigravity control is more related to static balance than dynamic balance in late childhood (that is 7 to 12 years of age). Supine flexion rather than prone extension is related more in quality of postural control in childhood. There were no gender significant differences in antigravity control but there were gender differences in postural control in children aged 4 to 12 years. Establishment of qualitative performance of prone extension and establishment of qualitative performance of supine flexion occur at late childhood.

Recommendations: Further studies are suggested to examine:

1. The relationship between antigravity and postural control in children with motor dysfunction.
2. To determine whether the relationship between antigravity and postural control continues in adolescence, adulthood and old age.
3. To determine whether racial differences affect antigravity and postural control.

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