The purposes of this study were 1) to determine the relationship between antigravity control (supine flexion and prone extension) and postural control (static and dynamic balance), 2) to determine the quality of antigravity and postural control, and 3) to determine whether sex and ethnic group differences correlate with differences in antigravity control and postural control in young children. I tested 107 black, Hispanic, and Caucasian children in a Head Start program, with a mean age of 61 months. The study results showed significant relationships between antigravity control and postural control. Subjects' supine flexion performance was significantly related to the quantity and quality of their static and dynamic balance performance, whereas prone extension performance was related only to the quality of dynamic balance performance. Quality scale measurements \( (r = .90) \) indicated that the children in this study had not yet developed full antigravity or postural control. The study results revealed differences between sexes in the quality of static balance and prone extension performance and ethnic differences in static balance, dynamic balance, and prone extension performance.

**Key Words:** Child development; Pediatrics, development; Pediatrics, evaluation.
The quality of movement patterns is more important to physical therapists than the quantity of movement, and reliable qualitative measures are needed to help physical therapists make objective assessments. The only movement quality rating scale available for antigravity control is a six-category scale for prone extension performance, and no movement quality scales were found for supine flexion or balance tasks.

The purposes of this study were 1) to determine the relationship between antigravity control and postural control, 2) to determine the quality of antigravity control and postural control, and 3) to determine whether sex and ethnic group variables are related to differences in antigravity control and postural control in young children. Postural control is defined in this study as the ability to maintain static and dynamic balance postures. Antigravity control is the ability to maintain static prone extension and supine flexion postures. I hypothesized that no significant relationship would exist between balance and postural control and that no differences would exist between sex and ethnic groups on the tasks examined. The quality of antigravity and postural control was expected to be less developed in young children than in older children.

METHOD

Subjects

One hundred seven children in a Head Start program (52 boys, 55 girls) participated in this study. The subjects ranged in age from 50 to 66 months (X = 61 months), and the sample consisted of 79 black children (74%), 22 Hispanic children (21%), and 6 Caucasian children (6%). The Head Start program director and school officials approved the study design.

TABLE 1

Means and Standard Deviations for Antigravity and Postural Control

<table>
<thead>
<tr>
<th>Task</th>
<th>Sex</th>
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<td>Boys</td>
<td>Girls</td>
<td>Black</td>
<td>Hispanic</td>
</tr>
<tr>
<td></td>
<td>(n = 52)</td>
<td>(n = 55)</td>
<td>(n = 79)</td>
<td>(n = 22)</td>
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<tr>
<td>SBL</td>
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<td>10.23</td>
<td>11.47</td>
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<tr>
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<tr>
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<tr>
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<tr>
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<td></td>
</tr>
<tr>
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<td>2.18</td>
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<td>2.60</td>
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<tr>
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<td>0.49</td>
<td>0.59</td>
<td>0.49</td>
</tr>
</tbody>
</table>

* SBL = static balance left; SBR = static balance right; SBQ = static balance quality; DB = dynamic balance; DBQ = dynamic balance quality; PE = prone extension; PEQ = prone extension quality; SF = supine flexion; SFQ = supine extension quality.

Procedures

I divided the subjects into groups of 3 to 4 children and tested each group in a quiet area outside the classroom. A four-point quality scale was devised to determine the quality of antigravity and postural control for 1) static balance, 2) dynamic balance, 3) prone extension, and 4) supine flexion tasks. The scale was similar to one used in a previous study. The scale ranged from 0, indicating inability to perform the task, to 3, indicating controlled and smooth execution of the task (Appendix). Interrater reliability was determined using a videotape of two children who were not subjects in the study. Six education students in an undergraduate motor development class rated the two children's antigravity and postural control, and a Spearman rank order correlation coefficient showed high interrater reliability (r = .90).

Each subject watched the examiner (J.S.S.) demonstrate the study tasks and performed a practice trial before being tested individually on static balance, dynamic balance, prone extension, and supine flexion tasks. I recorded quantitative measurements to the nearest second for static balance, prone extension, and supine flexion and assessed qualitative scores for each task. Static balance quality was based on the performance of the better leg.

Static balance. I asked the subjects to stand on their right foot with their eyes open and arms to the side for 30 seconds.

RESEARCH
Testing was halted and the time was recorded when the subject’s nonsupport foot touched the floor or when the support foot moved. The test was then repeated for the left foot.

**Dynamic balance.** I used a balance beam 2.4 m long, 10 cm wide, and 10 cm from the floor for this task. I asked subjects to walk the length of the beam with alternating steps, stepping back onto the beam if one foot or both feet touched the floor. A score of 0 was assigned if the child walked the length of the beam without stepping off. One point was assigned each time one foot or both feet touched the floor.

**Prone extension.** I instructed subjects to lift their head, chest, arms, and legs off the floor from a prone position for 20 seconds. Subjects’ arms were abducted to about 90 degrees with the forearms flexed, and the legs fully extended. Testing was stopped and the time recorded when the subject’s knees, arms, or chest touched the floor.

**Supine flexion.** I asked subjects to flex their head, arms, and legs into a curled position from a supine position for 20 seconds. Subjects folded their arms across their chest and were not allowed to hold their legs. Testing was stopped and the time recorded when the subject’s head or one foot touched the floor or the arms moved from their original position.

**Data Analysis**

I used Kendall’s rank order correlation to determine whether significant relationships existed between antigravity control and postural control. The Mann-Whitney U test was used to determine the source of any differences.

**RESULTS**

Table 1 shows a descriptive analysis of the data. Kendall’s rank order correlation showed significant relationships between antigravity control and postural control (Tab. 2). Dynamic balance quality was significantly related to prone extension, prone extension quality, and supine flexion (p < .01). Static balance right and static balance quality were also related to supine flexion (p < .05 and p < .001). Static balance left and dynamic balance were not significantly related to antigravity control. Supine flexion quality was the only antigravity task that was not significantly related to postural control.

No significant differences in antigravity or postural control existed for age, but differences were found between sex and ethnic groups (Tab. 3). The Mann-Whitney U test on these data revealed the source of these differences (Tab. 4). Differences in static balance quality (p < .011) and prone extension quality (p < .041) were found between boys and girls. Black and Hispanic subjects differed in static balance left (p < .03), and black and Caucasian subjects differed in dynamic balance quality (p < .037). Differences were also found between Caucasian and Hispanic subjects in prone extension (p < .045).

The mean movement quality score for subjects was between 2 and 3 on three tasks (static balance quality, Ẋ = 2.08; dynamic balance quality, Ẋ = 2.11; supine flexion quality, Ẋ = 2.43), with the score for one task (prone extension quality, Ẋ = 1.88) between 1 and 2 (Tab. 1). Twenty-three children (20%) achieved a score of 3 on the prone extension task, and 55 children (51%) scored a 3 on the supine flexion task. I recorded a score of 0 for only 6 children (6%) on the prone extension task and for no children on the supine flexion task. The mean quality static and dynamic balance score was 2 (static balance, Ẋ = 2.08; dynamic balance, Ẋ = 2.11). No subject received a score of 0 on either balance task.

**DISCUSSION**

**Antigravity and Postural Control**

Significant relationships between antigravity control and postural control would support Bly’s hypothesis that the at-
tainment of antigravity control is essential to the normal motor development of children. This study showed that supine flexion was the only antigravity posture significantly related to static and dynamic balance (static balance right, static balance quality, and dynamic balance quality), whereas prone extension and prone extension quality were significantly related only to dynamic balance quality. The supine flexion and prone extension postures were related more to the quality of postural control than to the quantity of postural control. These results suggest that the prone extension posture, which has received considerable attention in the literature, may be less important to postural control than the supine flexion position, especially for development of the quality of movement.

The mean prone extension score for 4-year-old subjects in this study (10.02 seconds) was lower than the mean scores reported in another study (18.15 seconds). No other studies reported mean prone extension scores for 5-year-old children. The mean supine flexion scores for 4- and 5-year-old subjects in this study were lower than the mean scores reported by Lefkof. The 4-year-old subjects in this study had slightly higher scores on the prone extension and supine flexion tasks than the 5-year-old subjects, contrary to most studies of motor development. The cause for this discrepancy is unknown; however, the 4-year-old subjects tended to try their best more consistently than the 5-year-old subjects.

The supine flexion posture was easier for the subjects to maintain than the prone extension posture. Only 2 children in this study were unable to assume the supine flexion posture; however, 20 children failed to assume the prone extension posture. Some children complained of neck discomfort after the supine flexion test. Neck discomfort has also been reported in another study.

Subjects' static balance mean duration scores were lower in this study than in other studies. Stott and associates studied 5-year-old children and reported a combined mean static balance score for both legs to be 15.6 seconds. The combined mean score for this study was 10.7 seconds. Morris and associates reported a considerable increase in static balance scores in children aged 4 to 5 years. This study found a very small increase in static balance scores with age.

Dynamic balance was relatively stable for the subjects in this study. Eighty-four subjects (79%) walked on the balance beam without stepping off. Nineteen subjects (18%) stepped off the balance beam only once. These duration scores may be somewhat misleading, because the subjects in this study were very familiar with the balance beam. One child, who stepped off the balance beam three times, had only recently enrolled in the Head Start program and may not have been as familiar with this task as the other children.

Quality of Movement

Mean movement quality scores for the four antigravity and postural control tasks ranged from 1.88 to 2.43, indicating that these skills were not yet fully developed in my subjects (Tab. 1). This finding agrees with those of other studies. Dunn noted that kindergarten-aged children had difficulty lifting their legs with their knees extended when attempting a prone extension posture, and I have seen this pattern repeated clinically. Shambes reported that 4-year-old children could not suppress extraneous muscular activity during static postural tasks when compared with 8-year-old children. The knees of younger children often may be flexed because they have not learned to fully suppress the flexor component of the hamstring muscles.

Development of the quality of gross motor skills has been of recent interest to researchers, although no reliable movement quality scales have been developed. The movement quality scale used in this study was reliable (r = .90) and easy to use. The scale was based on clinical experience in assessing young children on the tasks used in this study. Use of such a scale allows the pediatric physical therapist to make objective qualitative measurements of antigravity and postural control.

Sex and Ethnic Differences

The only sex differences this study revealed were in the quality of static balance and prone extension posture, where girls ranked slightly higher than boys. The sex difference in the prone extension posture differs from the findings of another study. Although sex differences for static balance have been reported on quantity scores, girls would also appear to be better on the quality of static balance than boys. The results of this study may have been distorted because static balance quality was based on the performance of the leg with the best quantitative score. Future researchers should measure both left and right leg static balancing.

The results of this study revealed definite differences between ethnic groups on antigravity and postural control. No previous studies on antigravity control have reported ethnic data. The black and Hispanic subjects in this study differed in static balance left and prone extension tasks, and Caucasian subjects differed from Hispanic subjects in static balance quality. Examination of the mean static balance scores revealed that black subjects scored considerably higher than Hispanic or Caucasian subjects, whose scores were similar (Tab. 1). Caucasian subjects demonstrated a higher dynamic balance quality score than the black or Hispanic subjects, possibly because they walked on the beam without stepping off. The ethnic differences in antigravity and postural control did not indicate consistency between groups.

Study Limitations

This study used children in one Head Start program as subjects. The children were not tested to ascertain whether motor dysfunctions were present, although none of the subjects had obvious orthopedic or neurological problems. I assumed that the subjects were motorically healthy. Retesting of the subjects was not possible, and reliability could not be determined for the tasks measured.

The low number of Caucasian subjects in this study may have affected the study results. A significant within-group difference in dynamic balance quality existed among Caucasian subjects. Generalizations of this study, therefore, should be made cautiously.

Clinical Implications

Antigravity postures are an important element in the normal motor development of children aged 4 to 5 years. Physical therapists should examine prone extension and supine flexion postures carefully when evaluating children and treat areas where a postural deficiency exists. Careful examination and treatment are especially critical for children with motor dysfunctions. This study showed that the supine flexion and...
prone extension postures are significantly related to balance, especially the quality of these movement patterns.

Although several researchers have examined the development of the prone extension posture in young children, more research is needed on supine flexion development. This study presents some normative data of interest to pediatric physical therapists. Young children will have more difficulty with prone extension tasks than with supine flexion tasks, and the quality of these antigravity postures will be less developed in young children than in older children.

A scale for measuring the quality of antigravity and postural control was found to be reliable and easy to use. Physical therapists can use the quality scale with quantity measurements to document improvement in both the quality and quantity of a child's movements.

Implications for Further Research

More research is needed on postural control. The results of this study raise two questions: 1) Does improvement of antigravity postures significantly improve static and dynamic balance in healthy children and children with motor dysfunction? and 2) Does the relationship between antigravity and postural control continue with increasing age? Equal numbers of Caucasian, black, and Hispanic subjects should be examined to determine whether the ethnic differences in antigravity and postural control in this study are reliable.

CONCLUSIONS

A study of 107 children aged 4 and 5 years old in a Head Start program showed that antigravity control (prone extension and supine flexion) was significantly related to postural control (static and dynamic balance). Supine flexion was significantly related to static and dynamic balance, whereas prone extension was significantly related to dynamic balance. Both supine flexion and prone extension were related to the quality of static and dynamic balance.

The subjects' quality of movement ranged from 1.88 to 2.43 on a four-category scale. The subjects in this study had difficulty executing prone extension with their legs fully extended, and had not developed the quality of movement of older children in other studies. Dynamic balance was more developed in the subjects than static balance. Significant sex differences were found in quality of prone extension and static balance, and significant ethnic differences were found in static balance left, dynamic balance quality, and prone extension. Further research is needed on the development of antigravity control, especially the supine flexion posture, in children.

REFERENCES


APPENDIX

Quality Scale for Antigravity and Postural Control Tasks

Static Balance
0—Unable to lift foot from floor
1—Excessive movements of arms and trunk or holding or supporting nonsupport foot
2—Arms and trunk used moderately to regain balance; nonsupport leg held between 45 and 90 degrees
3—Minimal or no body movements; arms relaxed at sides

Dynamic Balance
0—Unable to walk on balance beam
1—Movements jerky; excessive arm and trunk movements to maintain balance
2—Moderate arm and trunk movements
3—Walks smoothly, arms and trunk relaxed, uses reciprocal gait

Prone Extension
0—Unable to lift any body segments or lifts only one body segment at a time
1—Head, chest, and arms extended off floor; unable to lift legs off floor
2—Head, chest, and arms raised symmetrically off floor; thighs lifted, but knees bent
3—Extends body smoothly and symmetrically

Supine Flexion
0—Unable to lift any body segments off floor or lifts only one segment at a time
1—Difficulty lifting head off floor; limb movements asymmetrical
2—Maintains position with some difficulty; may roll to one or both sides
3—Flexes body smoothly and symmetrically