Evaluation of the Physical Growth Parameters on the Developmental Outcome of Children below Six Years of Age

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Noor Albusta** Reem Almarzooq, Arab Board-Pediatrics, MBBS***

Objective: To evaluate the impact of physical growth parameters on the developmental outcome of children below six years of age.

Design: A Retrospective Study.

Setting: Child Developmental Unit, Pediatric Department, Salmaniya Medical Complex, Bahrain.

Methods: Three hundred thirty-seven children below six years of age were followed-up at the child developmental unit from January 2015 to January 2018 and were included in the study. Children with congenital abnormalities were excluded. Their gestational age, birth-weight, and head circumference at birth were documented. Their medical records were reviewed. Anthropometric measurements were taken during the consultation visit, and their development was assessed by the developmental pediatrician using Griffith mental developmental scale.

Results: The mean gestational age was 32 weeks and the mean birth weight was 1,520 grams. The medical records showed that 85 (25.22%) of children were born small for gestational age (SGA), 142 (42.14%) had Respiratory Distress Syndrome (RDS), 24 (7.12%) had retinopathy of prematurity (ROP) and 34 (10.09%) had intraventricular hemorrhage (IVH). Statistical analysis indicates that there is a significant relationship between abnormal physical growth and abnormal development in children below six years of age.

Conclusion: The findings of our study showed that physical growth in the first six years of life has a significant relationship to developmental outcome. In addition, the head circumference (which is a reflection of the brain growth) had the most significant effect on the cognitive development.

Developmental disorders result in cognitive, motor impairment, and learning disabilities1. Developmental disorders could be seen across prenatal, ante-natal, post-natal, infancy and early childhood periods2. They require multi-disciplinary healthcare, educational, and social services because the disorders cause a significant burden on children, their families, and their communities3. There is evidence that a better nutritional status can improve the developmental outcome4-6. The contribution of physical growth to cognitive delay, learning disabilities, motor, and global developmental delay in children is difficult to isolate from other factors7-8. Thus, the relationship between the physical growth and the development of subsequent neuro-disabilities in children is complex and not very clear. Some studies suggest that impaired physical growth in the early years of follow-up is associated with three times increased risk of developing disabilities, health problems, and short and long-term psychological and social problems9-10. Therefore, identifying early predictors to developmental outcomes in children may allow early interventions.

The aim of this study is to identify early predictors of developmental outcome in children and to evaluate the impact of physical growth parameters on the developmental outcome of children below six years of age.

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METHOD

Three hundred thirty-seven children below six years of age were followed at the child developmental unit from January 2015 to January 2018 and were included in the study. Children with congenital abnormalities were excluded. Their gestational age, birth weight, and head circumference at birth were documented. Their medical records were examined for the presence of respiratory distress syndrome (RDS), neonatal sepsis, intraventricular hemorrhage (IVH), and necrotizing enterocolitis.

Anthropometric measurements (body length, weight, and head circumference) were taken during the consultation visit. The largest possible (fronto-occipital) circumference was measured with a flexible non-stretchable tape (measuring error 0.3–0.4 cm)\textsuperscript{11-12}. Weight was measured using an electronic weighing scale.

Children’s weight, head circumference, and height were plotted on the standardized WHO growth chart and their development were assessed by the developmental pediatrician using Griffith mental developmental scale\textsuperscript{13,14}.

RESULT

The mean gestational age was 32 weeks and the median was 32 weeks. One hundred fifty-three (45.40%) patients were females and 184 (54.60%) were males. The birth weight ranged from 610-4,100 grams, a mean of 1,520 grams. The medical records showed that 85 (25.22%) children were born small for gestational age (SGA), 142 (42.14%) had Respiratory Distress Syndrome (RDS), 24 (7.12%) had retinopathy of prematurity (ROP), 34 (10.09%) had intraventricular hemorrhage (IVH), and 49 (14.54%) had necrotizing enterocolitis.

Figure 1 represents the cases and percentage of children in each of the four growth parameters expressed as a percentage of all children included in this study.

Table 1, 2, and 3 compare the characteristics of children with normal physical growth to those with microcephaly, those who were underweight, and those with growth retardation. All P-values calculated using the Fisher’s exact tests were not significant. This indicates that the children with normal physical growth are comparable to those with abnormal physical growth in terms of patient’s characteristics.

Table 1: Characteristics of Children with Normal Physical Growth and Microcephaly

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Normal Physical Growth (n = 156)</th>
<th>Microcephaly (n = 90)</th>
<th>P-value\textsuperscript{a}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male patients</td>
<td>86</td>
<td>51</td>
<td>0.861</td>
</tr>
<tr>
<td>Female patients</td>
<td>70</td>
<td>60</td>
<td>0.861</td>
</tr>
<tr>
<td>Intraventricular hemorrhage (IVH)</td>
<td>12</td>
<td>10</td>
<td>0.088</td>
</tr>
<tr>
<td>Respiratory Distress Syndrome (RDS)</td>
<td>60</td>
<td>39</td>
<td>0.166</td>
</tr>
<tr>
<td>Necrotizing enterocolitis</td>
<td>21</td>
<td>14</td>
<td>0.751</td>
</tr>
<tr>
<td>Retinopathy of prematurity</td>
<td>9</td>
<td>8</td>
<td>0.252</td>
</tr>
</tbody>
</table>

\textsuperscript{a}Fisher’s exact tests for P-values

Table 2: Characteristics of Children with Normal Physical Growth and Underweight

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Normal Physical Growth (n = 156)</th>
<th>Underweight (n = 124)</th>
<th>P-value\textsuperscript{a}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male patients</td>
<td>86</td>
<td>64</td>
<td>0.712</td>
</tr>
<tr>
<td>Female patients</td>
<td>70</td>
<td>60</td>
<td>0.712</td>
</tr>
<tr>
<td>Intraventricular hemorrhage (IVH)</td>
<td>12</td>
<td>16</td>
<td>0.074</td>
</tr>
<tr>
<td>Respiratory Distress Syndrome (RDS)</td>
<td>60</td>
<td>57</td>
<td>0.527</td>
</tr>
<tr>
<td>Necrotizing enterocolitis</td>
<td>21</td>
<td>20</td>
<td>0.193</td>
</tr>
<tr>
<td>Retinopathy of prematurity</td>
<td>9</td>
<td>10</td>
<td>0.142</td>
</tr>
</tbody>
</table>

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\textsuperscript{*p}<0.05
One hundred twenty-four (36.8%) were underweight; 34 (10%) had normal development. Seventy-eight (23.1%) had cognitive delay, 51 (15%) had motor delay, 39 (11.6%) had global delay. Children who were underweight showed a significant motor, cognitive and global delays compared to children with normal physical growth, see table 5.

Table 5: Patients with Normal Physical Growth and Underweight

<table>
<thead>
<tr>
<th>Developmental Outcome</th>
<th>Normal Physical Growth (n = 156)</th>
<th>Underweight (n = 124)</th>
<th>P-value&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal development</td>
<td>102</td>
<td>6</td>
<td>'0.005</td>
</tr>
<tr>
<td>Delayed motor</td>
<td>39</td>
<td>21</td>
<td>'0.028</td>
</tr>
<tr>
<td>Delayed cognitive</td>
<td>30</td>
<td>24</td>
<td>'0.002</td>
</tr>
<tr>
<td>Global delay</td>
<td>15</td>
<td>18</td>
<td>'0.001</td>
</tr>
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Thirty-three (9.8%) children had growth retardation, 21 (6.2%), 24 (7.1%), 18 (5.3%) respectively presented with motor delay, cognitive delay, and global delay. The statistical analysis indicates that children with growth retardation show a significant level of delay in all developmental outcomes compared to children with normal physical growth, see table 6.

Table 6: Children with Normal Physical Growth and Growth Retardation

<table>
<thead>
<tr>
<th>Developmental Outcome</th>
<th>Normal Physical Growth (n = 156)</th>
<th>Growth Retardation (n = 33)</th>
<th>P-value&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal development</td>
<td>102</td>
<td>6</td>
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DISCUSSION

We found that the relationship between physical growth and the neurodevelopmental outcome in children is important for early intervention and in predicting the prognostic outcome of children below six years of age. The factors affecting physical growth in infancy and early childhood need to be further evaluated to plan a targeted intervention. Data supporting positive effects of increased protein intake is suggested by some researchers to have a positive impact on the physical growth and to a lesser extent on the increment of the head circumference<sup>15-16</sup>. Other studies concluded that micronutrients, such as omega-3 fatty acids, vitamin B12, and folic acid play an important role in children’s cognitive development<sup>17</sup>. Other studies examined the
role of breastfeeding in the neurodevelopmental outcome of children and found that breastfeeding is linked with a number of positive short and long-term outcomes. Short-term outcomes include lowered overall mortality and morbidity rates in children (especially in preterm). Breastfeeding is associated with better cognitive developmental outcomes and has a long-term protective effect against the risks of diabetes type 2, high blood pressure, and obesity.24. Considering all these positive impacts, both micronutrient supplementation and breastfeeding should be promoted in the community. On the other end of the spectrum, there is evidence that malnutrition is associated with impaired motor and cognitive development in children.25

The result of this study confirmed that abnormal growth is associated with abnormal neurodevelopmental outcomes. The relationship between microcephaly and cognitive delay may suggest that head circumference can be considered essential for brain volume.20-22. Earlier studies had shown that microcephaly at birth had a less significant impact on child development than microcephaly after the neonatal period.23. Avoiding growth impairment during the neonatal care period may allow for optimal cortical development and can thus decrease the overall rates of neurological disabilities.

Our results have shown that approximately 25% of children included in this study were born small for gestational age (SGA), which indicates the presence of sub-optimal nutritional supply in the prenatal period. SGA infants are at increased risk for impaired physical growth during their first years of life and continue to be at risk during their subsequent childhood and adolescence years.23-25. Some studies have shown that SGA children without catch-up growth are more likely to present with motor and cognitive developmental delays.26-27.

Poor postnatal growth has been associated with a negative long-term impact on the intelligence quotient of children at 4-7 years of age.26. Studies have shown that early postnatal growth has been strongly linked with the overall neurodevelopmental outcome of infants.20-21. Thus, early close follow-up and early intervention for poor growth in the first years of life may be beneficial for the early management of developmental delay.

**CONCLUSION**

Physical growth in the first six years of life has a significant relationship to developmental outcome. Also, the head circumference (which is a reflection of the brain growth) has the most significant effect on the cognitive development. This information would be beneficial in assisting pediatricians in providing appropriate long-term developmental follow-up. Evaluation of catch-up growth or postnatal growth may be useful in stratifying risk for developmental outcomes.

**Competing Interest:** None.

**Sponsorship:** None.

**Acceptance Date:** 5 September 2018.

**Ethical approval:** Approved by the Secondary Health Care Research Sub Committee (SHCRC), Bahrain.

**REFERENCE**