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

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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.

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Developmental disorders result in cognitive, motor impairment, and learning disabilities[1]. Developmental disorders could be seen across prenatal, ante-natal, post-natal, infancy and early childhood periods[2]. They require multi-disciplinary healthcare, educational, and social services because the disorders cause a significant burden on children, their families, and their communities[3]. There is evidence that a better nutritional status can improve the developmental outcome[4-6]. The contribution of physical growth to cognitive delay, learning disabilities, motor, and global developmental delay in children is difficult to isolate from other factors[7-8]. 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 problems[9-10]. 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)[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[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.

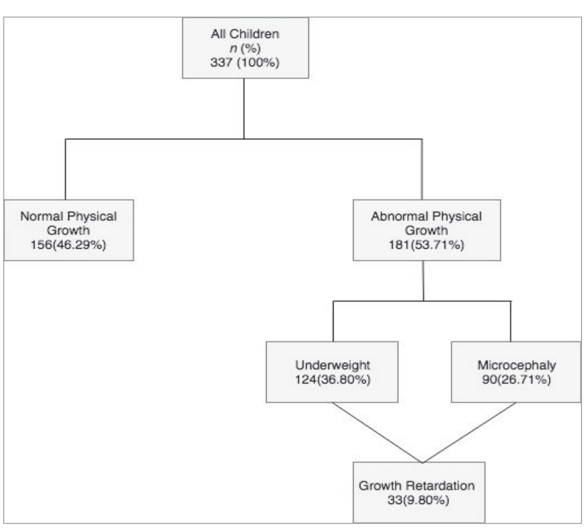

Figure 1: The Number of Cases and Percentage of Children in Each of the Four Growth Parameters

One hundred fifty-six (46.29%) children had a normal physical growth, 90 (26.71%) had microcephaly, 124 (36.80%) were underweight, and 33 (9.80%) had growth retardation (microcephaly and underweight).

Tables 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

Characteristics	Normal Physical Growth (n = 156)	Microcephaly (n = 90)	P-value[a]
Male patients	86	51	0.861
Female patients	70	39	0.861
Intraventricular hemorrhage (IVH)	12	10	0.088
Respiratory Distress Syndrome (RDS)	60	39	0.166
Necrotizing enterocolitis	21	14	0.751
Retinopathy of prematurity	9	8	0.252

[a]Fisher's exact tests for P-values
*p<0.05

One hundred forty-eight (43.92%) patients had normal development, 132 (39.17%) presented with delayed motor development, 123 (36.50%) with delayed cognitive development, and 66 (19.58%) showed global developmental delay (both cognitive and motor delay).

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

Characteristics	Normal Physical Growth (n = 156)	Underweight (n = 124)	P-value[a]
Male patients	86	64	0.712
Female patients	70	60	0.712
Intraventricular hemorrhage (IVH)	12	16	0.074
Respiratory Distress Syndrome (RDS)	60	57	0.527
Necrotizing enterocolitis	21	20	0.193
Retinopathy of prematurity	9	10	0.142

[a]Fisher's exact tests for P-values
*p<0.05

Table 3: Characteristics of Children with Normal Physical Growth and Growth Retardation

Characteristics	Normal Physical Growth (n = 156)	Growth Retardation (n = 33)	P-value[a]
Male patients	86	17	0.691
Female patients	70	16	0.691
Intraventricular hemorrhage (IVH)	12	4	0.067
Respiratory Distress Syndrome (RDS)	60	14	0.338
Necrotizing enterocolitis	21	6	0.089
Retinopathy of prematurity	9	3	0.181

[a]Fisher's exact tests for P-values
p<0.05*

Figure 2 represents the cases and percentage of children for each neurodevelopmental outcome expressed as a percentage of all children included in the study.

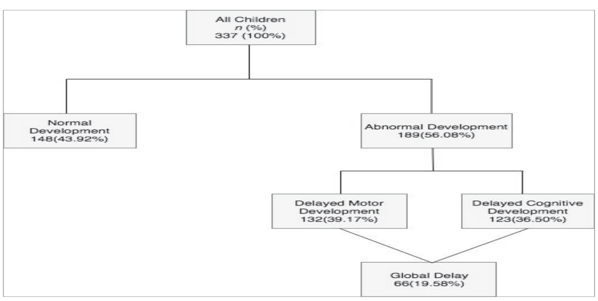

Figure 2: Children in Each Neurodevelopmental Outcome

Ninety (26.71%) children had microcephaly; 18 (5.3%) had normal development, 36 (10.7%) had motor delay and 66 (19.6%) had cognitive delay. Thirty (8.9%) presented with global delay. The statistical analysis indicates that children with microcephaly showed significant cognitive, motor and global delay compared to children with normal physical growth. The cognitive delay being the most significant (P-value≤ 0.001), see table 4.

Table 4: Patients with Normal Physical Growth and Microcephaly

Developmental Outcome	Normal Physical Growth (n = 156)	Microcephaly (n = 90)	P-value[a]
Normal development	102	18	0.021*
Delayed motor development	39	36	0.045*
Delayed cognitive development	30	66	0.001*
Global delay	15	30	0.011*

[a]Fisher's exact tests for P-values
*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

Developmental Outcome	Normal Physical Growth (n = 156)	Underweight (n = 124)	P-value[a]
Normal development	102	34	*0.037
Delayed motor development	39	78	*0.028
Delayed cognitive development	30	51	*0.042
Global delay	15	39	*0.022

[a]Fisher's exact tests for P-values
p<0.05*

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

Developmental Outcome	Normal Physical Growth (n = 156)	Growth Retardation (n = 33)	P-value[a]
Normal development	102	6	*0.005
Delayed motor development	39	21	*0.028
Delayed cognitive development	30	24	*0.002
Global delay	15	18	*0.001

[a]Fisher's exact tests for P-values
p<0.05*

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[15-16]. 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[17]. 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[18]. 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[19].

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[20-21]. Earlier studies had shown that microcephaly at birth had a less significant impact on child development than microcephaly after the neonatal period[22]. 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[28]. Studies have shown that early postnatal growth has been strongly linked with the overall neurodevelopmental outcome of infants[29-31]. 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.

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