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Evaluation of School Readiness Outcomes in Preterm and SGA Infant

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Abstract

Scientific studies emphasize long term developmental problems in children born as early preterm and show the great impact of early intervention services on developmental outcomes, while the studies regarding the developmental outcomes in late preterm and SGA children is quite controversial. Assessment of long term outcomes in late preterm and SGA children and revealing risk factors have a great importance for working out recommendations for improvement of developmental outcome in these group of children. Our objective was to assess school readiness in 6 years old children born prematurely and determine risk factors associated with the low school readiness scores. Case-control retrospective study covered assessment of school readiness in 188 children aged 6 years±2 months using adopted multi-dimensional School Readiness Test. According the gestational age and weight study group was divided into 3 subgroups (I group -46 late preterm, II group 34 early preterm and III group 54 SGA children), control group include 54 term born children. Groups were homogenous based on child age, gender, maternal health, maternal education, household income, family structure. Statistical analysis was based on SPSS 19. Our results show that children born preterm and small for gestational age have significantly lower cognitive school readiness.

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The early preterm and SGA children show lower scores then term infants: high and medium scores were seen 84,8% in I Group; 47,1% in II group; and 48,1% in III group and 79,6% in Control group accordingly. Elementary school readiness scores was in I group 15,2%, in II group -52,9%; in III group - 51,9% and in control group 20,4%. The study show that early and moderate preterm children as well as SGA children have significantly increased risk for low school readiness scores, while late preterm infants does not show significant difference from term population. We found that male gender, family low socio economical status and absence of preschool education have significant impact on school readiness scores. Our study does not reveal correlation between the feeding type in infancy, family size and school readiness scores.

Early detection of minimal delays and starting early intervention services can improve developmental outcomes of preterm and SGA children. High-quality and stable child care is important for all infants, but especially to those who may be at risk of prematurity or SGA.

Based on our study addressing the risk factors and inclusion of early and moderate preterm and SGA children in early intervention and preschool services will improve their school readiness scores and developmental outcomes.

Keywords: School Readiness scores; developmental outcomes; early and late preterm; SGA; risk factors.

1. Introduction

Every year, an estimated 15 million babies are born preterm and this number is rising. Across 184 countries, the rate of preterm birth ranges from 5% to 18% of babies born [1]. Problem is not only medical but also of social nature, as the rates of disability and mortality of these children are quite high. This problem is especially important in the developed countries, where the high percent of such children suffer from serious problems at a time of birth or in the future. Recent studies show, that preterm infants are at greater risk for mortality and variety of health and developmental problems than term infants. Complications highly associated with prematurity include acute respiratory, gastrointestinal, immunologic, central nervous system, hearing, and vision problems, as well as longer-term motor, cognitive, visual, hearing, behavioral, social-emotional, health, and growth problems [2]. Every year researchers learn more and more about the impact that prematurity has on the infant and the family. Several studies of the long-term developmental outcome of premature infants have highlighted a series of persistent deficits in cognitive ability across the life span and have shown significant risk for emotional, cognitive, behavioral and psychological problems. Some studies revealed, that preterm children are at risk of attention problems, language difficulties, and poor school performance [3, 4, 5, 6]. Early school age comprise the most complicated and significant period of child's development. If a child is ready for school, he or she is more likely to be successful. Readiness for school influences performance throughout the academic experience and success in the workplace during adulthood. So, early learning experiences impact later academic success. School readiness is a multidimensional and dynamic process that includes health and physical development, emotional well-being and social competence, communication skills, approaches to learning, and cognitive skills [7]. The study of Luciana M. et al, shows, that preterm birth is associated with high rates of neurodevelopmental disability, primarily due to hypoxic-ischemic events. Periventricular brain structures and

white matter tracts are particularly vulnerable to damage. Through school age, preterm children exhibit diminished levels of global intellectual function, attention, memory, and reasoning skills relative to full-term peers [8]. Preterm birth is strongly and negatively correlated with school performance [9]. From the developmental and life course perspective, cognitive and behavioral outcomes measured at school entry, often conceptualized as school readiness skills, are particularly important for success in learning in groups and maintaining positive relationships with peers [10, 11]. These skills provide a foundation upon which children build and develop new skills such that are important for children's learning and academic trajectories. Various studies have demonstrated that children's cognitive skills and behaviors measured in early school years strongly predict higher educational attainment and labor market successes [12,13].The study of Melissa Woythaler, Marie C. McCormick, at al. shows, that late preterm infants have worse outcomes at school entry, and development is variable during the early school years. The study revealed that socioeconomic status, language spoken in the home, maternal education and prematurity (even late preterm) have a large impact on school readiness and performance [14]. Most of research on long term developmental outcomes of premature infants is focused on children born very premature (< 32-0/7 weeks of gestation), only a few studies have followed late preterm children (34-0/7 to 36-6/7 weeks), as they are considered to be at low risk of neurodevelopmental problems, based on mostly uncomplicated neonatal period and normal brain function in early infancy.

Most Scientific studies regarding long term outcomes of preterm infants cover early preterm children and show the great impact of early intervention services on developmental outcomes, while the studies regarding the developmental outcomes in late preterm and SGA children is quite controversial. Assessment of long term outcomes in late preterm and SGA children and revealing risk factors have a great importance for working out recommendations for improvement of developmental outcomes in these group of children

Our objective was to assess school readiness in 6 years old children born prematurely and SGA and determine risk factors associated with the low school readiness scores.

2. Materials and methods

Case-control retrospective study was conducted in Child Developmental Center of Iashvili Central Hospital (Georgia, Tbilisi). We evaluate school readiness in 188 children aged 6 years $\pm$2 months using school readiness test. The children were divided in study group (n=134) and control group (n=54). The study group -was divided into 3 sub groups: I group include 46 late preterm born children (34 $^{0}/_{7}$ to 36 $^{6}/_{7}$ weeks); II group consists from 34 preterm children born at 26-33 weeks of gestation ($26^{0}/_{7}$ -$31^{6}/_{7}$ very +$32^{0}/_{7}$-$33^{6}/_{7}$), III Group includes 54 SGA children. Control group include 54 healthy, term children (37 to 42weeks). Inclusion criteria were child's age (6 years $\pm$2months), gestational age and weight at birth, child's and family's informed concept. Children with congenital anomalies, special health care needs, autism-spectrum disorders, cerebral palsy, chronic health problems and children of non-Georgian speaking parents or parents refusing participation in study were excluded from study. Study and Control groups were homogenous based on child age, gender, maternal health, maternal education, household income, and family structure. Statistical analysis was based on SPSS 19.School readiness was defined as the ability to function at age-appropriate levels in a variety of cognitive, sensory, and social domains, including functioning in activities of daily living, understanding of age-appropriate concepts,

understanding language and the ability to communicate, visual-motor integration and gross motor functioning, and visual and auditory status. The assessment included: detailed history covering a range of aspects of child development health, behavioral problems, and general family background. Information of birth records were collected for every investigated child, that include gestational age, and weight, complications during pregnancy and neonatal period and postnatal history. Multisectoral team assessment was conducted to evaluate health and development. The parental assessment of child development was conducted based on PEDS (Parents Evaluation of Developmental Status). The school readiness test (adopted a multi-dimensional school readiness test including different cognitive, emotional, motor, sensory skills) was performed with each child. The primary outcome measure was the Total School Readiness Score (TSRS), a composite measure derived from the individual test. The tool included reading, math, motor and expressive language testing. **Reading**- included Georgian-language and oral skills, phonological awareness, letter and letter-sound knowledge, print conventions and vocabulary. Some items assessed children's early writing skills. **Math Assessment**- included an understanding of numbers including cardinality, quantity, operations, and estimation; also the ability to compare objects by their attributes and shapes, geometry and spatial sense and skills of collecting, organizing and representing data. Some items assessed ability to sort by color, shape and size, count to 20 and etc. **Expressive Language Assessment-** based on reading stories using picture books and having the children retell the story to the examiner and by describing the pictures. **Motor skills** were assessed as gross motor (run, jump, skip and hop) and fine motor activities (drawing n person; complete a simple puzzle, good scissor skills, copy of shapes.) **(Table1)**.

Table1: School Readiness Test list

SCHOOL READINESS TEST:		0	1	2	Total
Math:	1. Understanding of arithmetic concepts, geometry and spatial sense. 2. Speed of processing, counting, collecting and organizing skills. 3. Ability to compare objects by their attributes, digit recognition.				0-6
Reading:	1. Georgian language skills, phonological awareness. 2. Letter and letter-sound knowledge, early writing skills. 3. Word recognition and vocabulary				0-6
Expressive language:	1. Retell the story, after reading stories using picture books. 2. Oral skills.				0-4
Fine Motor skills, Gross Motor activities:	1. Early motor skills, drawing. Hop skip, jump, grab.				0-2
TOTAL SCHOOL READINESS SCORE: (TSRS)	High: 14 and more Middle/medium: from10-to14. Elementary: below 10.	0-no answer. 1-answers partly. 2-full answer			

Main **school readiness test consist** of reading, expressive language, motor skills and math testing scores. Accordingly, we used each child's standardized scores. Each individual score for reading, math, motor skills and expressive language was weighted equally and then combined to arrive at the TSRS. Lower scores correlate with worse school readiness. Children were assigned to one of three levels of school readiness based on the number of test scores. Level 1 (High-14 and more), level 2 (Medium from10-to14) and level 3 (elementary-below10). Levels 1 and 2 were assigned to children who were ready for school, and levels 3 were assigned to children who were not ready for school.

3. Study Results

Overall, of the 188 children - 28,7% were full term, 24,5 % were late preterm,18,1% were moderate preterm and 28,7 % were SGA. The age of the child at the time of assessment was 6 years (±2months) old. The demographic and social characteristics of study cohort are summarized in table 2.

Children born preterm, small for gestational age, or with low birth weight have significantly lower cognitive school readiness. Our results show that children with high and medium scores (ready to start school) were 84,8%in Group I (late preterm),47,1% in group II (very and moderate preterm) and 48,1% in group III (SGA), while in control group accordingly 79,6%. Children with elementary scores (Not ready to start school) were in group1- 15,2%, in group 2-52,9% and in group 3 - 51,9% and in control group 20,4%.The results of school readiness data are presented in Table3.

The results of our study show, that 38,9% (n=21) of term children and 34,8% (n=16) of late preterm children have high scores in school readiness in contrast to II group(early preterm + moderate preterm) and III group (SGA), were high school readiness was accordingly 20,6% (n=7) and14,8% (n=8). 50% - (n=23) of late preterm children, 40,7% (n=22) of children from control group, 33,3% , (n=18) SCA group, 26,5% (n=9) of II group (early preterm + moderate preterm children show medium scores. We found that there are strong association between decreased school readiness levels and gestational age and birth weight.

The early preterm children as well as SGA children are at higher risk to have low school readiness scores. Approximately half of these children show low readiness for school. Very preterm and Moderate preterm children had a nearly 52,9% (n=18) elementary school readiness scores. II group of children often have language delays, but on the other hand some children from this group show excellent language skills. SGA also demonstrate association to lower school readiness scores: 51,9% (n=28) children of SGA group had elementary data, they tend to have language difficulties related to grammar and abstraction.

They also tend to be more inattentive and hyperactive. Fine motor skills are related to functioning in daily life and at school. Our study shows difference especially in drawing and coping skills in target and control group. Low scores were found in group I - 15,22% (n=7), in group II- 47% (n=16), in group III -48,15% (n=26) and in control group accordingly 9,26% (n=5). These data show association between fine motor skills and gestational age. Differences in early school-age outcomes (Total School Readiness Scores) between the groups are presented on diagram 1.

The difference in school readiness scores among the full-term and late preterm children shows low correlation and is not significant (Cramer's V is 0.098, Pearson Chi-square data 0,098 (p>0,05). While the school readiness score data in early and moderate preterm group compared to term infants show significant difference (Cramer's V is 0,339, Pearson Chi-square data 0,006 (P<0,05). Statistical analysis show medium correlation (Cramer's V is 0,335, Pearson Chi-square data 0,001) between SGA group school readiness data and control group data. This is a significant value (p<0,05) which tell us, that school readiness is a significantly associated with gestational age. So, small gestational age is correlated with school readiness problems (table 4).

Table 2: Characteristics of study children

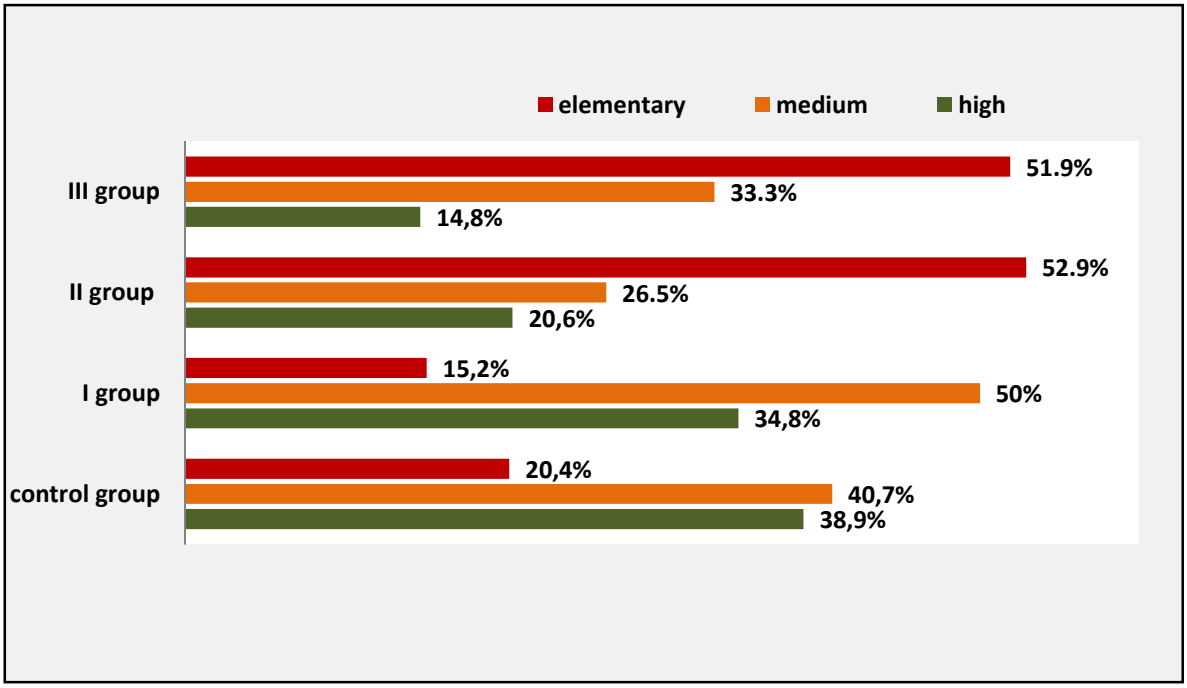
Characteristics of children		Control group FTI /54*child	LPI / 46 child *	MPI / 34 child*	SGA / 54 child
Gestational age(weeks)		37-42	34-36	32-34	Weight <10 percentile for age
Gender	Boy	29*	26*	18*	32*
	Girl	25*	20*	16*	22*
Birth order	1	20*	14*	11*	17*
	2-4	34*	32*	23*	37*
Family size	1-2	4*	5*	6*	3*
	3-4	30*	32*	22*	44*
	5+	20*	9*	6*	7*
Economic status	Low-income family	9*	6*	4*	7*
	Middle-income family	45*	40*	30*	47*
Preschool	yes	42*	38*	27*	45*
	no	12*	8*	7*	9*
Mother' education	Less than secondary	5*	6*	4*	7*
	Secondary and above	49*	40*	30*	47*
Mother's employment	House-wife	18*	16*	12*	7*
	Employed	36*	20*	22*	47*
Father's education	Less than secondary	7*	8*	3*	9*
	Secondary and above	47*	38*	31*	45*

Child*

Table3: School Readiness Test Data

		Math	Reading	Language	Motor	Total scores		
I Group (n=46*) *Late preterm*	High	16*	18*	16*	17*	High	6*	4,8%
	Medium	23*	21 *	23*	22*	Medium	23*	50%
	Elementary	7*	7 *	7*	7*	Elementary	7*	5,2%
II Group (n=34*) *Very preterm +Moderate preterm*	High	6*	7*	6 *	5*	High	7*	0,6%
	Medium	12*	11*	12*	13*	Medium	9*	6,5%
	Elementary	16*	16 *	16*	16*	Elementary	18*	52,9%
III Group (n=54*) *SGA*	High	8*	8*	7*	6*	High	8	14,8%
	Medium	20*	20*	21*	22*	Medium	18	33,3%
	Elementary	26*	26*	26*	26*	Elementary	28	51,9%
IV Group (n=54*) *Control group*	High	21*	22*	20*	22*	High	21	38,9%
	Medium	28*	27*	29 *	27*	Medium	22	40,7%
	Elementary	5*	5*	5*	5*	Elementary	11	20,4%

Child*



Control group- full term children. **I Group1-late preterms**

II Group-Very and moderate preterm children. **III Group-GSA children**

Figure 1: Total School Readiness Data

Table 4: Statistical Significance of study Results

	Pearson Chi-square	Cramer's V	Correlation
Control group → late preterm children	**Sig.0,621 (p>0,05)**	**0,098**	**Low**
Control group → Early and moderate preterm children	**Sig.0,006 (p<0.05)**	**0,339**	**Medium**
Control group → Small for Gestational age	**Sig.0,001 (p<0,05)**	**0,335**	**Medium**

Children's readiness for school is influenced by many different factors; in our study we focus on following aspects: gender, feeding type, family income, family size and parental education. Male gender is considered as one of the risk-factors for school readiness. We find that overall girls (n=83) have higher school readiness scores, then boys (n=105) and from 64 test with lowest test scores 62,5% (n=40) were boys scores, and 37,5% (n=24) were girls. So our study reveal that girls show significantly higher school readiness scores then boys (p< 0,05), but we did not find significant difference inside each study group, that can be explained by the small sample size within the groups. Parents and family members play a crucial role in a child's readiness for school. Parents' education and socio economic status has a great impact on children's school performance. We found, that overall children from low-SES families often begin school with significantly less linguistic knowledge (p<0.05). We did not find significant correlation between family size and school readiness scores (p>0.05) In our study about of children 81,9% (n=154) had attended preschool. From overall children who had attended preschool only 28, 57 % (n=44) have low elementary school readiness scores and children without preschool education (n=34) had 58,8% (n=20) elementary scores. We compare children inside each group, and our data shows, that preschool education significantly improves school readiness scores. We also analyzed association between the school readiness scores and feeding practices. 52% (n=98) of study population were breastfeed and 48% (n=90) formula feed. We found little relationship between infant feeding practices and the cognitive development, the difference was not significant (p > 0.05), that can be explained by small sample size.

4. Discussion

The results of our study showed that late preterm infants at age 6 had nearly the same findings as full term children. There was no significant difference between term and late preterm groups. It was surprising to find that medium school readiness scores were better in I group (50%), then in control group (40, 7%) that can be explained with small number of children. There are several controversial studies, Tanya Tripathi, Stacey C

Dusing review suggest that infants born LPT, as a group, are at an increased risk of having neurodevelopmental outcomes that are worse than infants born full term even, when social and medical risk factors are controlled for [15]. Study of MelissaWoythaler, Marie C. and McCormick, shows that in multivariable analysis, late preterm infants had higher odds of worse TSRSs, so compared with full-term infants (FTIs) are at increased risk for short- and long-term morbidity [14].In our study very preterm and moderate preterm children (52, 9%) had significantly lower school readiness scores. The same results were found in several studies. Study of Pritchard VE et all shows, that VPT children were at high risk of delay/impairment (odds ratios 2.5-3.5). Multiple problems were also more common (47%).At follow-up, almost two-thirds of VPT children were subject to significant educational delay in either literacy, numeracy or both compared with 29% to 31% of full-term children [16]. The main results of the study of Giovanna Perricone et al highlight the presence of a profile of moderately preterm children who, even at preschool age, are “at risk” of precursors of attention deficit and hyperactivity disorder. Preterm children of the research group are described, especially at home, as hyperactive and restless, children, showing difficulties in self-regulating and self-controlling during calm play activities [17].

As we show in our study birth weight may also have indirect effects on cognitive development. We found that SGA children have lower school readiness scores. There are controversial findings according association between the SGA and cognitive outcomes. The study of Mc Carton et all show that irrespective of degree of prematurity, SGA infants are at greater risk for neurodevelopmental impairment than are equally premature AGA infants. The cognitive impairment can be largely, but not entirely, attributed to a higher incidence of neurologic abnormalities in the SGA infants at each gestational age [18, 19]. While some other studies SGA was associated with hyperactive behavior, but not with cognition, neurodevelopmental impairment or use of therapy. Birth weight <10th percentile alone does not appear to be an independent risk factor of neurodevelopmental adverse outcome in preterm children [20, 21]. Some authors show (Athena I. Patrianakos-Hoobler, and et all), that decreased socioeconomic status plays a far greater role in determining school readiness than biomedical risks [22]. However, a combination of low socioeconomic status and SGA resulted in significant decreases in both intellectual ability and educational outcomes. Based on the studies systematic follow-up and/or assessment at school entry be beneficial to improve the outcomes of infants born LPT [15].Our results showed correlation with prematurity and language development. The results of Allison M. Tanner study indicated that the children born premature consistently performed at a lower level than the children that were born full-term in receptive and expressive vocabulary, expressive language, and phonological short-term memory for non words and digit sequences [12]. Language difficulties are prevalent in premature children and include articulation problems and expressive language delays, which can manifest themselves as poor vocabulary and grammar. Difficulties with phonological awareness are also common and predict later poor reading and writing. In fact, preterm birth is likely to have long-term consequences, affecting linguistic development beyond preschool [23].

We found a strong association between the fine motor skills especially and gestational age. Study of SasjaSchepers, and etc. shows, that preterm children experience developmental delays in motor skills, have lower cognitive scores at school age andA normal drawing score by a very preterm child at age 5-6 generally indicates normal cognitive and motor development at that age, while a clearly deviant drawing of a person could

be a feasible warning signal to refer the child for further investigation of cognitive and motor skills with standardized tests [24].Our study does not demonstrated significant association between breastfeeding and child development, that can be explained by small sample size. Study of Gibbs BG; Forste R as well as study of Feldman R1, Eidelman AI. show, that there is a positive relationship between predominant breastfeeding for 3 months or more and child reading skills, but this link is the result of cognitively supportive parenting behaviors and greater levels of education among women who predominantly breastfed. The study found little-to-no relationship between infant feeding practices and the cognitive development of children with less-educated mothers. Instead, reading to a child every day and being sensitive to a child's development were significant predictors of math and reading readiness outcomes [25, 26].Some studies suggests that a longer duration of breast feeding benefits cognitive development [27]. The meta-analysis of American Pediatric Academy indicated that, after adjustment for appropriate key cofactors, breast-feeding was associated with significantly higher scores for cognitive development than was formula feeding [28].

Our study reveal significant difference between school readiness scores among girls and boys, overall boys were at increased risk of low readiness compared with girls, but difference inside each group was not seen. Past research suggested that girls are in general more successful in school than boys. The study of Hartley and Sutton, have recently reported that especially boys develop gender stereotypes according to which girls are perceived as academically superior with regard to motivation, ability, performance, and self-regulation [29]. Some studies show gender-dependent differences in the development of infants assessed during the first 2 years of life [30].Our data shows, that preschool education had positive role in achievement of school readiness. Reading and writing skills are better in preschool attended children. Studies show that that preschool attendance have an impact on school readiness and school performance [31]. Comparison of full-day preschool intervention was associated with increased school readiness skills in 4 of 6 domains, attendance, and reduced chronic absences compared with a part-day program [32].

5. Conclusion

Based on results of our study early and moderate preterm children as well as SGA children are at increased risk for low school readiness scores up to 6 years of age, while late preterm infants does not show significant difference from term population. Male gender, absence of preschool education and low family socioeconomic status can be considered as risk factors for low school readiness scores. Too many children enter school with physical, social, emotional and cognitive limitations that could have been minimized or eliminated through early attention to child and family needs. Addressing the risk factors and inclusion of early and moderate preterm and SGA children in early intervention and preschool services will improve their school readiness scores and developmental outcomes.

6. Suggestion

1. Addressing risk factors, early identification of minimal delays and inclusion of SGA and early and moderate preterm children in early intervention services can improve developmental outcomes. Interventions are required before and around school age to facilitate preterm children to perform at

their potential.

2. High-quality and stable child care and preschool education services is important for all infants and toddlers, but especially SGA and preterm born children. Inclusion of children in preschool improves school readiness scores.

3. Strong parent-child and caregiver-child relationship should be focused on knowledge how to support child development and optimal school readiness skills, because early school age is a distinct developmental period that is the foundation for future lifelong success.

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