Original Article

# History of Small for Gestational Age at Birth With Verbal and Non-verbal Intelligence: A Case-Control Study Among Preschool Children

**Hosein Dalili; M.D.[1], Arya Moezi; M.D.[2], Shirin Ansari; M.Sc.[3], Zahra Farahani; Ph.D[4], Mamak Shariat; M.D.[4]**

1 Breastfeeding Research Center, Family Health Research Institute, Tehran University of Medical Sciences, Tehran, Iran
2 School of Medicine, Tehran University of Medical Sciences, Tehran, Iran
3 Psychology Department, Tehran University of Medical Sciences, Tehran, Iran
4 Maternal, Fetal, and Neonatal Research Center, Family Health Research Institute, Tehran University of Medical Sciences, Tehran, Iran

Received July 2022; Revised and accepted November 2022

## Abstract

**Objective:** Advances in technology and treatments have improved the survival rate of small for gestational age (SGA) infants that need more concern for their neurodevelopmental outcomes. In the present study, we hypothesized that a history of SGA may affect verbal and non-verbal intelligence indices among pre-school children.

**Materials and methods:** A case-control study was conducted at the Tehran University of Medical Sciences (Tehran-Iran, 2020). Totally 232 children entered the study. An expert pediatrician examined all included subjects. Based on birth weight (extracted from medical records), participants were divided into the case (born SGA) and control (born Appropriate for gestational age (AGA)) groups. Wechsler Intelligence Scale (WISC) and Conners tests were implemented to assess intelligence quotient (IQ), verbal, attention, development, and executive functions. Finally, total scores were compared between groups.

**Results:** Totally, 232 preschool children were included in the study. Of all, 114 (49.1%) and 118 (50.9%) subjects had the history of born SGA and AGA, respectively. The results related to WISC scores showed that the mean WISC-verbal score among children born SGA was significantly higher than children born AGA; (114.288±18.130 vs. 108.898±20.145; P=0.024). This significant difference was associated with Vocabulary (13.531±2.843 vs. 12.745±3.242; p=0.046) and Similarities (14.054±3.630 vs. 13.279±4.898; p=0.048) domains between the groups. The results related to different domains of the Conners test also showed that the mean scores of Inattention (B) and attention deficit hyperactive disorder score (D) in the case group were higher than these scores in the control group; however, these differences were not significant (4.929±3.511 vs. 4.906±4.300; p=0.495 &10.371±5.867 vs. 10.093±7.588; p=0.211).

**Conclusion:** Our results indicated that the development of non-verbal intelligence in children born with SGA had been delayed. This finding shows that these children may need more consideration during the preschool period and after that.

**Keywords:** Small for Gestational Age; Intelligence; Children

## Introduction

Small for gestational age (SGA) is defined as birth with weight below the 10th percentile of intrauterine

**Correspondence:**
*Dr. Mamak Shariat*
*Email: mshariat@tums.ac.ir*

cut-off growth (1). The prevalence of SGA has been reported to be between 4.6 to 15.3%; however, this range may increase to more than 70% depending on the reference population (2, 3).

It was reported that infants born SGA are at greater risk for mortality and severe developmental-psychopathologic morbidities (4, 5). Short and long-term squeals related to SGA birth include cerebral palsy, mental retardation, cognitive and language dysfunction, sensory impairment, poor school performance, depression, anxiety, symptoms of attention deficit hyperactivity disorder (ADHD), and a higher risk for psychiatric problems (6). Lower intelligence quotients, reduced verbal comprehension, deficits in symbolic learning, and lack of memory have also been reported in the SGA cases (7). On the other hand, several investigations have shown that SGA children are not more prone to adverse neurodevelopmental outcomes than children born with appropriate for gestational age (AGA) (8, 9). Hubert et al. demonstrated no differences between AGA and SGA groups regarding incidences of behavioral disorders, hyperactivity, or cerebral palsy (10).

These discrepant reports from various studies show the necessity of further investigation. Moreover, advances in technology and treatments have improved the survival rate of SGA infants that need more concern for their neurodevelopmental outcomes. We recently assessed the association between small for gestational age and attention deficit in 3-6 years old children (6). In the present study, we hypothesized that a history of SGA may affect other verbal and non-verbal intelligence indices among preschool children. So, detailed data related to verbal and non-verbal intelligence were compared between two groups of preschool-aged children with and without a history of SGA.

## Materials and methods

A case-control study was conducted in the Maternal, Fetal, and Neonatal Research Center affiliated with the Tehran University of Medical Sciences (Tehran-Iran) from January to December 2020. The study population was consisted of 3-6 years old preschool children from all kindergartens and health centers located in District 19- Tehran. These kindergartens and health centers were determined and proposed for our research by Tehran Municipality (The Office of Vice- Chancellor in Health) according to a former letter of agreement. Totally 232 children entered the study. All included subjects were examined by an expert pediatrician. Then, participants were divided into the case (born SGA) and control (born AGA) groups based on their birth weights (extracted from medical records).

Inclusion criteria were the age of 3-6 years old, positive history of SGA at birth for the case (< -2 standard deviations below the mean for weight at birth), and AGA for the control groups. Physical or mental disabilities, history of neonatal or infantile acute diseases, no cooperation in performing tests, the occurrence of any complication or disease, and reluctance of parents to enter or continue the study were considered as the exclusion criteria.

All neonatal/childhood demographic information, including age, weight, and anthropometric measures at birth, were extracted from their medical records. Parents' demographic data, including age, education, socioeconomic status, underlying disease, obstetric outcome, and history of drug abuse, were also gathered and recorded in a checklist.

Wechsler Intelligence Scale (WISC; Fourth version) and Conners tests were implemented to assess intelligence quotient (IQ), verbal, attention, development, and executive functions. The Conner's questionnaire (Teachers and Parent Rating Scale; rating score 0: Never - 2: Frequently) determines the severity of attention impairment and is composed of 4 items (Oppositionality, inattention, hyperactivity/impulsivity & final ADHD score; A-D). WISC test assessing verbal (A-E: Comprehension, Information, Mathematical, Similarities, Vocabulary), as well as practical non-verbal (A-E: Object Assembly, Coding, Recognition, Spatial Span, Picture Arrangement, and Matrices) domains, were implemented as an intelligence test (11, 12). The questionnaires were standard, and their validities in the Iranian population were identified as more than 85% (13).

Before undertaking the study, parents of children were invited and briefed about the purpose of the study. Then they were asked to sign an informed consent. All details related to the implemented questionnaires were presented and explained to them. Parents were also asked to interview, complete, and score each question for their children. Finally, total scores were calculated, analyzed, and interpreted by the research team.

***Primary/Secondary outcomes:*** Completed questionnaires related to attention deficit and indices of verbal and executive functions were evaluated. Our primary objective was to compare correct answers between typically developing pre-schoolchildren who were born with a history of

SGA with their control counterparts. The secondary purpose was the assessment of correlations between verbal and non-verbal development indices with parents/children demographic factors.

***Data Analysis:*** All recorded data were analyzed using Statistical Package for the Social Sciences (SPSS version 23.0). Quantitative and qualitative variables were reported by mean ± SD and percent, respectively. Chi-square tests were used for comparing qualitative variables data. Using the Kolmogorov-Smirnov test showed no normal distribution related to Wechsler and Conner's scores. A P-value of less than 0.05 was considered significant.

***Ethical considerations:*** All parents' participants gave written consent. They were assured of the confidentiality of their personal information and their right to discontinue the study course whenever they wished.

This manuscript was taken from a student's thesis. Ethics approval for the study was obtained from the institutional review board of Tehran University of Medical Sciences according to the Helsinki declaration (TUMS approval ID; IR.TUMS.IKHC.REC.1398.146).

## Results

Totally 232 pre-school children; 118 males (50.9%) and 114 females (49.1%), with gestational age 37.117 ± 2.553 (26-42) weeks, birth weight 2862.663 ± 638.428 (1090-4500) grams, length 48.614 ± 3.958 Cm, and head circumference 33.896±2.584 Cm were included the study.

Of all, 114 (49.1%) and 118 (50.9%) subjects had a history of born SGA and AGA, respectively. A history of preterm birth was observed in 100 (43.1%) children. A history of low birth weight (weight<2500 g) was reported in 108 (46.6%) participants. Admission to the hospital was reported in 72 (31%) children due to fever, lethargy, convulsion, sepsis, vomiting, diarrhea, Jaundice, RDS and respiratory complications, hypoglycemia, GI infection, intestinal obstruction, complications related to prematurity or low birth weight, etc.

The means of maternal age and parity numbers were 27.389±5.175 years and 1.6537±.74686. The level of education in the majority of mothers (75.5%) and fathers (72.9%) was a diploma or lower. About 45% of fathers were self-employed, 80% of mothers were housekeepers, and 25.9% of mothers had a history of prenatal complications (Diabetes, hypertension, anemia, or others). Cigarette smoking was reported in a mother (0.4%).

Demographic data related to children and parents were compared, and the results are shown in Table 1.

There was a significant difference in children's gender between the AGA and SGA groups; more children in the SGA group were female (P=0.018). History of preterm birth, LBW, or hospital admission was notably higher in the SGA group than in the AGA group (P<0.0001). All birth anthropometric measures, including weight, length, and head circumference in the SGA group were significantly lower than in the AGA group (P=0.0001).

Regarding the comparison of parents' variables, more parents in the SGA group had university education than the parents in the AGA group (P<0.005). Parents' professions were also significantly different between the SGA and AGA groups (P<0.05); the frequency of employed mothers in the SGA group was higher than in the AGA group (P=0.035). The history of hypertensive disorders was more frequent in mothers of the SGA group, while a history of anemia was more frequent in the mothers of the counterpart group (P=0.001). On the other hand, there were not any significant differences between groups regarding the mother's age, type of delivery, and cigarette smoking (P>0.05).

Regarding children's verbal and non-verbal development, the mean scores of implemented questionnaires were compared between 2 groups. The results related to WISC scores showed that the mean WISC-verbal score among children born SGA was significantly higher than children born AGA; (114.288±18.130 vs. 108.898 ± 20.145; P = 0.024). This significant difference was associated with Vocabulary (13.531 ± 2.843 vs. 12.745 ± 3.242; p = 0.046) and Similarities (14.054 ± 3.630 vs. 13.279±4.898; p=0.048) domains between the groups. On the other hand, no significant difference was observed in the mean scores related to WISC-non-verbal functions (P=0.917) or total WISC (P=0.630) between groups. The results related to different domains of the Conners test also showed that the mean scores of Inattention (B) and ADHD score (D) in the case group were higher than these scores in the control group; however, these differences were not significant (4.929±3.511 vs. 4.906±4.300; p=0.495 &10.371±5.867 vs. 10.093±7.588; p=0.211). All detailed data are shown in Table 2.

## Discussion

In present study, we implemented two specific and commonly used intelligence tests to assess verbal and non-verbal functions in preschool children who were born SGA.

**Table 1:** Comparison of quantitative and qualitative variables between appropriate (AGA) and small for gestational age (SGA) groups

| Variables | Case group (n=114) | Control group (n=118) | P value |
|---|---|---|---|
| Gender (n %) | | | 0.018 |
| Male | 49 (43.0) | 69 (58.5) | |
| Female | 65 (57.0) | 49 (41.5) | |
| Preterm birth (n %) | | | <0.0001 |
| Yes | 72(63.2) | 28(23.7) | |
| No | 42(36.8) | 90(76.3) | |
| LBW (n %) | | | <0.0001 |
| Yes | 99(86.8) | 9(7.6) | |
| No | 15(13.2) | 109(92.4) | |
| Gestational age (Mean±SD) | 36.072±2.928 | 38.1271±1.58274 | 0.0001 |
| Birth weight (Mean±SD) | 2367.429±419.734 | 3341.110±405.882 | 0.0001 |
| Birth length (Mean±SD) | 46.487±3.913 | 50.250±3.143 | 0.0001 |
| Birth head circumference (Mean±SD) | 32.629±3.008 | 34.691±1.903 | 0.0001 |
| Hospital admission (n %) | | | <0.0001 |
| Yes | 51(44.7) | 21(17.8) | |
| No | 63(55.3) | 97(82.2) | |
| Mother's age (year; (Mean±SD) | 27.9115±5.38443 | 26.8673±4.92716 | 0.171 |
| Mothers' education (n %) | | | <0.0001 |
| <High school | 21(18.4) | 27(23.3) | |
| High school | 49 (43.0) | 77(66.4) | |
| >High school | 44 (38.6) | 12 (10.3) | |
| Fathers' education (n %) | | | <0.005 |
| <High school | 26 (22.8) | 37(31.4) | |
| High school | 46(40.4) | 60(50.8) | |
| >High school | 42(36.8) | 21(17.8) | |
| Mother's profession (n %) | | | 0.035 |
| Housekeeper | 85(74.6) | 101(85.6) | |
| Employed | 29(25.4) | 17(14.4) | |
| Father's profession (n %) | | | 0.005 |
| Employed | 48 (42.1) | 66 (53.4) | |
| Self-employed | 56 (49.1) | 48 (40.7) | |
| Others | 10 (8.8) | 7 (5.9) | |
| Prenatal complication (n %) | | | 0.001 |
| Diabetes | 8 (7.0) | 5 (4.2) | |
| Hypertension | 10 (8.8) | 4 (3.4) | |
| Anemia | 6 (5.3) | 16 (13.6) | |
| Other | 11 (9.6) | 0 | |
| None | 79 (69.3) | 93 (78.8) | |
| Smoking (n %) | | | 0.491 |
| Yes | 1(0.9) | 0 | |
| No | 113(99.1) | 118(100) | |
| Type of delivery (n %) | | | 0.554 |
| NVD | 43(37.7) | 49(41.5) | |
| C/S | 71(62.3) | 69(58.5) | |

Based on the results, there was a significant difference in children's gender between the AGA and SGA groups; more children in the SGA group were female.

This finding was compatible with another recent study that showed a more significant number of female SGA compared to the male SGA cases (24.1% vs. 18.2%) (11).

**Table 2:** Comparison of the mean scores of WISC and Conners tests between the case and control groups

| Developmental variables | Case group (n=118) (Mean ± SD) | Control group (n=114) (Mean ± SD) | P value |
|---|---|---|---|
| WISC scores | | | |
| Verbal | 114.288±18.130 | 108.898±20.145 | 0.024 |
| Non-verbal | 108.279±15.427 | 106.618±19.538 | 0.917 |
| Total | 113.540±12.811 | 112.483±14.722 | 0.630 |
| WISC verbal scores | | | |
| A | 12.252±2.368 | 11.915±2.857 | 0.292 |
| B | 12.270±2.891 | 13.000±4.723 | 0.982 |
| C | 10.324±2.867 | 10.178±2.971 | 0.662 |
| D | 13.531±2.843 | 12.745±3.242 | 0.046 |
| E | 14.054±3.630 | 13.279±4.898 | 0.048 |
| WISC non-verbal scores | | | |
| A | 12.045±4.997 | 13.559±9.329 | 0.590 |
| B | 11.288±2.495 | 11.516±2.994 | 0.664 |
| C | 10.774±2.715 | 11.076±2.786 | 0.536 |
| D | 11.243±2.89895 | 11.296±3.141 | 0.870 |
| E | 12.648±2.539 | 12.762±2.969 | 0.627 |
| Conners scores | | | |
| A | 5.315±3.348 | 5.347±3.866 | 0.720 |
| B | 4.929±3.511 | 4.906±4.300 | 0.495 |
| C | 5.495±4.009 | 5.661±4.880 | 0.694 |
| D | 10.371±5.867 | 10.093±7.588 | 0.211 |

Our results related to mothers' characteristics showed that more mothers in the SGA group were employed and had a higher education. These findings may be associated with a higher risk for SGA birth among mothers who postponed their pregnancy for the completion of their education or finding a job. Compatible to our finding, an investigation by Ahmed et al. reported a higher risk of SGA birth among newborns of employed mothers compared to the newborns of housewives mothers. They showed that this relationship was associated with the type of maternal jobs. The highest risks were observed among mothers working in factories, mining, construction, and the lowest risk was reported among mothers working in office, non-manual, and service work (12). In contrast to our results, an investigation from 12 European countries with 75296 included subjects reported a positive correlation between low levels of maternal education and the risk of small for gestational (13). The other study also indicated a link between mother's unemployment and adverse neonatal outcomes such as SGA birth (14). These diversities in the results may associate with differences in the participants' nationality, culture, social inequality, and so on.

In line with other studies (15, 16), our results have indicated a significant relationship between the history of maternal hypertensive disorders and SGA birth. It was reported that hypertensive disorders by uteroplacental dysfunction, fetal hypoxia, and accumulation of oxidative stress unfavorably affect normal fetal growth (15).

Regarding children's verbal development, the results showed that the mean WISC-verbal score among children born SGA was significantly higher than children born AGA. This significant difference was associated with Vocabulary and Similarity domains between the groups. It is supposed that SGA infants during the first years of life may show a notable postnatal catch-up growth in neuroanatomical structures, particularly in the frontal and temporal lobes, that could beneficially affect language functions (17). The other study also confirmed a higher level of IGF1, more rapid weight gain, and certain advantages in improved neurodevelopment in the SGA children compared to their AGA counterparts (18). Moreover, in the present study, mothers of the SGA group had higher education. It seems that parents by implementing early medical and family-based interventions, as well as serial follow-up visits, could improve the neurobehavioral capabilities of their children (19). These interventions may mask the defects of adverse effects of SGA birth. Our findings support former investigations that reported no significant relationship between adverse effects of SGA status on cognitive-developmental problems such as verbal complications in preschool children (10, 20). On the other hand, Sommerfelt et al. indicated three times lower verbal IQ points among SGA children when compared with their AGA counterparts. Christian et al. by using Universal Nonverbal Intelligence and Wechsler tests also demonstrated that a history of SGA birth could significantly increase the negative consequences for preschool children's verbal and executive intelligence (20, 21). This diversity in the results may be due to differences in the intelligence scale and tests, sample size, or other factors like birth weights and gestational age.

Moreover, our results have shown that the mean scores of non-verbal skills like inattention and ADHD scores (measured by the Conners test) in the case group were higher than those scores in the control group; however, these differences were not significant. These complications related to childhood inattention and executive functions among children born with SGA and low birth weight were also demonstrated in our previous study (6). Another survey by Hubert et al. presented that a history of SGA at birth significantly decreased the non-verbal intelligence score among 50-months old aged children (10). Another study also demonstrated that assessing non-verbal skills (Performance scales using WISC-test) in 50 children aged ten years old, SGA children had lower scores than the controls regarding Performance scales (22).

## Conclusion

Our results indicated that verbal performances were not adversely affected by a history of small for gestational age at birth. However, this finding requires further research with a larger sample size, as well as considering more involving factors. Also, the development of non-verbal intelligence in the children born with SGA has been delayed. It shows that these children during the preschool period and after that may need more consideration.

## Conflict of Interests

Authors declare no conflict of interests.

## Acknowledgments

This research has been supported by the Tehran University of Medical Sciences and Health Service Grant. We acknowledge the parents for their participation in this study.

## References

1. Labayru G, Aliri J, Santos A, Arrizabalaga A, Estevez M, Cancela V, et al. Small for Gestational Age Moderate to Late Preterm Children: A Neuropsychological Follow-up. Dev Neuropsychol 2021; 46(4):277-287.
2. He H, Miao H, Liang Z, Zhang Y, Jiang W, Deng Z, et al. Prevalence of small for gestational age infants in 21 cities in China, 2014–2019. Sci Rep 2021; 11(1): 7500.
3. Chiavaroli V, Castorani V, Guidone P, Derraik JGB, Liberati M, Chiarelli F, et al. Incidence of infants born small- and large-for-gestational-age in an Italian cohort over a 20-year period and associated risk factors. Italian Journal of Pediatrics 2016; 42(1):42.
4. Gortner L, Wauer RR, Stock GJ, Reiter HL, Reiss I, Jorch G, et al. Neonatal outcome in small for gestational age infants: Do they really better?. J Perinat Med 1999; 27(6):484-9.
5. Anne RP, Vardhelli V, Oleti TP, Murki S, Reddy GMM, Deshabhotla S, et al. Propensity-Matched Comparison of Very Preterm Small-and Appropriate-for-Gestational-Age Neonates. Indian Journal of Pediatrics 2022; 89(1):59-66.
6. Shariat M, Gharaee J, Dalili H, Mohammadzadeh Y, Ansari S, Farahani Z. Association between small for gestational age and low birth weight with attention deficit and impaired executive functions in 3–6 years old children. The Journal of Maternal-Fetal & Neonatal Medicine 2019; 32(9):1474-7.
7. Viggedal G, Lundalv E, Carlsson G, Kjellmer I. Neuropsychological follow-up into young adulthood of term infants born small for gestational age. Medical Science Monitor 2004; 10(1):CR8-CR16.
8. Ferguson KK, Sammallahti S, Rosen E, van den Dries M, Pronk A, Spaan S, et al. Fetal growth trajectories among small for gestational age babies and child neurodevelopment. Epidemiology 2021; 32(5):664-71.
9. Fishel Bartal M, Chen H-Y, Blackwell SC, Chauhan SP, Sibai BM. Neonatal morbidity in late preterm small for gestational age neonates. The Journal of Maternal-Fetal & Neonatal Medicine 2021; 34(19):3208-13.
10. Hubert J, Gilarska M, Klimek M, Nitecka M, Dutkowska G, Kwinta P. Small for Gestational Age is an Independent Risk Factor for Neurodevelopmental Impairment. Iranian Journal of Pediatrics 2020; 30(5).
11. Chaudhary N, Yadav SN, Kalra SK, Pathak S, Gupta

BK, Shrestha S, et al. Prognostic factors associated with small for gestational age babies in a tertiary care hospital of Western Nepal: A cross-sectional study. Health science reports 2021; 4(1):e250.
12. Ahmed P, Jaakkola JJ. Maternal occupation and adverse pregnancy outcomes: a Finnish population-based study. Occupational medicine 2007; 57(6):417-23.
13. Ruiz M, Goldblatt P, Morrison J, Kukla L, Švancara J, Riitta-Järvelin M, et al. Mother's education and the risk of preterm and small for gestational age birth: A DRIVERS meta-analysis of 12 European cohorts. J Epidemiol Community Health 2015; 69:826-33.
14. Cantarutti A, Franchi M, Monzio Compagnoni M, Merlino L, Corrao G. Mother's education and the risk of several neonatal outcomes: an evidence from an Italian population-based study. BMC Pregnancy and Childbirth 2017; 17(1):221.
15. Grisaru-Granovsky S, Halevy T, Eidelman A, Elstein D, Samueloff A. Hypertensive disorders of pregnancy and the small for gestational age neonate: not a simple relationship. Am J Obstet Gynecol. 2007; 196(4): 335.e1-5.
16. Lepercq J, Coste J, Theau A, Dubois-Laforgue D, Timsit J. Factors associated with preterm delivery in women with type 1 diabetes: a cohort study. Diabetes care 2004; 27(12):2824-8.
17. Fitzpatrick A, Carter J, Quigley MA. Association of gestational age with verbal ability and spatial working memory at age 11. Pediatrics 2016; 138(6): e20160578.
18. Cho WK, Suh B-K. Catch-up growth and catch-up fat in children born small for gestational age. Korean journal of pediatrics 2016; 59(1):1.
19. Dalili H, Zaker Z, Keihanidoust Z, Farahani Z, Shariat M. Comparison of neuro-developmental status in preterm neonates with and without family based interventions. World Journal of Advanced Research and Reviews 2020; 8(2):056-63.
20. Sommerfelt K, Andersson HW, Sonnander K, Ahlsten G, Ellertsen B, Markestad T, et al. Cognitive development of term small for gestational age children at five years of age. Archives of Disease in Childhood 2000; 83(1):25.
21. Christian P, Murray-Kolb LE, Tielsch JM, Katz J, LeClerq SC, Khatry SK. Associations between preterm birth, small-for-gestational age, and neonatal morbidity and cognitive function among school-age children in Nepal. BMC Pediatrics 2014; 14(1):58.
22. Lagerström M, Bremme K, Eneroth P, Faxelius G, Magnusson D, Smedler A. WISC-test scores at the age of 10 for children born to women with risk pregnancies. J Perinat Med 1991; 19(4):269-83.

**Citation:** Dalili H, Moezi A, Ansari S, Farahani Z, Shariat M. **History of Small for Gestational Age at Birth With Verbal and Non-verbal Intelligence: A Case-Control Study Among Preschool Children.** J Family Reprod Health 2023; 17(1): 14-20.