

**CESAREAN BIRTH AND THE NUTRITIONAL DEVELOPMENT IN CHILDHOOD:
 RESULTS FROM A COHORT IN SOUTHERN BRAZIL**

Rodrigo Dias Nunes^{1,2}
 Eliane Traebert^{1,2}
 Mayara Seemann¹
 Jefferson Traebert²

ABSTRACT

Background and aim: The cesarean births have increased, just like observed for obesity and overweight in childhood. This study aims to report the association between cesarean birth and the nutritional development status of 6/7-year-old. Materials and methods: As part of the Coorte Brasil Sul, the study involved 475 randomly selected children from the city of Palhoça, Brazil, born in 2009. Demographic, pregnancy and birth characteristics and children nutritional status were obtained. Measures of weight and height were converted to age and sex-adjusted z-scores of height-for-age (HFAz), weight-for-age (WFAz) and BMI-for-age (BMIz). Results: Among these children, 196 (41.3%) were born by cesarean section and 279 (58.7%) were born by vaginal birth. No differences were found between the means of the BMIz, WFAz and HFAz according to the mode of delivery, as well as the average treatment effect. Conclusion: Cesarean birth was not associated with the nutritional development status of 6/7-year-old in the studied population.

Key words: Obesity. Delivery. Obstetric. Cesarean Section. Child.

RESUMO

Cesariana e o estado nutricional na infância: resultados de uma coorte no sul do Brasil

Introdução e objetivo: A incidência de cesariana tem aumentado, bem como o observado para a obesidade e o sobrepeso na infância. Este estudo tem como objetivo reportar a possível associação entre o parto ocorrido por cesariana e o status de desenvolvimento nutricional aos 6/7 anos de idade. Materiais e métodos: Como parte da Coorte Brasil Sul, o estudo envolveu 475 crianças selecionadas randomicamente na cidade de Palhoça, Brasil, nascidas em 2009. Foram identificadas as características demográficas, gestacionais e relativas ao nascimento, bem como o status no desenvolvimento nutricionais destas crianças. Foram realizadas as aferições de peso e altura e convertidos para os escores Z ajustados por idade e sexo para altura-por-idade (HFAz), peso-por-idade (WFAz) e IMC-por-idade (BMIz). Resultados: Entre estas crianças, 196 (41,3%) foram nascidas por cesariana e 279 (58,7%) por parto vaginal. Não foram identificadas diferenças entre as médias de BMIz, WFAz e HFAz ajustados pela via de parto, bem como quando realizado o efeito médio de tratamento dos dados. Conclusão: O nascimento por cesariana não esteve associado ao desenvolvimento nutricional aos 6/7 de idade na população estudada.

Palavras-chave: Obesidade. Parto obstétrico. Cesariana. Infância.

1-School of Medicine, University of Southern Santa Catarina, Palhoça-SC, Brazil.

2-Post-Graduate Program in Health Sciences. University of Southern Santa Catarina, Palhoça-SC, Brazil.

E-mails:

rodrigo.dias.nunes@hotmail.com

elisazevedot@gmail.com

mayaraseemann@gmail.com

jefferson.trabert@gmail.com

INTRODUCTION

Obesity is considered a public health problem in several countries and the World Health Organization (WHO) has considered obesity an epidemic due to its increase in prevalence (WHO, 2000). Economically, it has raised financial costs and reduced productivity in certain populations over the last three decades, despite its stabilization in some developed and developing Western countries for the last years (Kelly and colaboradores, 2008; Weng and colaboradores, 2013).

Overweight and obesity in childhood have been identified as predictors of obesity in adulthood³, with consequent increase in the risks of clinical conditions, such as cardiovascular diseases, diabetes mellitus, pulmonary diseases and musculoskeletal complications, aggravating the morbidity and mortality in middle age individuals (O'Dea, Hueiwen and Peralta, 2013; Widen and colaboradores, 2017).

In this way, educational programs and public policies have contributed to achieving a stabilization of the incidence of obesity in children and adolescents in some developed countries (Aeberli and colaboradores, 2010; Andersen, Baker and Sorensen, 2012; De Jong and colaboradores, 2011; Stamatakis, Wardle and Cole, 2010). However, these results were not achieved among some different population subgroups, indicating the existence of certain genetic or environmental characteristics that contribute to the occurrence of childhood obesity (Olds and colaboradores, 2011; Martínez-Vizcaíno and colaboradores, 2015; Paz and colaboradores, 2017).

The possibility that these environmental factors are not limited to late childhood, but also associated with the perinatal period, including prenatal care, the conditions of birth and the mode of delivery should be considered (Møller and colaboradores, 2014; Santos and colaboradores, 2017; Sorensen and colaboradores, 2016).

Over the last three decades, the cesarean births have also increased, just like observed for obesity and overweight, stabilizing in the last few years. Several outcomes have been associated to the cesarean, such as postpartum hemorrhage, injury to urinary tract, neonatal respiratory morbidity, abnormal placentation, and uterine rupture in future pregnancies, as well as breastfeeding difficulties (Kankoon and colaboradores, 2018).

Some authors Vinding and colaboradores (2017) and Weng and colaboradores (2013) have attributed obesity and overweight in childhood to the operatory birth. In Brazil, a continental country with great cultural miscegenation, the high rates of obesity and cesarean section have not been well explained as they were in other developing countries.

However, the Brazilian southern region presents socioeconomic, cultural and genetic characteristics different from the rest of the country and very alike to those found in the European continent, due to its colonization.

Thus, population studies in this region may contribute to elucidate witch perinatal factors and genetic conditions might be effectively associated with the onset of obesity in childhood. They also may contribute to the development of educational measures to prevent this condition in the adult population, such as other several cohorts around the world (Leonard and colaboradores, 2017; Massion and colaboradores, 2016; Mastroeni and colaboradores, 2017; Mueller and colaboradores, 2017; Smithers and colaboradores, 2017).

The aim of this study is to report the association between cesarean birth and the nutritional development status of 6/7-year-old schoolchildren.

MATERIALS AND METHODS

This study was approved by the Ethics Committee on Human Research of the University of Southern Santa Catarina, Brazil. This study is part of the Coorte Brasil Sul, a broad population-based study involving children from the city of Palhoça, Brazil, born in 2009. Its objective is to understand the influence of the first thousand days of life on the schoolchildren's health-related behaviors and health.

A sample size was calculated according to the following parameters: total of 1,903 schoolchildren born in 2009; an unknown outcome prevalence (overweight and obesity); a relative error of 5% and a confidence level of 95%. The minimum sample size was 475 schoolchildren.

Data regarding demographic, pregnancy and birth characteristics were obtained from interviews with children's parents at home. Also, birth records were collected from the health portfolio. Children's nutritional status was obtained from anthropometric measures performed at

schools. Children's weight and height were converted to age and sex-adjusted z-scores of height-for-age (HFAz), weight-for-age (WFAz) and BMI-for-age (BMIz) (Freedman and Berenson, 2017).

The t-test was used to evaluate the homogeneity between the way of birth and the anthropometric measures, according to the WHO parameters. To measure the difference in mean outcomes between both way of birth, the average treatment effect (ATE) was

calculated. Statistical analysis was performed using SPSS version 18.0 and the level of significance was $p < 0.05$.

RESULTS

Data from 475 children and their mothers were included in this study. Among children, 196 (41.3%) were born by cesarean section and 279 (58.7%) were born by vaginal birth.

Table 1 - Characteristics of the study sample according to route of delivery.

	Cesarean		Vaginal		Mean difference (95% CI)	p value
	Mean ± SD or n (%)					
Mother's age	27.0 ± 6.6	25.6 ± 6.6			-1.6 (-2.8; -0.4)	0.010
Mother's ethnicity						0.273
Caucasian	155 (79.5)	207 (74.5)				
African-Brazilian	39 (20.0)	64 (23.0)				
Others	1 (0.5)	7 (2.5)				
Mother with partner	177 (92.7)	255 (93.1)				0.870
Planned pregnancy	87 (45.3)	106 (38.5)				0.144
Prenatal care	189 (98.4)	272 (98.2)				0.842
Appointments	9.3 ± 3.2	9.1 ± 3.2			-0.2 (-0.8; -0.4)	0.489
Mother's weight gain	15.2 ± 8.6	12.8 ± 6.6			-2.4 (-4.0; -0.9)	0.002
Gestational age	38.8 ± 2.5	39.1 ± 3.1			0.3 (-0.3; 0.8)	0.309
Breastfed	178 (91.8)	250 (90.3)				0.578
Breastfeeding (months)	18.7 ± 7.5	17.1 ± 4.9			1.6 (-1.2; 4.7)	0.332
Alcohol in pregnancy	9 (4.9)	19 (7.1)				0.346
Tobacco in pregnancy	25 (13.2)	47 (17.2)				0.245
Drugs in pregnancy	4 (2.1)	4 (1.5)				0.610
Child's sex						0.117
Male	96 (49.0)	157 (56.3)				
Female	100 (51.0)	122 (43.7)				
Apgar 1 st minute	8.3 ± 1.1	8.1 ± 1.1			-0.2 (-0.4; 0.1)	0.164
Apgar 5 th minute	9.0 ± 1.0	9.0 ± 1.0			0.1 (-0.2; 0.2)	0.719

Table 2 - Associations between cesarean compared to vaginal birth on z-scores of weight-for-age (WFAz), height-for-age (HFAz) and BMI for age (BFAz).

	Cesarean		Vaginal		t-test Mean difference ± SD (95% CI)	p value
	Minimum	Maximum	Mean ± SD	Mean ± SD		
WFAz	-2.66	7.03	0.61 ± 1.33	0.55 ± 1.30	-0.06 ± 0.12 (-0.30; 0.18)	0.607
HFAz	-2.26	3.09	0.26 ± 1.06	0.27 ± 1.06	0.01 ± 0.10 (-0.18; 0.21)	0.917
BFAz	-3.09	7.13	0.62 ± 1.36	0.53 ± 1.30	-0.09 ± 0.12 (-0.34; 0.15)	0.452

Legends: Children's nutritional status was obtained from anthropometric measures performed at schools. Children's weight and height were converted to age and sex-adjusted z-scores of height-for-age (HFAz), weight-for-age (WFAz) and BMI-for-age (BMIz). The t-test was used to evaluate the homogeneity between the way of birth and the anthropometric measures, according to the WHO parameters. To measure the difference in mean outcomes between both way of birth, the average treatment effect (ATE) was calculated. Statistical analysis was performed using SPSS version 18.0 and the level of significance was $p < 0.05$.

The characteristics of the studied sample are shown in Table 1 and some imbalances were found. Women of greater age at delivery had more children born from cesarean section ($p=0.010$). This happened also with mothers that presented a greater gain of weight during pregnancy ($p=0.002$). It is known that children born from women with na excessive weight gain during pregnancy tend to be heavier, the greater mother's weight

gain. This can be associated with heavier infant growth, but by age 6-7 years, the age at outcome measurement for this study, the differences may no longer be observable.

No differences were found between the means of the BMIz, WFAz and HFAz according to the route of delivery (Table 2). The mean effect (ATE) for cesarean birth compared to vaginal birth on the 6/7 year-old-

schoolchildren nutritional status in the studied population was also not different.

Among the 428 children with anthropometric measurements, 55 (12.9%) were within the obesity range and 94 (22.0%) were in overweight.

DISCUSSION

In this study no evidence was found regarding the association between cesarean birth and anthropometric measures in childhood among 6/7 years-old-schoolchildren. Previously, cesarean delivery was associated with obesity rating from 15% (Chen and collaborators, 2017; Yuan and colaboradores, 2016) to 46% (Mueller and colaboradores, 2015).

However, other large population studies have shown that this association occurs in early childhood, but not in the age evaluated in this study (Vinding and collaborators, 2017; Pey and colaboradores, 2014). The cohort studies present different analytical approaches, samples or definitions for the choice of birth, such as elective or emergency cesarean section and normal or instrumented vaginal delivery. Such methodological differences can interfere in the results.

This cohort still does not present the long-term follow-up. It is possible that future results show differences that have not yet been possible to evaluate. However, if the association between obesity and childbirth manifests at earlier ages and ceases to exist with the child's growth, it might be tackled, since its main argument includes the difference in the colonization microbiota according to the way of childbirth (Dao and Clément, 2017).

In fact, it is difficult to explain such changes during children's growth. The hypothesis that the intestinal flora of the child does not pass through the ideal colonization due to vaginal delivery, and that would contribute to the metabolism in childhood, cannot be the only way to explain obesity.

Several environmental and behavioral factors could have interfered with these results. In addition, modern surgical techniques and more precise indications, out of the risk of emergence during labor, can contribute to reduce the relationship between the surgical procedure and childhood obesity (Vinding and collaborators, 2017).

In this way, we must reflect on the real negative and positive repercussions of elective

cesareans that seem to be being strengthened by medical entities and by the population.

A limitation of this study is on the non-differentiation between the two modes of childbirth, but this was not its initial goal.

Although further research is needed to elucidate the underlying mechanisms of overweight in childhood, the simple observation of a similar pattern of the increasing incidence of childhood obesity and cesarean section rates is not enough to explain this imbalance in child development.

Several metabolic complications have been associated with children born by surgery, such as neonatal hypoglycemia, immune disorders and allergic conditions in childhood (Leonard and collaborators, 2017; Vinding and collaborators, 2017).

CONCLUSION

Therefore, this study has not found association between cesarean birth and the nutritional development status of 6/7-year-old schoolchildren.

Other characteristics might contribute to childhood obesity and the follow-up of this children might also demonstrate different results.

REFERENCES

- 1-Aeberli, I.; Henschen, I.; Molinari, L.; Zimmermann, M.B. Stabilisation of the prevalence of childhood obesity in Switzerland. *Swiss Medical Weekly*. Vol. 140. 2010. p. W13046.
- 2-Andersen, L.G.; Baker, J.L.; Sorensen, T.I.A. Contributions of incidence and persistence to the prevalence of childhood obesity during the emerging epidemic in Denmark. *Plos One*. Vol. 7. Num. 8. 2012. p. e42521.
- 3-Chen, G.; Chiang, W.L.; Shu, B.C.; Guo, Y.L.; Chiou, S.T.; Chiang, T.L. Associations of caesarean delivery and the occurrence of neurodevelopmental disorders, asthma or obesity in childhood based on Taiwan birth cohort study. *BMJ Open*. Vol. 7. Num. 9. 2017. p. e017086.
- 4-Dao, M.C.; Clément, K. Gut microbiota and obesity: Concepts relevant to clinical care. *European Journal of International Medicine*. Vol. S0953-6205. Num. 17. 2017. p. 30413-30412.

- 5-De Jong, E.; Schokker, D.F.; Visscher, T.L.S.; Seidell, J.C.; Renders, C.M. Behavioural and sociodemographic characteristics of Dutch neighbourhoods with high prevalence of childhood obesity. *International Journal of Pediatric Obesity*. Vol. 6. Num. 3-4. 2011. p. 298-305.
- 6-Freedman, D.S.; Berenson, G.S. Tracking of BMI z Scores for Severe Obesity. *Pediatrics*. Vol. 140. Num. 3. 2017. p. e20171072.
- 7-Kankoon, N.; Lumbiganon, P.; Kietpeerakool, C.; Sangkomkarn, U.; Betrán, A.P.; Robson, M. Cesarean rates and severe maternal and neonatal outcomes according to the Robson 10-Group Classification System in Khon Kaen Province, Thailand. *International Journal of Gynaecology and Obstetrics*. Vol. 140. Num. 2. 2018. p. 191-197.
- 8-Kelly, T.; Yang, W.; Chen, C.S.; Reynolds, K.; He, J. Global burden of obesity in 2005 and projections to 2030. *International Journal of Obesity*. Vol. 32. Num. 4. 2008. p. 1431-1437.
- 9-Leonard, S.A.; Petito, L.C.; Rehkopf, D.H.; Ritchie, L.D.; Abrams, B. Weight gain in pregnancy and child weight status from birth to adulthood in the United States. *Pediatr Obes*. 2016. *Pediatric Obesity*. Vol. 12. Num. Supl. 1. 2017. p. 18-25.
- 10-Massion, S.; Wickham, S.; Pearce, A.; Barr, B.; Law, C.; Taylor-Robinson, D. Exploring the impact of early life factors on inequalities in risk of overweight in UK children: findings from the UK Millennium Cohort Study. *Archives of Disease in Childhood*. Vol. 101. Num. 8. 2016. p. 724-730.
- 11-Martínez-Vizcaíno, V.; Solera-Martínez, M.; Cavero-Redondo, I.; García-Prieto, J.C.; Arias-Palencia, N.; Notario-Pacheco, B.; Martínez-Andrés, M.; Mota, J.; Sánchez-López, M.; Cuenca Study Group. Association between parental socioeconomic status with underweight and obesity in children from two Spanish birth cohorts: a changing relationship. *BMC Public Health*. Vol. 15. 2015. p. 1276.
- 12-Mastroeni, M.F.; Mastroeni, S.S.B.S.; Czarnobay, S.A.; Ekwaru, J.P.; Loehr, S.A.; Veugelers, P.J. Breast-feeding duration for the prevention of excess body weight of mother-child pairs concurrently: a 2-year cohort study. *Public Health Nutrition*. Vol. 20. Num. 14. 2017. p. 2537-2548.
- 13-Møller, S.E.; Ajslev, T.A.; Andersen, C.S.; Dalga, C.; Sørensen, T.I.A. Risk of childhood overweight after exposure to tobacco smoking in prenatal and early postnatal life. *Plos One*. Vol. 9. Num 10. 2014. p. e109184.
- 14-Mueller, N.T.; Whyatt, R.; Hoepner, L.; Oberfield, S.; Dominguez-Bello, M.G.; Widen, E.M.; Hassoun, A.; Perera, F.; Rundle, A. Prenatal exposure to antibiotics, cesarean section and risk of childhood obesity. *International Journal of Obesity*. Vol. 39. Num. 4. 2015. p. 665-670.
- 15-Mueller, N.T.; Mao, G.; Bennet, W.L.; Hourigan, S.K.; Dominguez-Bello, M.G.; Appel, L.J.; Wang, X. Does vaginal delivery mitigate or strengthen the intergenerational association of overweight and obesity? Findings from the Boston Birth Cohort. *International Journal of Obesity*. Vol. 31. Num. 4. 2017. p. 497-501.
- 16-O'Dea, J.A.; Hueiwen, C.; Peralta, L.R. Socioeconomic patterns of overweight, obesity but not thinness persist from childhood to adolescence in a 6-year longitudinal cohort of Australian schoolchildren from 2007 to 2012. *BMC Public Health*. Vol. 14. 2014. p. 222.
- 17-Olds, T.S.; Maher, C.; Zumin, S.; Peneau, S.; Lioret, S.; Castetbon, K.; Bellisle, J.; De Wilde, J.; Hohepa, M.; Maddison, R.; Lissner, L.; Sjoberg, A.; Zimmermann, M.; Aeberli, I.; Ogden, C.; Flegal, K.; Summerbell, C. Evidence that the prevalence of childhood overweight is plateauing: data from nine countries. *International Journal of Pediatric Obesity*. Vol. 6. Num. 5-6. 2011. p. 342-360.
- 18-Paz, L.D.; Sheiner, E.; Wainstock, T.; Sergienko, R.; Landau, D.; Walfisch, A. Evidence that children born at early term (37-38 6/7 weeks) are at increased risk for diabetes and obesity-related disorders. *American Journal of Obstetrics and Gynecology*. Vol. S0002-9378. Num. 17. 2017. p. 30857-30858.
- 19-Pei, Z.; Heinrich, J.; Fuertes, E.; Flexeder, C.; Hoffmann, B.; Lehmann, I.; Schaaf, B.; von Berg, A.; Koletzko, S.; Influences of Lifestyle-Related Factors on the Immune System and the Development of Allergies in Childhood plus Air Pollution and Genetics (LISAplus) Study

Group. Cesarean delivery and risk of childhood obesity. *Journal of Pediatrics*. Vol. 164. Num. 5. 2014. p. 1068-1073.

20-Santos, D.F.B.; Strapasson, G.C.; Golin, S.D.P.; Gomes, E.C.; Wille, G.M.F.C.; Barreira, S.M.W. Implicações da pouca preocupação e percepção familiar no sobrepeso infantil no município de Curitiba, PR, Brasil. *Ciência & Saúde Coletiva*. Vol. 22. Num 5. 2017. p. 1717-1724.

21-Sorensen, T.I.A.; Ajslev, T.A.; Angquist, L.; Morgen, C.S.; Ciuchi, I.G.; Smith, G.D. Comparison of associations of maternal peripregnancy and paternal anthropometrics with child anthropometrics from birth through age 7 y assessed in the Danish National Birth Cohort. *American Journal of Nutrition*. Vol. 104. 2016. p. 389-396.

22-Smithers, L.G.; Mol, B.W.; Jamieson, L.; Lynch, J.W. Cesarean birth is not associated with early childhood body mass index. *Pediatric Obesity*. Vol. 12. Num. Supl. 1. 2017. p. 120-124.

23-Stamatakis, E.; Wardle, J.; Cole, T.J. Childhood obesity and overweight prevalence trends in England: evidence for growing socioeconomic disparities. *International Journal of Obesity*. Vol. 34. Num. 1. 2010. p. 41-47.

24-Vinding, R.K.; Sejersen, T.S.; Chawes, B.L.; Bonnelykke, K.; Buhl, T.; Bisgaard, H.; Stokolm, J. Cesarean delivery and body mass index at 6 months and into childhood. *Pediatrics*. Vol. 39. Num. 6. 2017. p. e20164066.

25-Weng, S.F.; Redsell, S.A.; Nathan, D.; Swift, J.A.; Yang, M.; Glazebrook, C. Estimating overweight risk in childhood from predictors during infancy. *Pediatrics*. Vol 132. Num. 2. 2013. p. e414-e421.

26-Widen, E.M.; Kahn, L.G.; Cirillo, P.; Cohn, B.; Kezios, K.L.; Factor-Litvak, P. Prepregnancy overweight and obesity are associated with impaired child neurodevelopment. *Maternal Child Nutrition*. Vol. 14. Num. 1. 2017. p. 1-8.

27-World Health Organization. *Obesity: Preventing and managing the global epidemic: report of a WHO consultation*. Geneva. 2000.

28-Yuan, C.; Gaskins, A.J.; Blaine, A.I.; Zhang, C.; Gillman, M.W.; Missmer, S.A.; Field, A.E.; Chavarro, J.E. Association Between Cesarean Birth and Risk of Obesity in Offspring in Childhood, Adolescence, and Early Adulthood. *JAMA Pediatrics*. Vol. 170. Num. 11. 2016. p. e162385.

Disclosure Statement

This paper is based on the COORTE BRASIL SUL. The original project was sponsored by FAPESC/Brazil grant number 2016TR222. But all the authors declare no conflicts of interest once this funding aims to develop scientific data regarding the improvement of community' health.

Informed Consent

All patients provided written consent to participate in this research.

Ethical Considerations

This study was approved by the Ethics Committee on Human Research of the University of Southern Santa Catarina, Brazil, under CAAE 38240114.0.0000.5369, in accordance with the ethical standards of the Helsinki Declaration of 1975, as revised in 2008.

Funding

This paper is based on the COORTE BRASIL SUL.

The Project was sponsored by FAPESC/Brazil grant number 2016TR222.

Correspondent author:

Rodrigo Dias Nunes.

University of Southern Santa Catarina (UNISUL).

Avenida Pedra Branca 25, Cidade Universitária, Palhoça-SC, Brazil .

ZIP CODE: 88137-270.

Received for publication in 07/27/2018

Accept in 01/20/2019