

## NUTRIENTS | 探究中国城市母亲母乳中蛋白质成分的变化趋势

本文关键字：母乳、蛋白质、免疫因子、中国母亲、剖宫产

影响因子：4.196

建议阅读时间：1.5 分钟

母乳中的蛋白质组成可能会受到哺乳阶段及地理位置的影响。本研究旨在评估中国城市母亲母乳中的主要蛋白质随哺乳阶段的变化趋势及分娩方式对免疫因子的影响。

研究在中国三个城市收集了 450 份涵盖 0-8 个月哺乳阶段的母乳样本，并采用微流控芯片或 ELISA 定量方法，对母乳中的  $\alpha$ -乳清蛋白、乳铁蛋白、血清白蛋白、总酪蛋白、免疫球蛋白 (IgA、IgM 和 IgG) 及转化生长因子 (TGF)  $\beta$ 1、 $\beta$ 2 的含量进行测定。并将含量及随哺乳阶段的变化趋势与既往研究中的数据进行了对比。

结果表明，中国城市母亲母乳中的  $\alpha$ -乳清蛋白、乳铁蛋白、IgA、IgM 和 TGF- $\beta$ 1 的含量与既往研究所报告的一致，在哺乳早期浓度最高，之后趋于平稳，并在哺乳期结束前迅速下降。TGF- $\beta$ 2 的浓度在再次增加之前，表现出相同的早期动态。而总酪蛋白则呈现出先升高后下降的不同增长模式。血清白蛋白和 IgG 水平在整个哺乳期中趋于平稳。

总之，中国城市母亲母乳中主要蛋白质的含量与既往在世界其他地区进行的研究结果相似，而剖宫产对母乳免疫因子的影响非常有限。

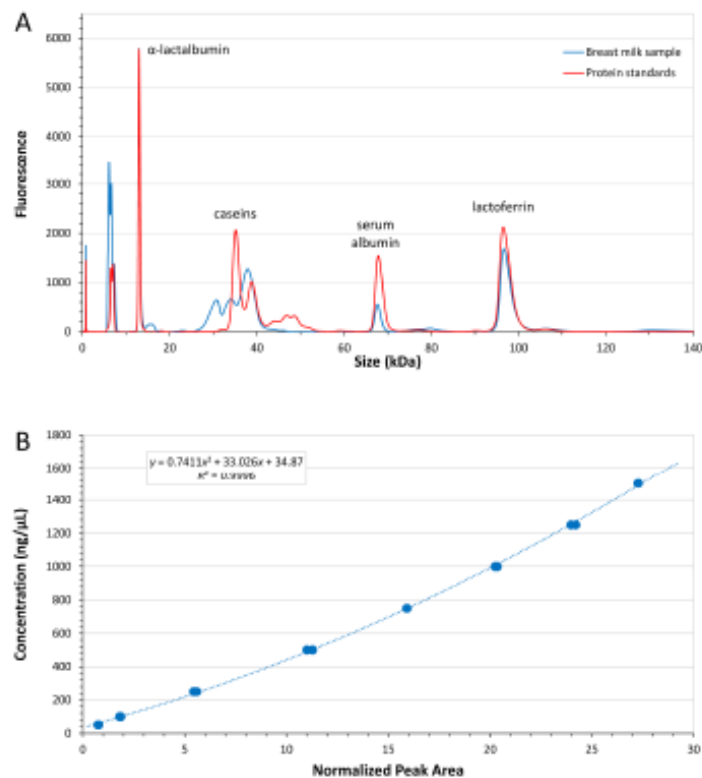
参考文献：

Affolter M, et al. *Nutrients*. 2016 Aug 17;8(8). pii: E504.

文献链接：<https://www.ncbi.nlm.nih.gov/pubmed/27548208>

**Table 1.** Maternal and infant characteristics (adapted from [31]).

Study Population	5–11 Days	12–30 Days	1–2 Months	2–4 Months	4–8 Months
	(n = 90)	(n = 90)	(n = 90)	(n = 90)	(n = 90)
<b>Mother</b>					
Age (years), Mean (SD)	27 (4)	27 (3)	28 (4)	27 (4)	26 (4)
Height (cm), Mean (SD)	160 (4)	160 (5)	161 (5)	161 (5)	159 (5)
Weight (kg), Mean (SD)	60.7 (8.7)	60.8 (7.9)	61.9 (8.9)	58.4 (8.3)	56.2 (8.1)
BMI (kg/m <sup>2</sup> ), Mean (SD)	23.7 (3.3)	23.7 (2.8)	23.9 (3.1)	22.5 (2.9)	22.2 (3.1)
Gestational weight gain (kg), Mean (SD)	16.7 (7.4)	16.2 (6.0)	15.9 (5.7)	15.9 (5.9)	14.9 (7.6)
Postpartum weight loss (kg), Mean (SD)	9.1 (6.1)	8.6 (5.3)	9.8 (4.0)	10.0 (6.2)	10.6 (5.9)
Caesarean delivery, N (%)	39 (42)	43 (48)	53 (59)	35 (39)	35 (38)
<b>Infant</b>					
Males, N (%)	51 (57)	48 (53)	48 (53)	54 (60)	43 (48)
Gestational age at birth (weeks), Mean (SD)	39.3 (1.2)	39.2 (1.3)	39.2 (1.6)	39.4 (1.3)	39.5 (1.5)

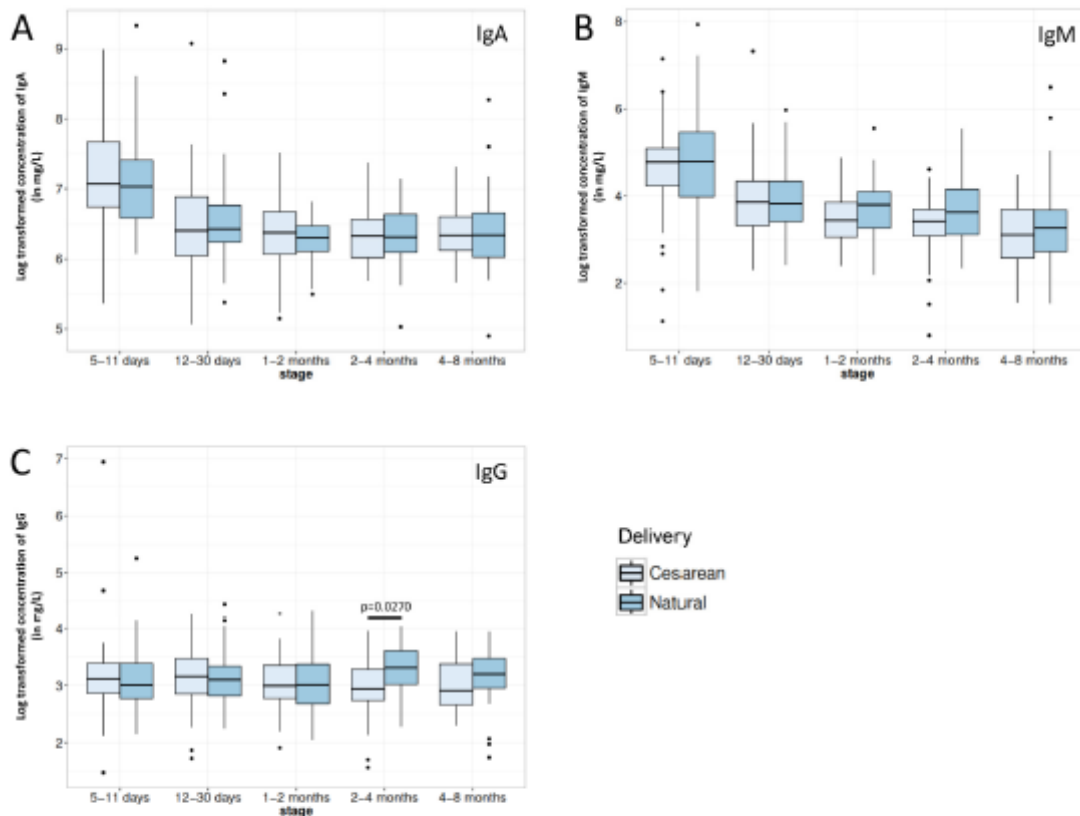


**Figure 2.** (A) Human breast milk protein separation on the LabChip GX II system. The electropherogram overlay depicts individual standard milk proteins (red) and a typical human breast milk sample trace (blue); (B) Calibration curve for  $\alpha$ -lactalbumin (in duplicates, 50–1500 ng/ $\mu$ L,  $R^2$  0.9996).

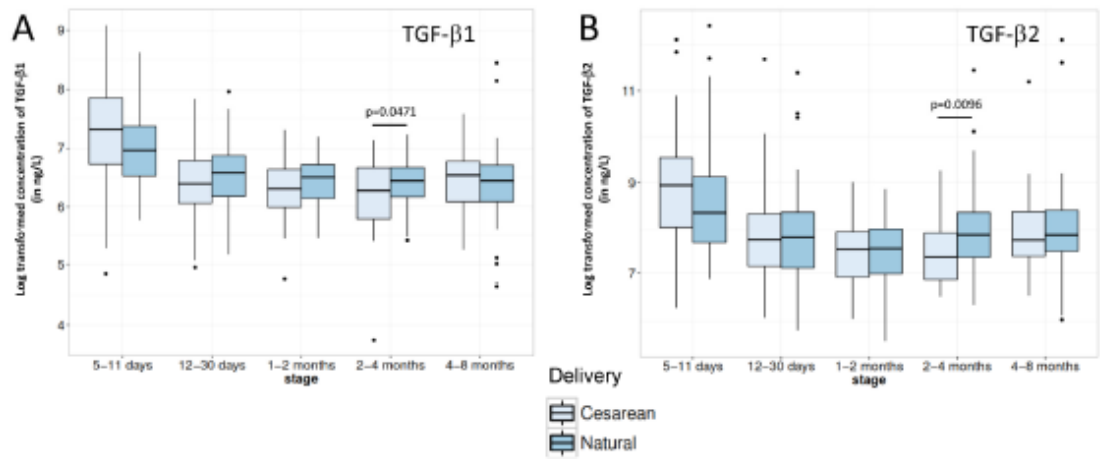
**Table 2.** Protein content of human breast milk from the different lactation stages (see also Figure S1).

Proteins	5–11 Days	12–30 Days	1–2 Months	2–4 Months	4–8 Months
	(n = 90)	(n = 90)	(n = 90)	(n = 90)	(n = 90)
<b>Major breast milk proteins</b>					
α-lactalbumin (g/L), Median (IQR)	3.27 (0.60)	3.16 (0.55)	2.84 <sup>a</sup> (0.55)	2.53 <sup>a</sup> (0.47)	2.28 <sup>a</sup> (0.63)
Lactoferrin (g/L), Median (IQR)	3.30 (2.11)	1.86 <sup>a</sup> (0.89)	1.24 <sup>a</sup> (0.53)	1.15 (0.46)	1.17 (0.47)
Serum albumin (g/L), Median (IQR)	0.48 (0.14)	0.48 (0.14)	0.42 (0.09)	0.44 (0.10)	0.42 (0.08)
Total caseins (g/L), Median (IQR)	5.84 (3.17)	6.57 <sup>a</sup> (2.15)	6.24 (2.25)	5.79 <sup>a</sup> (1.69)	5.60 (1.73)
<b>Immune factors</b>					
IgA (mg/L), Median (IQR)	1148 (1022)	615 <sup>a</sup> (494)	553 <sup>a</sup> (232)	557 (312)	564 (337)
IgM (mg/L), Median (IQR)	117 (168)	47 <sup>a</sup> (47)	35 <sup>a</sup> (31)	35 (29)	25 <sup>a</sup> (25)
IgG (mg/L), Median (IQR)	22 (13)	23 (12)	20 (14)	24 (15)	23 (14)
TGF-β1 (ng/L), Median (IQR)	1258 (1305)	685 <sup>a</sup> (482)	600 (356)	598 (379)	659 (410)
TGF-β2 (ng/L), Median (IQR)	5286 (10,444)	2322 <sup>a</sup> (3100)	1877 <sup>a</sup> (1890)	1920 <sup>a</sup> (2112)	2311 <sup>b</sup> (2868)

<sup>a</sup>  $p < 0.05$  vs. previous stage; <sup>b</sup>  $p < 0.05$  vs. previous 1–2 months stage.



**Figure 3.** Comparison of (A) IgA; (B) IgM and (C) IgG immunoglobulin contents in breast milk from mothers delivering their infant either vaginally (Natural) or by Caesarean section for each lactation period of this study. Box plot represent medians with 25th and 75th percentile, min-max range and outliers. Statistical significance was set at  $p < 0.05$  and significant  $p$ -values are indicated in the graphs.



**Figure 4.** Comparison of (A) TGF- $\beta$ 1 and (B) TGF- $\beta$ 2 contents in breast milk from mothers delivering their infant either vaginally (Natural) or by Caesarean section for each lactation period of this study. Box plot represent medians with 25th and 75th percentile, min-max range and outliers. Statistical significance was set at  $p < 0.05$  and significant  $p$ -values are indicated in the graphs.