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Does emigration by itself improve birth weight? Study in European newborns of Indo-Pakistan origin

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ABSTRACT

Objective: Our aim was to evaluate the effect of emigration on fetal birth weight (BW) in a group of pregnant women coming from the Indian subcontinent.
Methods: This was a retrospective study in a mixed population of pregnant women from the Indian subcontinent that either moved to Europe or stayed in their original countries. The influence of emigration along with several pregnancy characteristics: GA at delivery, fetal gender, maternal age, height, weight, body mass index (BMI) and parity on BW was evaluated by means of multivariable linear regression analysis.
Results: According to European standards, babies born to Indo-Pakistan emigrants and babies born to women staying in the Indian subcontinent were similarly small (BW centile 30± 29 and 30.1 ± 28, $p<0.68$). Multivariable regression demonstrated that emigration by itself did not exert a direct influence on BW ($p = 0.27$), being BMI and gestational age at delivery the true determinants of BW ($p<0.0001$).
Conclusions: Maternal BMI is the most relevant parameter affecting fetal growth regardless of the place of residence.

Introduction

Fetuses from the Indian subcontinent present poor birth weights (BW) (Subramanyam et al., 2010), which could be a consequence of different genetic backgrounds or different environmental influences decreasing their growth potential (Subramanyam et al., 2011; McGovern et al., 2017). Among these environmental factors, emigration to wealthier countries represents at least in theory one of the mayor health modifiers (Wickramage et al., 2019) especially influencing body mass index (BMI) as a result of changes in nutritional habits (Maqoud et al., 2016; Casali et al., 2015). However, It is unclear whether emigration by itself is able to modify fetal growth as it could exert its influence, as above indicated, through changes in other maternal and fetal characteristics, changes that might take place successfully regardless of the place of residence.

Aiming to discern this controversy, a mixed group of Indian subcontinent pregnant women who either moved to Europe or stayed in their original countries were studied. In these pregnancies we evaluated the circumstance of emigration, along with several maternal and fetal characteristics to investigate the true determinants of birth weight.

Material and methods

This was a retrospective cohort study of 244 pregnant women born in the Indian subcontinent who underwent routine ultrasound scans at the end of pregnancy. 86 were Indo-Pakistan region emigrant mothers that moved to Europe (Spain and Italy) and 158 were Indo-Pakistan mothers who stayed in their original country. The cohorts included all patients available in the files of the participant centers. Emigrant mothers were examined either at Hospital Universitario y Politécnico La Fe (Valencia, Spain) or at Fondazione Policlinico Universitario Agostino Gemelli IRCSS (Rome, Italy), while non-emigrant mothers, were examined at Colombo North Teaching Hospital (Sri-Lanka), also within the Indian Subcontinent region. We were aware of the different ethnicities existing at the Indian subcontinent, however, considering that all cases were ethnically and culturally of Indo-Pakistan origin, the notorious contrast

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with Europe made these cohorts homogeneous enough to perform an emigration study.

All fetuses underwent a biometry with an estimated fetal weight plus Doppler examination of the umbilical artery (UA) and middle cerebral artery (MCA) at and beyond 37+0 weeks as previously described (Morales-Roselló et al., 2015; Acharya et al., 2005). In brief, Doppler ultrasound examinations were performed with General Electric Voluson® (E8/E6/730) and Alpinion e-cube 15® ultrasound machines using 1–8 MHz abdominal convex probes, during fetal quiescence, in the absence of fetal tachycardia, and keeping the insonation angle with the examined vessels as small as possible. All examinations were performed by consultants certified as experts either by the Fetal medicine Foundation, or by the Italian or Spanish Ultrasound in Obstetrics and Gynecology Societies. The gestational age (GA) was determined according to the crown-rump length in the first trimester. The cerebroplacental ratio (CPR) was calculated as the ratio between the MCA and the UA pulsatility index (PI) (Morales-Roselló et al., 2015; Baschat and Gembruch, 2003) and only the last Doppler examination obtained within two weeks of birth, was included in the analysis. For study purposes CPR values were also converted in multiples of the median (CPR MoM) and BW into BW centiles according to local standards. Although the population was unselected, pregnancies complicated by significant maternal diseases, congenital fetal abnormalities, stillbirths, and multiple pregnancies were excluded. Fetuses and parents belonged to the same ethnicity and there were no gamete or embryo donations. Data concerning BW, mode of delivery and Apgar score were recorded after birth and also collected for the analysis.

Statistical analysis

Descriptive statistics were performed evaluating emigration (present or absent), maternal age, height and weight, BMI, BW, gravidity (defined as the total number of pregnancies including the current pregnancy and all previous miscarriages), parity (defined as the total number of previous vaginal deliveries and cesarean sections), fetal gender, GA at examination, GA at delivery, the interval between examination and delivery, mode of delivery (spontaneous vaginal delivery, instrumental delivery and emergency or elective cesarean section), and Apgar scores at 1 and 5 min. Mean (SD) and median (plus 1st, 3rd Quartiles) were calculated in case of continuous variables and absolute and relative frequencies were calculated in case of categorical variables.

Subsequently, to explain BW differences, and following an interpretative approach, a multivariable linear regression analysis was performed with the above-mentioned variables, selecting the informative parameters, and describing their estimates with their 95% confidence intervals, and p-values. Given that GA at examination and gravidity were respectively correlated with GA at birth and parity, the model included only the latter parameters.

Some of these variables such as the mode of delivery and the Apgar at 1 and 5 min were not included in the analysis, as they were not considered predictive variables but rather delivery outcomes.

Statistical analysis and graphs were performed with StatPlus® Pro 7 and Graph Pad Prism® 5 for Apple Macintosh. Comparisons were done with Mann-Whitney U test and Fisher exact test. Significance was considered with a $p<0.05$.

Results

The study included 244 pregnancies, of which 86 (35.2%) were emigrants and 158 (64.8%) non-emigrants. Most pregnant women delivered spontaneously (59.4%) a few days after examination a female sex fetus (52%) with a normal Apgar score (98.8%). In addition, most pregnancies presented BW centiles under the average, with a tendency to a low CPR MoM.

Table 1 and Fig. 1 shows the differentiated characteristics of the emigrant and non-emigrant women. In both cases, values showed BW centiles and CPR MoM values below the European median (50th centile or 1 MoM), proving that smallness was due in many cases to the existence of a certain degree of intrauterine growth restriction (IUGR). However, while no BW and BW centile differences between emigrant and non-emigrant women appeared, CPR differences ($P<0.05$) and CPR MoM (borderline differences, $P=0.056$) were observed, suggesting that IUGR was slightly more severe in those fetuses born to mothers who stayed in their home country. Moreover, these pregnancies presented a lower maternal weight, height, and BMI. In addition, delivered later after the examination and with less instrumental delivery.

Finally, as shown in Table 2, a multivariable linear regression analysis was performed with a selection of the above-mentioned variables to explain the determinants of BW. In this model ($R^2 = 22.0\%$, adjusted $R^2 = 19.7\%$), only GA at delivery (estimate =141.70945, 95% CI [94.19399, 189.22491], $p<0.00001$), maternal weight (estimate = 6.01543, 95% CI [1.20658, 10.82428], $p<0.05$) and maternal height

Table 1
Comparisons between the emigrant and non-emigrant study populations.

NS	Emigrant (N = 86) Mean (SD) Median (1st, 3rd Q)	Non-emigrant (N = 158) Mean (SD) Median (1st, 3rd Q)	p-value
Maternal age (years)	29.38 (5.02) 29 (26, 33)	28.23 (5.87) 28 (24, 32)	NS
Gravidity	2.06 (1.11) 2 (1, 3)	1.98 (1.11) 2 (1, 2.25)	NS
Parity	0.70 (0.91) 0 (0, 1)	0.83 (0.96) 1 (0, 1)	NS
MCA PI	1.50 (0.37) 1.46 (1.27, 1.72)	1.48 (0.38) 1.43 (1.21, 1.7)	NS
UA PI	0.94 (0.26) 0.89 (0.77, 1.04)	1.0 (0.27) 0.96 (0.81, 1,10)	<0.05
CPR	1.72 (0.60) 1.65 (1.28, 2.14)	1.59 (0.60) 1.50 (1.23, 1.79)	<0.05
CPR MoM	0.97 (0.34) 0.93 (0.73, 1.19)	0.90 (0.34) 0.85 (0.69, 1.02)	NS
GA at ultrasound (week)	38.9 (1.14) 38.9 (38, 40)	39.06 (1.04) 39.14 (38.14, 40)	NS
GA at delivery (week)	39.68 (1.07) 39.7 (38.9, 40.6)	39.49 (1.04) 39.57 (38.57, 40.29)	NS
Interval*	5.7 (4.52) 5 (1, 9)	3.04 (3.02) 2 (1, 5)	<0.0001
BW (g)	3062 (418) 3080 (2800, 3346)	3023 (449.4) 2990 (2750, 3265)	NS
BW centile	30.67 (27.72) 21.5 (7.75, 51.75)	29.98 (29.29) 20.5 (5, 48)	NS
Apgar score at 1 min	8.87 (1.45) 9 (9, 9.25)	8.93 (0.95) 9 (9, 9)	NS
Apgar score at 5 min	9.77 (0.81) 10 (10, 10)	9.87 (0.58) 10 (10, 10)	NS
Maternal weight (kg)	61.63 (10.82) 60 (55, 68.2)	54.5 (12.25) 54 (44.38, 63)	<0.0001
Maternal height (cm)	157.5 (5.38) 157 (154, 160)	154.5 (6.38) 154 (150, 159)	<0.001
BMI	24.8 (4.05) 24 (27.2, 22)	22.8 (4.9) 22.5 (25.8, 19)	<0.01
Categorical data	**N (%)**	**N (%)**	**P-value**
Fetal gender (male)	39 (45.3)	78 (49.4)	NS
SGA fetuses	26 (30.2)	54 (34.2)	NS
Apgar <7 at 5 min	1 (1.16)	2 (1.26%)	NS
Mode of delivery			
-Cesarean section	26 (30.2)	56 (35.4)	
-Instrumental vaginal delivery	15 (17.4)	2 (1.3)	<0.001
-Spontaneous vaginal delivery	45 (52.3)	100 (63.3)	

Notes: GA: gestational age, SD: standard deviation, 1st, 3rd Q: 1st and 3rd Quartiles, CPR = Cerebroplacental ratio, BW = birth weight centile, SGA: small for gestational age, *Interval between the ultrasound examination and delivery in days, BMI¡ Body mass index, NS = No statistical significance.

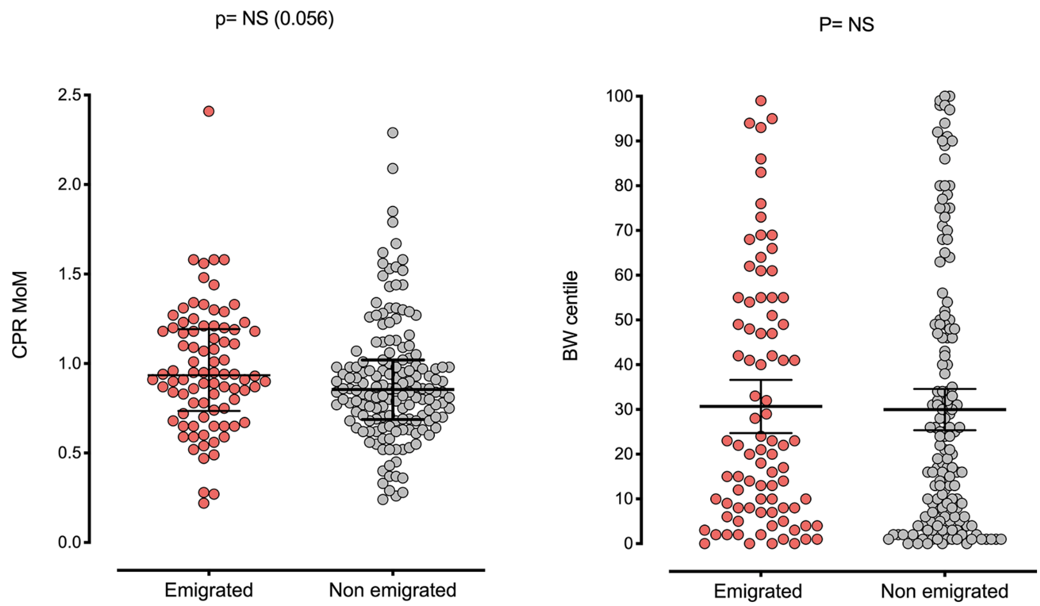

Fig. 1. CPR MoM and BW centile of fetuses born to mothers that emigrated and mothers that did not emigrate.

Table 2
Multivariable linear regression analysis of the studied parameters for the prediction of birth weight. Only GA at delivery and maternal weight were statistically significant. R^2 = 22.0% and adjusted R^2 = 19.7%.

	Estimate	Lower 95% CI	Upper 95% CI	P-value
Intercept	−4584.517	−6792.34643	−2376.68801	<0.0001
GA at delivery (weeks)	141.70945	94.19399	189.22491	<0.00001
Fetal gender (male)	−1.00394	−100.777	98.76912	NS
Maternal height (cm)	9.69054	0.80444	18.57663	<0.05
Parity	38.24103	−19.49425	95.97631	NS
Maternal weight (kg)	6.01543	1.20658	10.82428	<0.05
Maternal age (years)	5.49514	−4.20099	15.19127	NS
Emigration to Europe	−61.64919	−172.19193	48.89356	NS

Note: GA: gestational age, NS: Statistically non-significant.

(estimate = 9.69054, 95% CI [0.80444, 18.57663], p<0,05) influenced positively BW, while there was not any evidence to establish an influence from emigration to Europe by itself (estimate = −61.64919, 95% CI [−172.19193, 48.89356], p>0.05).

Finally, another analysis (Table 3) was performed to evaluate data using BMI with similar results. In this model (R^2 = 18.4%, adjusted R^2 = 16.3%), as expected, only GA at delivery (estimate =148.66433, 95% CI [100.34367, 196,985], p<0.00001), and BMI (estimate =14.29425, 95% CI [−2.50753, 26.08097], p<0,05) influenced positively BW.

Table 3
Multivariable linear regression analysis of the studied parameters for the prediction of birth weight. Only GA at delivery and maternal BMI were statistically significant. R^2 = 18.4% and adjusted R^2 = 16.3%.

	Estimate	Lower 95% CI	Upper 95% CI	P-value
Intercept	−3375.324	−5299.82168	−1450.82671	<0.001
GA at delivery (weeks)	148.66433	100.34367	196.985	<0.00001
Fetal gender (male)	8.83212	−92.80054	110.46478	NS
Maternal BMI	14.29425	2.50753	26.08097	<0.05
Parity	32.96086	−25.93922	91.86095	NS
Maternal age (years)	5.99033	−3.90047	15.88113	NS
Emigration to Europe	−19.09972	−128.78685	90.5874	NS

Note: GA: gestational age, BMI = Body mass index, NS: Statistically non-significant.

Discussion

Summary of the study findings

In comparison with western standards, both, children born to emigrant and non-emigrant mothers, presented low BW values at term. The multivariable analysis showed that BW was determined by BMI (weight and height), while emigration in itself did not exert any influence.

Interpretation of results

Considering that all mothers belonged to a similar ethnicity, if BW differences were caused by socio economic factors related to the place of residence, we would expect to find higher BW values in fetuses born to emigrant mothers, with a clear emigration influence in the multivariate analysis. However, our data suggested that, apart from GA al delivery, the only parameter influencing BW was BMI, independently of the place of residence.

No benefit of emigration

A controversy exists regarding the possibility that emigrants have better outcomes than the hosting population (healthy immigrant paradox) (Abdullahi et al., 2019; Wingate and Alexander, 2006; Kana et al., 2019; Hsieh et al., 2011; Juárez et al., 2017). However, our data were not in line with this, as we found low BW centiles in both groups: those that emigrated and those that remained in the Indian subcontinent. Our results therefore contradicted the existence of a benefit induced by emigration. Another important aspect was the possible cause of these phenomenon. As we earlier suggested, the existence of low CPR values, would reflect a higher degree of growth restriction, regardless of BW centile (Morales-Roselló et al., 2014; Morales-Roselló and Khalil, 2015). This was earlier observed in fetuses born in the Indian subcontinent (Morales-Roselló et al., 2018), but this trend to growth restriction might be also carried by emigrants to the new place of residence

(Morales-Roselló et al., 2022) and according to our results would be only modified by the maternal BMI. This is also in line with investigations in emigrants suggesting that most of the BW variation is produced at the maternal and fetal level and very few (3%) at the place of residence level (Mulinari et al., 2015).

Influence of pre-pregnancy weight and BMI

The flip side of this phenomenon was the clear influence of pre-pregnancy weight, maternal height, and BMI on fetal growth. This influence had been earlier described, and many authors had underlined how these ponderal magnitudes including maternal weight increase, pre-pregnancy weight, maternal height and BMI influenced not only BW but also other perinatal outcomes (Shi et al., 2019; Soltani et al., 2017; Murai et al., 2017; Nucci et al., 2018; Lima et al., 2018; Rafei et al., 2018; El Rafei et al., 2016; Fouelifack et al., 2015; Liu et al., 2016). Our data confirmed the importance of maternal weight, height and logically BMI. Of note, other maternal parameters such as maternal age and parity, earlier described to influence BW (although with a much lower intensity) (Vega et al., 1993; Mavalankar et al., 1994; Kaur et al., 2019; Bazyar et al., 2015; Weng et al., 2014; Inoue et al., 2016), did not influence BW in our study cohorts, probably because these were very too homogeneous in size and parity to show statistical influences.

Clinical implications

If maternal pre-pregnancy BMI is the key factor influencing BW in the Indo-Pakistan population, efforts should be focused to detect nutrition disorders prior to pregnancy, to avoid or minimize the high frequency of low BW in this ethnicity, wherever the place of residence is.

Strengths and limitations

The main strengths of this study include the possibility to compare within the same ethnicity how BW evolves at different locations and the inclusion of the CPR in the studied variables. Conversely, the main shortcoming is the small number of cases and the retrospective nature, which hinders the collection of some important perinatal data such as the smoking habit (Shea and Steiner, 2008) or the maternal weight gain throughout the pregnancy. In addition, although we recognize it could exert some influence on the analysis, we did not stratify for the time emigrants were living in the host country.

Conclusions

Emigration does not influence neonatal weight by itself. Conversely, maternal BMI seems to be the most relevant parameter affecting fetal growth regardless of the place of residence.

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Declaration of Competing Interest

Declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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