Factors Associated with Low Birth Weight in Indigenous Populations: a systematic review of the world literature

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Abstract

Objectives: we aimed to identify etiological factors for low birth weight (LBW), prematurity and intrauterine growth restriction (IUGR) in the Indigenous Population.

Methods: for this systematic review, publications were searched in Medline/PubMed, Scopus, Web of Science, and Lilacs until April 2018. The description in this review was based on the PRISMA guideline (Study protocol CRD42016051145, registered in the Centre for Reviews and Dissemination at University of York). We included original studies that reported any risk factor for one of the outcomes in the Indigenous Population. Two of the authors searched independently for papers and the disagreements were solved by a third reviewer

Results: twenty-four studies were identified, most of them were from the USA, Canada and Australia. The factors associated were similar to the ones observed in the non-indigenous including unfavorable obstetric conditions, maternal malnutrition, smoking, and maternal age at the extremes of childbearing age, besides environmental factors, geographic location, and access to health care in indigenous communities.

Conclusions: etiologic factors for LBW in Indigenous Population have been receiving little attention, especially in Latin America. The three outcomes showed common causes related to poverty and limited access to healthcare. New studies should ensure explicit criteria for ethnicity, quality on the information about gestational age, and the investigation on contextual and culture-specific variables.

Key words *Indigenous Population, Health Status Disparities, Low birth weight*

http://dx.doi.org/10.1590/1806-93042019000100002

Introduction

Low birth weight (LBW) is defined as a weight less than 2500g at birth and is an important predictor of unfavorable outcomes in the child's health such as acute respiratory infections and diarrhea, delay in the growth and development, and child mortality, besides being associated to cardiovascular diseases in adulthood.[1-3] LBW is frequently reported as a prevalent in low life standard populations.[4]

LBW may result from intrauterine growth restriction (IUGR), prematurity, or both.[1] Some studies only analyze factors associated to LBW,[2,5,6] while others investigate specific factors for the incidence of IUGR[7] or prematurity.[8,9] IUGR has been associated to socioeconomic factors such as low family income, maternal age and marital status, maternal malnutrition (low BMI and height), smoking, and low-quality prenatal care.[7] Meanwhile, prematurity has been more frequently associated to obstetric conditions like placental abruption and infections, but also to socioeconomic conditions, teenage pregnancy, low maternal schooling and inadequate prenatal care.[8,9] In low and middle income countries, such as Brazil, IUGR and preterm childbirth share several common determinants and its, prevalence tend to be high.[4]

Indigenous Population have precarious living conditions and the worst conditions in health when compared to the general population.[10-12] This population is specially affected by poverty, high prevalence of infectious diseases, particularly at childhood, food insecurity, and limited access to healthcare.[11-18] High prevalence has also been reported for malnutrition, anemia, and smoking in childbearing age women,[11,19] as well as greater proportions of home childbirth and low cesarean rates.[20] Although these conditions are related to LBW as a cause or consequence, only few studies have assessed etiological factors for LBW in Indigenous Population worldwide.

For non-indigenous population in Brazil, studies have shown similarities with the international literature in terms of risk factors for LBW. A recent increase in LBW in the country has been related to the growing rates of prematurity due to medical interventions like elective cesareans.[9,21] Despite the broad national and international literature on etiological factors for LBW,[1,2,5,7,16] there are also few specific studies on indigenous population.[13,14] The prevalence of LBW in indigenous children in the country was recently estimated (7.5%) and is similar to the national prevalence of LBW in the general population.[10] However, the prevalence was not estimated by ethnic groups, which can result in inequalities within the indigenous groups.

The combination of multiple risk factors for LBW and the high level of acute respiratory infections, diarrhea, malnutrition, as well as infant mortality in indigenous children reinforce the hypothesis that LBW is a relevant determinant of morbidity and mortality in some indigenous groups in Brazil. However, there may be some differences in the determination of LBW between indigenous and non-indigenous populations, as for example in cesarean rates, and possibly in the contextual factors in these populations. To understand the magnitude of prematurity and IUGR in the composition of LBW in the indigenous population and to identify its etiological factors are essential for intervening effectively in the indigenous health, reducing morbidity and mortality diseases related to poverty.[11] The aim of this study was to identify and analyze factors associated to LBW in indigenous children worldwide, characterizing etiological factors associated to prematurity and IUGR.

Methods

Identification and selection of studies

A systematic review was carried out from scientific literature on factors associated to LBW in indigenous population worldwide. Data were collected in April 2018 through a search on *Medline/PubMed*, *Scopus, Web of Science,* and *Lilacs databases*. The description of this review was based on *Preferred Reporting Items for Systematic Reviews* (PRISMA) guidelines.[22] The protocol of the study was registered and published in the *Centre for Reviews and Dissemination, University of York* (PROSPERO), under the document number CRD42016051145.[23]

No limits were considered for the research, such as language or date of publication. The terms for each research database were designed with the assistance of a library scientist.

For the *SCOPUS* and *Medline/PubMed databases*, the terms used were: ("Risk Factors" OR "Protective Factors") AND ("Premature Birth" OR "Infant Premature" OR "Fetal Growth Retardation" OR "Infant Low Birth Weight") AND ("Indigenous Infants" OR "Native Children" OR "Indigenous Children" OR "Child* Aborigines" OR "Indigenous Population" OR "Indians Central American" OR "Indians North American" OR "Indians South American" OR "Health of Indigenous Infants" OR "Aborigines, Australian" OR "Native Americans" OR "Inuits" OR "First Nations" OR "Alaska Native" OR "American Indians").

In the *Web of Science* and *Lilacs databases*, the terms removed were: "Risk Factors" OR "Protective Factors" and added "Health of Indigenous Infants". In Lilacs, the inclusion of the term Aborigines did not add up to any articles. The inclusion of the terms "population groups", "continental population groups", "tribal", and "etiologic factors" were tested, with no gain in efficiency.

Studies included were based on factors associated to LBW outcomes, prematurity, or IUGR in indigenous populations. Editorials, descriptive articles, and those considering ethnicity as a risk factor, as well as papers which did not present results separately for indigenous individuals were excluded.

Data extraction

The references were managed by Zotero Standalone software. The studies were selected independently by two reviewers and the following stages were included: exclusion of duplicates articles; review of the title and abstract to verify inclusion criteria; full reading of the articles applying the exclusion criteria; and manual search of references from the selected articles by a third reviewer.

A form was used for data extraction with the following information: study identification and author, name of the periodical, and date of publication, data collecting period, sample size, study design, criterion to define ethnicity and its source of information, analyzed outcomes, exposure of the studied variables and the significance of the anaysis model and the control for confounding.

Classification of indigenous population

For the purposes in the study, an attribution of indigenous identity to the child was organized in categories: maternal or paternal ethnicity (self-reported, registered in national or local registries, classified by a health professional, or established by residence in indigenous villages, language spoken, or last name) or the child's ethnicity as registered in the national health registry.

Methodological quality analysis

The quality of the studies was assessed according to five criteria based on the adapted instrument of *Newcastle-Ottawa Scale*[24] for cohort and case-control studies and the STROBE guidelines for cross-sectional studies:[25] (A) used a census or representative probabilistic sample of the target population; (P) having fewer than 20% of losses; (I) having the adjusted LBW by gestational age (GA) or analyzed the IUGR and prematurity separately; (E) having a description of the criteria used to classify the population as indigenous; and (C) having the estimates of the adjusted effect controlling confounded factors. One point was assigned for each fulfilled criterion. The total score could vary from zero to five.

Results

The reference search resulted in the selection of 286 (103 in Scopus, 8 in Web of Science, 110 in Lilacs, and 65 in Medline). After excluding 74 duplicates, 212 titles and abstracts were read and 155 were excluded because they did not fit the eligibility criteria. Afterwards, 57 of them were fully read, 33 were excluded for the reasons shown in Figure 1. The reference manual search of the 23 selected articles resulted in the identification of one more article, totalizing 24 articles in the systematic review (Figure 1).

All the articles for the review were published in English. More than half (14/24 -58.3%) were from the USA and Canada, followed by Australia (6/24 – 25.0%). Only one article from Latin America was identified, it was from Chile. A cross-sectional design was used in 12/24 studies (50.0%), followed by a cohort design (9/24 - 31.8%) (Table 1).

In most of the studies, the authors defined the newborns as indigenous based on secondary registrations of the infants or of their parents (local or national information systems, the father's and/or the mother's birth certificate, and the mother's medical record. Fourteen of the 24 studies failed to specify the classification criteria for ethnicity. Of the 24 studies, only 3 attributed to the child's ethnicity by the mother's or father's self-declared at the time of the study, in other words, as a primary data source (Table 2).

Only four articles met all the established quality criteria, and nine did not meet any of the quality criteria. Nine articles studied birth weight without adjusting for GA or differentiating between prematurity and IUGR. In six studies, no adjustment was made for the confounding variables, and three of them only made comparisons between proportions or means. Among the five criteria adopted to analyze the quality of the articles, the worst one was the description of the criteria used to classify ethnicity (Table 3).

Table 4 and 5 show the variables explored as factors associated to LBW, prematurity, and IUGR and the respective measures of association. The most frequently studied variables were: maternal smoking, evaluate mainly the number of cigarettes smoked per day, followed by maternal age.

Figure 1

Flow chart of the systematic review on factors associated to low birth weight in indigenous children.

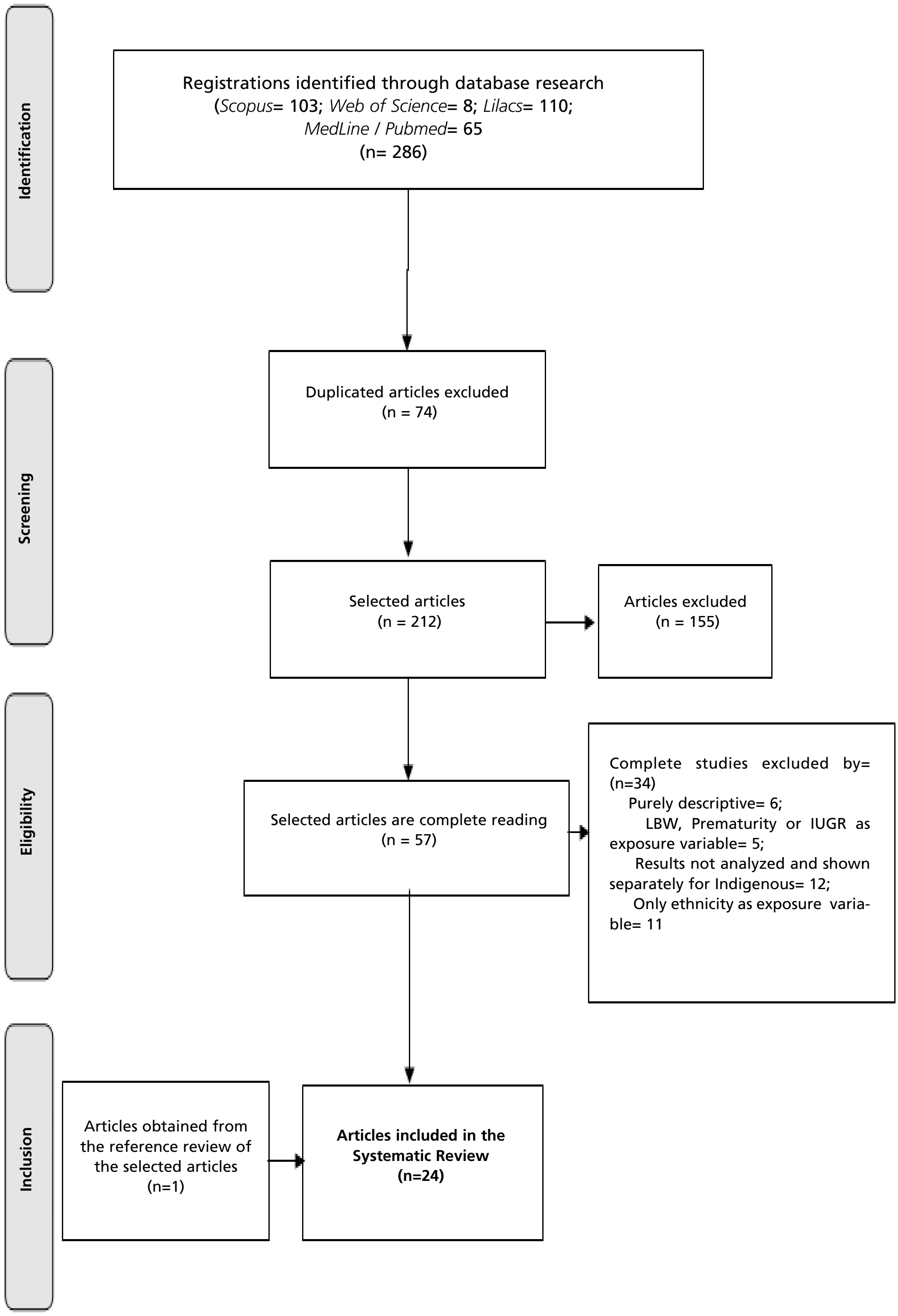

Table 1

Studies identified by author, year of publication, country, and year of data collecting, sample size, and study design.

Author(s)	Year of Publication	Country (year of data collecting)	Total sample indigenous		Study design
			n	%	
Abdulrazzaq *et al.*[26]	1995	Emirados Árabes Unidos (1992-1993)	3485	100.0	Case-Control
Kieffer *et al.*[27]	1995	EUA - Havaí (1979-1990)	7474	100.0	Cross-Sectional
Murphy *et al.*[28]	1996	EUA (1989-1991)	8994	100.0	Cross-Sectional
Sayers e Powers[29]	1997	Austrália (1987-1990)	503	100.0	Cross-Sectional
Rousham e Gracey[30]	1998	Austrália (1981-1993)	4508	100.0	Cross-Sectional
Abel *et al.*[31]	2002	EUA (1978-1992)	156512	8.6	Cross-Sectional
Baldwin *et al.*[32]	2002	EUA (1989-1991)	148482	100.0	Cross-Sectional
Emanuel *et al.*[33]	2004	EUA (1992–1995)	5626	15.9	Cohort
Muggah *et al.*[34]	2004	Canadá (1998-2000)	938	89.0	Cross-Sectional
Heaman *et al.*[35]	2005	Canadá (1999-2000)	684	37.7	Case-Control
Gilbreath e Kass[36]	2006	EUA (1997-2001)	10073	71.0	Cohort
Panaretto *et al.*[37]	2006	Austrália (2000-2003)	456	100.0	Cohort
Yang *et al.*[38]	2006	China (2003)	1143	100.0	Cross-Sectional
Graham *et al.*[39]	2007	Austrália (2001 – 2004)	35240	100.0	Cross-Sectional
Simonet *et al.*[40]	2009	Canadá (1989-2000)	2726	100.0	Cohort
Mehaffey *et al.*[41]	2010	Canadá (2003-2005)	918	100.0	Cross-Sectional
Wojtyniak *et al.*[42]	2010	Groelândia[1], Ucrânia e Polônia (2002 – 2004)	1702	35.1	Cohort
Coughlin *et al.*[43]	2013	EUA (1998-2008)	4149	100.0	Cohort
England *et al.*[44]	2013	EUA-Alaska (1997-2005)	1104	100.0	Case-Control
Dorfman *et al.*[45]	2015	EUA-Alaska (2004-2011)	12420	100.0	Cohort
Rothhammer *et al.*[46]	2015	Chile (2004-2010)	5295	24.2	Cross-Sectional
Brown *et al.*[47]	2016	Austrália (2011-2013)	337	100.0	Cross-Sectional
Oster e Toth[48]	2016	Canadá (2000-2009)	426945	6.6	Cohort
Kildea *et al.*[49]	2017	Austrália (2004-2006/2009-2011)	713	100.0	Cohort

[1] Only the data from Greenland were used, the only country that studied indigenous population (Inuit).

Table 2

Source of information , form and attribution and classification for the child's race/ethnicity.

References	Source of information on race and / or ethnicity	Criterion for the child's race and / or ethnicity	Race / Ethnicity
Abdulrazzaq *et al*.[26]	Maternal medical file	Not specified	Indigenous Population/ Bedouins
Kieffer *et al*.[27]	National live births database	Maternal ethnicity registered on mother's birth certificate	Samoan and Hawaiian
Murphy *et al*.[28]	National live births database	Not specified	Alaska Native
Sayers e Powers[29]	Interview with mother	Self-reported maternal ethnicity	Aboriginal
Rousham e Gracey[30]	Regional health monitoring program	Not specified	Aboriginal
Abel *et al.*[31]	Maternal classification in information systems of the State Health Department	Not specified	Native American
Baldwin *et al*.[32]	Mother's or father's birth registration in the national information system	Not specified	American /Alaska Natives
Emanuel *et al*.[33]	Birth certificate	Not specified	Native Americans
Muggah *et al*.[34]	Hospital registrations	Maternal ethnicity classified by health professional	Inuit
Heaman *et al*.[35]	Interview with mother in hospital after childbirth	Self-reported maternal ethnicity	Aboriginal
Gilbreath e Kass[36]	Vital statistics bank	Maternal ethnicity defined by residence in federally acknowledged native villages	Alaska Native
Panaretto *et al*.[37]	National live births bank	Self-reported maternal or paternal ethnicity	Aboriginal and Torres Strait Natives
Yang *et al*.[38]	Hospital registrations	Not specified	Aboriginal
Graham *et al*.[39]	Maternal ethnicity in national bank of perinatal data	Not specified	Aboriginal and Torres Strait Natives
Simonet *et al*.[40]	Identification of mother tongue in national vital statistics bank	Maternal ethnicity defined by language spoken by mother	Inuit
Mehaffey *et al*.[41]	Hospital registrations	Not specified	Inuit
Wojtyniak *et al*.[42]	Interview with mother and partner	Not specified	Inuit
Coughlin *et al*.[43]	Mother or father's registration in a federally recognized tribe in the national birth registry	Paternal or maternal ethnicity registered in federally acknowledged village	American Indian
England *et al*.[44]	Hospital registrations	Not specified	Alaska Native
Dorfman *et al*.[45]	Birth certificate	Not specified	American Indians/Alaska Natives
Rothhammer *et al*.[46]	Hospital registrations	Maternal ethnicity defined according to mother's last name	Aymara
Brown *et al*.[47]	Interview or filling out questionnaire	Not specified	Aboriginal and/or Torres Strait Natives
Oster e Toth[48]	Health insurance plan registrations	Ethnicity registered on health insurance plan	First Nations and Inuit
Kildea *et al*.[49]	Health centers registrations	Not specified	Aboriginal

Table 3

Studies identified in bibliographic research according to outcome, the use of statistical analysis, and quality assessment.

References	Outcome	Statistical analysis	Quality assessment[1]					
			A	P	I	E	C	Total
Oster e Toth[48]	LBW	Logistic regression and multiple linear	1	1	1	1	1	5
Coughlin *et al*.[43]	LBW; Prematurity; SGA	Multiple logistic regression	1	1	1	1	1	5
Simonet *et al*.[40]	LBW; Prematurity; SGA	Multilevel logistic regression	1	1	1	1	1	5
Panaretto *et al*.[37]	LBW; Prematurity; SGA	Multiple logistic regression	1	1	1	1	1	5
Heaman *et al*.[35]	Prematurity	Multiple logistic regression.	1	0	1	1	1	4
Kieffer *et al*.[27]	Birth weight	Logistic regression and multiple linear	1	1	0	1	1	4
Wojtyniak *et al*.[42]	Birth weight; Prematurity	Logistic regression and multiple linear	1	1	1	0	1	4
Graham *et al*.[39]	LBW; prematurity	Multiple logistic regression	1	1	1	0	1	4
England *et al*.[44]	Prematurity	Multiple logistic regression	1	1	1	0	1	4
Brown *et al*.[47]	LBW; Prematurity; SGA	Multiple logistic regression	1	1	1	0	1	4
Kildea *et al*.[49]	LBW; prematurity; SGA	Multiple logistic regression	1	1	1	0	1	4
Muggah *et al*.[34]	Prematurity	Pearson correlation and ANOVA (bivariate)	1	1	1	1	0	4
Dorfman *et al*.[45]	Prematurity	Multiple logistic regression	1	1	1	0	1	4
Gilbreath e Kass[36]	Birth weight	Covariance multivariate analysis	1	0	0	1	1	3
Rothhammer *et al*.[46]	Birth weight	Comparison of means[2]	1	1	0	1	0	3
Baldwin *et al*.[32]	LBW	Multiple logistic regression	1	1	0	0	1	3
Mehaffey *et al*.[41]	LBW; Prematurity; SGA	Univariate logistic regression	1	1	1	0	0	3
Simonet *et al*.[40]	LBW; prematurity; IUGR	Multiple logistic regression	0	0	1	1	1	3
Abel *et al*.[31]	LBW; Prematurity	Multiple logistic regression	1	0	1	0	1	3
Abdulrazzaq *et al*.[26]	LBW	Univariate logistic regression	1	1	0	0	0	2
Emanuel *et al*.[33]	LBW	Multiple correlation	1	0	0	0	1	2
Yang *et al*.[38]	LBW	Multiple logistic regression	0	1	0	0	1	2
Rousham e Gracey[30]	Birth weight	Univariate logistic regression	1	1	0	0	0	2
Murphy *et al*.[28]	Birth weight	Comparison of means (t-test)	1	0	0	0	0	1
	Total articles per item		22	18	15	10	18	-

[1](A) census or representative probabilistic sample of the target population; (P) proportion of losses less than 20%; (I) adjustment performed for gestational age or differentiated between prematurity and SGA/IUGR as outcomes; (E) description of the criterion used to classify the population as indigenous; (C) adjusted effects estimates with control for confounding factors. [2] Study describes that it performed multiple regression, but did not show the results, the table only shows the comparison among means.

Table 4

Obstetric and maternal factors associated to LBW, prematurity and IUGR, with association measurements, CI95% or *p*.

Associated factors	References	Birth weight		Prematurity		IUGR / SGA	
		Association Measurement	CI / *p*	Association Measurement	CI / *p*	Association Measurement	CI / *p*
Obstetric factors							
Prolonged rupture of membranes	Sayers e Powers[29]	-	-	OR= 18.7*	5.9 - 59.7	_	_
Premature rupture of membranes	Abdulrazzaq *et al*.[26]	OR= 6.2	1.3 - 27.04	-	-	_	_
	Gilbreath e Kass[36]	-	-	OR= 12.7*	5.31 - 30.39	_	_
Primiparous (and ≥18 years)	Kieffer *et al*.[27]	β= -151.3*	*p*<0.01	-	-	_	_
		OR= 1.43*	1.05 - 1.94	-	-	_	_
Parity 0 (Ref.1 or 2 children)	Oster e Toth[48]	OR= 1.07*	1.02 - 1.13	-	-	_	_
Parity (Ref. Multiparous)	Kildea *et al*.[49]	OR= 3.06*	1,68 - 5.58	NS	NS	OR=1.89*	1.25 - 2.86
Parity (and ≥18 years)	Kieffer *et al*.[27]	β= 142.0*	*p*<0.01	-	-	-	-
Multiple gestation	Oster e Toth[48]	OR= 16.31*	14.0 - 19.0	-	-	-	-
Pregnancy-induced hypertension	Sayers e Powers[29]	NS	NS	OR= 12.7*	5.2 - 30.9	NS	NS
	Heaman *et al*.[35]	-	-	OR= 7.51*	2.11 - 26.76	-	-
	Panaretto *et al*.[37]	NS	NS	NS	NS	POR= 6.1*	1.8 - 20.4
	Dorfman *et al*.[45]	-	-	OR= 1.89	1.49 - 2.40	-	-
	Panaretto *et al*.[37]	POR= 8.2*	1.7 - 40.3	NS	NS	POR= 7.4*	1.1 - 50.1
Pre-history of stillbirth	Panaretto *et al*.[37]	POR= 7.6*	2.5 - 22.8	NS	NS	NS	NS
	Oster e Toth[48]	OR= 2.18*	1.73 - 2.74	-	-	-	-
History of LBW	Abdulrazzaq *et al*.[26]	OR= 2.23	1.48 - 3.33	-	-	-	-
	Oster e Toth[48]	OR= 1.40*	1.20 - 1.63	-	-	-	-
Pre-history of neonatal death	Oster e Toth[48]	OR= 1.55*	1.11 - 2.17	-	-	-	-
Pre-history of prematurity	Oster e Toth[48]	OR= 1.76*	1.59 - 1.94	-	-	-	-
	Heaman *et al*.[35]	-	-	OR= 4.32*	1.67 - 11.22	-	-
	Panaretto *et al*.[37]	NS	NS	POR= 18.5*	6.7 - 51.2	-	-
	Kildea *et al*.[49]	NS	NS	OR= 2.07*	1.26 - 3.41	NS	NS
Pre-history of Small to GA	Oster e Toth[48]	OR= 3.64*	2.60 - 5.09	-	-	-	-
Diabetes	Dorfman *et al*.[45]	-	-	OR= 1.83*	1.21 - 2.78	-	-
Diabetes or HBP	Graham *et al*.[39]	OR= 1.44*	1.32 - 1.57	NS	NS	-	-
Preexisting HBP	Oster e Toth[48]	OR= 3.44*	2.39 - 4.94	-	-	-	-
Chronic renal disease	Oster e Toth[48]	OR= 3.18*	1.23 - 8.18	-	-	-	-
Antepartum hemorrhage and / or placental complication	Kildea *et al*.[49]	-	-	OR= 5.59*	2.49 - 12.56	-	-
Hospitalization during pregnancy	Heaman *et al*.[35]	-	-	OR= 3.27*	1.28 - 8.33	-	-
Other obstetric problems	Sayers e Powers[29]	NS	NS	OR= 15.7*	5.0 - 44.9	NS	NS

continue

* Variables that were adjusted in multiple models. [1] R^2: multiple correlation coefficients; OR= *Odds Ratio*; NS= Non significant; POR= Prevalence *Odds Ratio*.

Table 4 **continuation**

Obstetric and maternal factors associated to LBW, prematurity and IUGR, with association measurements, CI95% or *p*.

Associated factors	References	Birth weight		Prematurity		IUGR / SGA	
		Association Measurement	CI / *p*	Association Measurement	CI / *p*	Association Measurement	CI / *p*
Maternal behavioral factors:							
Maternal smoking	Oster e Toth[48]	OR= 1.29*	1.17 - 1.43	-	-	-	-
	Graham *et al.*[39]	OR= 1.80*	1.66 - 1.95	NS	NS	-	-
	Mehaffey *et al.*[41]	OR= 3.8	1.4 - 10.5	NS	NS	OR= 2.5	1.1 - 5.4
	Panaretto *et al.*[37]	NS	NS	NS	NS	OR= 3.7*	1.2 - 11.4
No (reference)	Kildea *et al.*[49]	NS	NS	1	1	NS	NS
Yes	Kildea *et al.*[49]	NS	NS	OR= 1.00	0.58 - 1.74	NS	NS
Not Registered	Kildea *et al.*[49]	NS	NS	OR= 3.35*	1.90 - 5.89	NS	NS
>10 cigarettes a day	-	OR= 6.7	2.3 - 19.6	OR= 2.1	1.1 - 4.2	OR= 3.7	1.6 - 8.8
>1/2 pack a day	Sayers e Powers[29]	OR= 2.8*	1.3 - 6.1	NS	NS	OR= 1.8*	1.1 - 3.0
Betel chewing	Yang *et al.*[38]	OR= 1.7*	1.07 - 2.72	-	-	-	-
Alcohol use	Oster e Toth[48]	OR= 1.45*	1.26 - 1.67	-	-	-	-
Maternal behavioral factors							
Alcohol abuse	Panaretto *et al.*[37]	NS	NS	NS	NS	POR= 7.4*	1.1 - 50.1
Drug use	Oster e Toth[48]	OR= 2.05*	1.76 - 2.39	-	-	-	-
Marijuana use during pregnancy	Brown *et al.*[47]	OR= 3.9*	1.4 - 11.2	NS	NS	NS	NS
Maternal nutrition							
Maternal BMI <18.5 (postpartum)	Sayers e Powers[29]	OR= 5.1*	2.1 - 12.0	NS	NS	OR= 2.5*	1.4 - 4.6
Maternal BMI>25 (1st prenatal visit)	Panaretto *et al.*[37]	1.0	-	1.0	-	NS	NS
Maternal BMI 20 to 24.9		NS	NS	POR= 2.0*	1.2 - 3.2	NS	NS
Maternal BMI<20		POR= 5.5*	2.0 - 14.6	POR= 4.9*	1.5 - 15.9	NS	NS
Maternal birth weight	Emanuel *et al.*[33]	R^2= 3.87%	*p*<0.001	-	-	-	-
Maternal height	Emanuel *et al.*[33]	R^2= 4.16%*	*p*<0.001	-	-	-	-
Low gestational weight gain (<9.1kg)	Heaman *et al.*[35]	-	-	OR= 8.95*	1.86 - 42.94	-	-
Pre-gestational weight	Emanuel *et al.*[33]	R^2= 6.16%*	*p*<0.001	-	-	-	-
Pre-gestational weight<45kg	Oster e Toth[48]	OR= 1.82*	1.01 - 2.99	-	-	-	-
Pre-gestational weight>91kg	Oster e Toth[48]	OR= 0.54*	0.46 - 0.64	-	-	-	-
Anemia (ref. No)	Kildea *et al.*[49]	NS	NS	OR= 0.51*	0.33 - 0.80	NS	NS

continue

* Variables that were adjusted in multiple models. [1] R^2: multiple correlation coefficients; OR= *Odds Ratio*; NS= Non significant; POR= Prevalence *Odds Ratio*.

Table 4 **concluded**

Obstetric and maternal factors associated to LBW, prematurity and IUGR, with association measurements, CI95% or *p*.

Associated factors	References	Birth weight		Prematurity		IUGR/SGA	
		Association Measurement	CI / *p*	Association Measurement	CI / *p*	Association Measurement	CI / *p*
Prenatal							
Inadequate prenatal care	Wells *et al.*[24]	β= 43.3*	*p*<0.01	-	-	-	-
≤ 3 prenatal consultations	Panaretto *et al.*[37]	NS	NS	POR= 3.4*	1.4 - 8.1	NS	NS
Recommended number of antenatal consultations (Ref.yes)	Kildea *et al.*[49]	NS	NS	OR= 2.16*	1.27 - 3.42	NS	NS
Childbirth conditions:							
History of cesarean	Oster e Toth[48]	OR= 1.24*	1.09 - 1.42	-	-	-	-

* Variables that were adjusted in multiple models. [1] R^2: multiple correlation coefficients; OR= *Odds Ratio*; NS= Non significant; POR= Prevalence *Odds Ratio*.

Table 5

Sociodemographic and environmental factors associated to LBW, prematurity, and IUGR, with association measurements, CI95% or *p*.

Associated factors	**References**	**Birth weight**		**Prematurity**		**IUGR / SGA**	
		Association Measurement	CI / *p*	Association Measurement	CI / *p*	Association Measurement	CI / *p*
Infant 's Sex (ref. Male)	Kieffer *et al.*[27]	OR=2.10*	1.17 - 3.78	OR= 1.74*	1.12 - 2.69	NS	NS
Maternal characteristics:							
Mother single	Oliveira *et al.*[51]	β= - 67.5*	*p*<0.01	-	-	-	-
age <20 years	Santos *et al.*[53]	NS	NS	NS	NS	OR= 1.9*	1.2 - 2.9
age <19 years	Gilbreath e Kass[36]	-	-	OR= 0.19*	0.04 - 0.89	-	-
age ≥18 years and primiparous	Oliveira *et al.*[51]	β= -151.3*	*p*<0.01	-	-	-	-
		OR= 1.43*	1.05 - 1.94	-	-	-	-
age ≥18 years and high parity	Oliveira *et al.*[51]	β= 142.0*	*p*<0.01	-	-	-	-
age 17 years	Abdulrazzaq *et al.*[26]	OR= 0,76*	0.62 - 0.94	-	-	-	-
age ≥35 years	Abdulrazzaq *et al.*[26]	OR= 1.61*	1.39 - 1.87	-	-	-	-
age 18 to 34 years	Abdulrazzaq *et al.*[26]	1.00	-	-	-	-	-
age 21 to 24 years	Oster e Toth[48]	-	-	1.00	-	-	-
age ≥35 years	Oster e Toth[48]	-	-	OR= 2.09	1.45 - 3.00	-	-
age <20 years	Kieffer *et al.*[27]	NS	NS	OR= 1.69*	1.04 - 2.76	NS	NS
age 20-34	Kieffer *et al.*[27]	NS	NS	1.00	-	NS	NS
High schooling	Abel *et al.*[31]	β= 75.2*	*p*<0.01	-	-	-	-
		OR= 0.61*	0.41 - 0.92	-	-	-	-
Education >12 years	-	-	-	1.00	-	-	-
Education 12 years	Oster e Toth[48]	-	-	OR= 1.38	1.08 - 1.76	-	-
Education <12 years	-	-	-	OR= 1.58	1.22 - 2.05	-	-
Physical abuse with lesions	Abel *et al.*[31]	OR= 2.43*	1.06 – 5.55	-	-	-	-
Environmental conditions							
Maternal serum CB 153 concentration	Sayers e Powers[29]	β= -59.2*	-100.6 / -17.8	NS	NS	-	-
Maternal serum p.p-DDE log concentration	Sayers e Powers[29]	β= -56.0*	-99.5 / -12.5	NS	NS	-	-
Open dumpsite in village - Low contamination	Wojtyniak *et al.*[42]	Reference	-	-	-	-	-
High contamination	Wojtyniak *et al.*[42]	Mean Dif.= -77.3*	-138.1 / 16.6	-	-	-	-
Rainy season (Birth weight<1500g)	Murphy *et al.*[28]	OR= 2.73	2.03 - 3.67	-	-	-	-
Dry season	Murphy *et al.*[28]	1	-	-	-	-	-
Living in rural area	Kildea *et al.*[49]	OR= 0.89*	0.85 - 0.93	-	-	-	-
Living in remote area	Baldwin *et al.*[32]	OR= 1.09*	1.01 – 1.19	NS	NS	-	-

continue

*Variables that were adjusted in multiple models. [1] R^2= multiple correlation coefficients. [2] Healthy Start Program (HS) - Each HS works within a specific tribal service area. All the clients will receive a nurse's visit to assess the individualized, medical, social, and educational needs based on the risks identified, referrals for the necessary services, monthly home visits during pregnancy, and additional services according to as needed. OR= *Odds Ratio*; NS= Non significant; POR= Prevalence *Odds Ratio.*

Table 5 **concluded**

Sociodemographic and environmental factors associated to LBW, prematurity, and IUGR, with association measurements, CI95% or *p*.

Associated factors	**References**	**Birth weight**		**Prematurity**		**IUGR / SGA**	
		Association Measurement	**CI / *p***	**Association Measurement**	**CI / *p***	**Association Measurement**	**CI / *p***
Socioeconomic factors							
Grouped socioeconomic factors (maternal age, parity, schooling, and prenatal care)	Dorfman *et al.*[45]	R^2= 9.53%*	p<0.001	-	-	-	-
Paternal age	England *et al.*[44]	OR= 1.04*	1.01 - 1.08	NS	NS	-	-
Participant in HS[2], does not live in difficult-to-reach access area	Brown *et al.*[47]	OR= 0.37*	0.14 - 0.96	NS	NS	NS	NS

*Variables that were adjusted in multiple models. [1] R^2= multiple correlation coefficients. [2] Healthy Start Program (HS) - Each HS works within a specific tribal service area. All the clients will receive a nurse's visit to assess the individualized, medical, social, and educational needs based on the risks identified, referrals for the necessary services, monthly home visits during pregnancy, and additional services according to as needed. OR= *Odds Ratio*; NS= Non significant; POR= Prevalence *Odds Ratio*.

Considering only the variables adjusted for confounding, the main risk factors for prematurity were: obstetric conditions such as prolonged and premature rupture of the membranes, pregnancy-induced hypertension, diabetes and obstetric history of prematurity; hospitalization during pregnancy; maternal malnutrition, defined as pre-gestational maternal BMI <20, low gestational weight gain (<9.1kg) or anemia; low number of prenatal consultations; and low maternal age (<19 years) as a protective factor. For IUGR featured smoking and alcohol abuse during pregnancy; maternal malnutrition (BMI <18.5); obstetric conditions like pregnancy-induced hypertension and urinary tract infection; and low maternal age (<20 years).

Factors associated to LBW included the same ones as for prematurity and IUGR, plus featuring those related to specific indigenous environmental contexts, like inadequate waste disposal; environmental contamination with persistent organic pollutants; rainy season (versus dry seasons); reside in villages located in rural or remote areas; and have limited access to health services.

Discussion

The studies identified in this review were concentrated in 3 countries (Australia, Canada, and USA).

This fact does not only restrict itself to studies on birth weight, but also studies were observed on adverse pregnancy or neonatal outcomes in indigenous populations.[15,48] These studies are rare in Latin America although 10% of its population may be indigenous and the region concentrates one of the greatest ethnic diversities in the world.[12]

The literature on etiological factors for LBW in indigenous population is incipient, especially when comparing to non-indigenous population. However, there are similarities between the two groups about factors associated to LBW, prematurity and IUGR.

IUGR has been reported as the main component of LBW in indigenous population,[48] unlike the observations made in the general population. Nevertheless, this outcome was only studied in 7 of the 24 studies. IUGR was associated to maternal smoking and alcohol abuse, maternal malnutrition, and hypertension and infections in the pregnancy, all these factors are considered to be modifiable by improving the living conditions and having access to health services. On the other hand, prematurity was investigated in more than half of the studies in this review, and its etiological factors were mostly obstetric conditions. The low cesarean rates in indigenous population[20,49] indicate that prematurity in these groups may result in a spontaneous premature delivery, resulting in an adverse obstetric conditions, maternal malnutrition, and limited access to prenatal care.[8] Spontaneous premature childbirth has complex and multifactorial causes related to infections or inflammations in pregnancy, besides economic and social vulnerability, which are highly prevalent conditions in indigenous peoples.[8,9,11]

Maternal smoking was a risk factor most frequently associated to LBW in indigenous population. Sayers and Power[29] reported 18% attributable the risk of industrialized cigarettes for the LBW outcome and 10% for IUGR. Mehaffey *et al*.[41] investigated smoking in the first trimester of pregnancy and identified a significant dose-response effect for the three investigated outcomes (LBW, prematurity, and IUGR), even though the associations were only estimated as gross. However, other studies that presented adjusted estimates have reiterated this association.[29,34,38-40,47]

The difficulty in measuring tobacco exposure is a problem in the studies with indigenous populations.[26,35] Difficulties are reported in quantifying the number of cigarettes smoked, since industrialized tobacco tends to be used intermittently and depends on the availability of monetary resources. It is also difficult to measure the consumption of tobacco in other forms, such as chewing, domestic preparations with or without mixing other substances,[35] and pipe smoking for recreational or religious purposes.[50] Thus, studies on factors associated to LBW in indigenous population should develop strategies to measure accurately, in different contexts, the type of tobacco consumed, doses, periods, and the duration of exposure during pregnancy.

Some studies found in this review describe an inverse association between maternal age and LBW, which is commonly reported in non-indigenous populations.[2,6,51] In the Western societies, this association has been attributed to biological immaturity in adolescence and social determinants such as inadequate prenatal care and fragile social support networks, or pregnancy rejection by the family or the partner.[51] However, two studies found a direct association between LBW and maternal age.[30,35] The authors discussed that the indigenous women's health deteriorates more rapidly with age due to the conditions of poverty and high fertility. A second hypothesis emerged from a community focus group, when it was reported that younger pregnant women tend to receive more family and community support.

The effect of maternal age on LBW can differ according to the level of development in the country and its regions. In population with high socioeconomic status and adequate prenatal care, the negative perinatal effects of maternal age are minimized, reinforcing the relation between LBW and social and economic factors, especially in women under 20 years old.[52,53] Such findings suggest that the effect of maternal age can be expressed in different ways, depending on the local contexts. For example, in different indigenous communities, pregnancy before 20 years of age is not viewed negatively,[54] which could explain the direct association between maternal age and LBW found in the two studies.

Low maternal BMI and low pre-gestational maternal weight were associated to LBW. A study carried out on aborigines in Australia[29] found an inverse association between postpartum maternal BMI and LBW. The authors discussed that the prevalence of maternal malnutrition would be higher if measured in early pregnancy, recommending nutritional rehabilitation of pregnant women to reduce the risk of fetal malnutrition.[29] In the same line, a study on indigenous population in Manitoba, Canada,[35] showed an association between low gestational weight gain and prematurity.

In relation to environmental factors, a study carried out in Alaska showed that a mean birth weight was lower in indigenous villages that lacked adequate trash disposal. This effect probably resulted on water and soil contamination and inhalation of potentially toxic smoke due to burning residues.[36]

Another environmental factor studied was the seasonality. Children born in the rainy season were more likely to have been born with very low birth weight (<1,500g), due to the scarcity and difficult access to food, crowding, and confinement in the home and higher risk of environmental contamination and infection. This scenario reinforces the hypothesis that LBW results from the adverse socioeconomic and environmental situations to which indigenous population are exposed.[30]

Living in rural areas showed controversial effects in relation to the risk of LBW. According to Baldwin *et al.*[32], close and permanent contact with urban centers can result in worse living conditions for indigenous population. Villages located close to urban centers tend to have smaller territories, limiting their food plantation, hunting and fishing. However, Graham *et al.*[39] reported higher risk of LBW in remote areas due to greater difficulty in access to the health services, as prenatal care. Coughlin *et al.*[43] observed an attenuation of this effect when the community has access to health services, particularly when it is located in the village and culturally adapted.

The investigation of environmental factors has advanced and proven to be relevant in the studies on the determination of LBW in indigenous populations.[32,37,39,43,45] In the other hand, socioeconomic factors[34,38,49] have received little attention, demonstrating to be less relevant in the determination of LBW. A possible explanation is the relative socioeconomic homogeneity of indigenous groups,[30] which is not possible to capture this differentiation with the usual socioeconomic indicators. This would require the development of more sensitive indicators to capture the inequalities in different indigenous contexts.

Six of the 24 articles were methodologically less robust, since they did not adjust for confounding, although their results are consistent with the literature in non-indigenous populations. We would like to highlight the frequent lack of information on the methods or criteria in defining indigenous individuals. According to Smyliea and Firestone,[55] this fact limits the interpretation of the results, since the allocation of indigenous individuals to other racial or ethnic categories and vice versa underestimates the inequalities in the health indicators between indigenous and non-indigenous groups, limiting the identification of needs and contributing to the marginalization of these people.[10] In addition, explicit criteria allow better comparability among studies and facilitates the understanding of the studied contexts.

Therefore, considering to be essential, studies on etiological factors for LBW in indigenous population present adjusted association measurements which specify the methods for racial ethnic classification, and inform gestational age (GA), indicating the sources and its form to estimate. Studies are needed to ensure the best source of data collection on GA, since correct GA is essential to differentiate between LBW due to prematurity and LBW due to IUGR, and such information is still scarce for indigenous populations worldwide.[30,37] New studies should be recommended for further examine specific contextual variables in these populations, as climate and environmental conditions, location and type of housing, proximity to urban centers, structure and organization of local health services, and culture-specific behavioral factors as tobacco and other substances use and exposure to pollutants and contaminants.

Conclusions

Low birth weight has received little attention in indigenous population when compared to the non-indigenous population, and Latin America is considered the poorest and most populous regions and, is underrepresented. The risk factors identified in the review are similar to those of the general population as obstetric causes, maternal nutritional conditions, access to health services, and environmental conditions, and are modifiable by actions of the health services in partnership with other sectors.

Prematurity and IUGR show common causes related to poverty and limited access to health services. The studies lack quality and methodological clarity on relevant aspects in order to guarantee their comparability. More studies are necessary on factors related to LBW in indigenous population in Latin America. Investment is needed to have access in the high-quality prenatal care and to decrease the prevalence of prematurity and IUGR related to morbidity and mortality among the indigenous population.

Contribution of the authors

Barreto CTG and Cardoso AM - participated in the design of the study, selection of articles to be included in the study, interpretation of the data and writing of the article. Tavares FG selection of articles to be included in the study. Theme-Filha M - interpretation of the data and writing of the article. All authors approved the final version of the manuscript.

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Received on June 11, 2018

Final version presented on January 09, 2019

Approved on January 25, 2019