Maternal and Child Health Journal (2022) 26:2079–2089
https://doi.org/10.1007/s10995-022-03474-7

Severe Adverse Maternal and Neonatal Outcomes in Adolescent Mother-Newborn Dyads: A Multicentre Study in Latin America

Leticia Suárez-López[1] · Dolores González-Hernández[1] · Elvia de la Vara-Salazar[1] · Lourdes Campero[1] · Guillermo Carroli[2] · Eduardo Ortiz-Panozo[1]

Accepted: 17 July 2022 / Published online: 9 August 2022

Abstract

Objectives To compare the risk of severe adverse maternal outcomes (SMO) and neonatal outcomes (SNO) and analyse their maternal correlates in adolescent mother-newborn and young mother-newborn dyads in secondary and tertiary care users in Latin America.

Methods We performed a secondary analysis of the WHO Multicountry Survey on Maternal and Newborn Health database in 83 secondary and tertiary hospitals in seven countries in Latin America. We constructed a composite indicator of both SMO and SNO and estimated odds ratios (OR) comparing adolescent mothers (aged 12–19) with young mothers (aged 20–24). Our unit of analysis was the mother-newborn dyad.

Results We found that the combination of SMO and SNO was three times more likely in adolescent mother as compared to young mother dyads (OR 3.56; 95% CI 1.67–7.59). SNO either alone or in combination with SMO were more likely in adolescents aged 12 to 16 than in young women (OR 1.27 and 4.87, respectively).

Conclusions for Practice Adolescent mothers and their newborns are at an increased risk of severe adverse outcomes during child birth and in the first week postpartum compared to young mother dyads, especially young adolescents. Focusing on the dyad as a whole may facilitate a step towards integrated care which maximizes the health benefits of both mother and newborn. Continued efforts are needed to improve health care and prevention initiatives directed towards adolescent women and their newborns in Latin America.

Keywords Adverse outcomes · Maternal death · Perinatal death · Adolescent · Latin America

Significance

What is already known on this subject? Globally, the evidence shows that adolescent mothers are the most vulnerable group in terms of adverse maternal and neonatal health outcomes in comparison with young women. The situation is aggravated in Latin America where the prevalence of teenage pregnancy is high.

What this study adds? Information on the state of health status of the mother and newborn simultaneously, as a dyad, for comprehensive understanding of the problem of extreme morbidity and mortality, especially in young adolescents. These findings can be useful for stakeholders in order to improve health care and prevention initiatives directed towards adolescent women and their newborns.

Background

In 2017, 194 thousand deaths of women with maternal disorders and 1.78 million neonatal deaths (ND) were reported worldwide (GBD 2017 Causes of Death Collaborators, 2018). Maternal deaths (MD) and ND are concentrated in low and middle-income countries, including Latin American countries (UNICEF, 2016). However, within the region the burden experienced differs between countries; Nicaragua and Paraguay display the highest figures of MD, while Mexico and Brazil have the lowest. In addition, disparities in

✉ Eduardo Ortiz-Panozo
eduardo.ortiz@insp.mx

[1] Centre for Population Health Research, National Institute of Public Health, Av. Universidad 655. Col. Santa Maria Ahuacatitlan, 62100 Cuernavaca, Morelos, Mexico

[2] Centro Rosarino de Estudios Perinatales, Mariano Moreno 878, S2000DKR Rosario, Santa Fe, Argentina

ND were also reported; Argentina exhibits a rate of 6 deaths per 1000 live births while Ecuador and Paraguay show rates of 11 deaths per 1000 live births (UNICEF, 2016).

Globally, adolescent mothers are the most vulnerable group in terms of adverse maternal and neonatal health outcomes. Adolescent pregnancy rates in Latin America are high (Ganchimeg et al., 2014), and it is estimated that one out of five women will have her first pregnancy before age 20 (Cluet de Rodríguez et al., 2013). A pregnant adolescent woman, compared to an adult, is at a greater risk of preterm delivery, intrauterine growth restriction and low birth weight (Barrera-de Leon et al., 2014; Conde-Agudelo et al., 2005). The two latter conditions are determined by the adolescent's nutritional status and the process of growth that characterizes this stage (Verdura et al., 2011). Adolescent pregnancies are also 50% more likely to have adverse results at delivery and an increased risk of foetal or neonatal death and asphyxia (Bhutta et al., 2014).

While the aforementioned factors can trigger maternal and neonatal morbidity and mortality, the health conditions under which women arrive at delivery and the development of the obstetric event are of great importance (Roos & von Xylander, 2016; Souza et al., 2015). Moreover, the presence or absence of labour, the type of delivery, the surveillance of foetal health, and the occurrence of hypertension, haemorrhage and infections are crucial variables affecting the wellbeing and health status of both mothers and newborns (Conde-Agudelo et al., 2005). Given the diverse circumstances surrounding this obstetric event, attention needs to be focused on the mother-newborn dyad to better understand the interaction between their health statuses. This approach was proposed in 1996 by the World Health Organization with the Mother-Baby Package (WHO, 1996), and assumes that what is good for the mother is also good for the infant. Evidence suggests that strategies that focus on the continuum of maternal and child care are cost-effective (Mason et al., 2014).

The mother-newborn dyad approach allows accurate and comprehensive identification of the causes that lead to joint adverse maternal and perinatal outcomes during birth and/or at immediate postpartum. This view is complementary to the care that usually is delivered to mothers and children separately and makes evident the need for conceptualizing and providing healthcare during birth in an interdisciplinary manner.

Our objective is to compare the risk of severe adverse maternal outcomes (SMO) and neonatal outcomes (SNO) and analyse their maternal correlates in adolescent mother-newborn and young mother-newborn dyads in secondary and tertiary care users in Latin American countries. As a novel approach, we analyse SMO and SNO simultaneously by means of a composite indicator. We hypothesized that adolescent mother-newborn dyads were at a higher risk of severe adverse outcomes as compared to young mother-newborn dyads. Our results might contribute to a deeper understanding of the magnitude of morbidity and mortality in the mother-newborn dyad.

Methods

Population and Sample

The data for this secondary analysis comes from the WHO Multicountry Survey on Maternal and Newborn Health (WHOMCS), which objective was to analyse the incidence and management of maternal and neonatal complications associated with maternal and neonatal mortality in 29 countries. The detailed methods of the WHOMCS are described elsewhere (Souza et al., 2013). Briefly, it is a multicentre multi-country study where countries were selected randomly, and three cities (including the capital) were selected within each country. In each city, hospitals were randomly selected with probability proportional to the annual number of births. Only hospitals with capacity to perform C-sections were included, and all births that took place in the selected hospitals during the recruitment period (2010–2012) were eligible to participate. Trained personnel collected maternal and neonatal information by reviewing medical records using standardized instruments. The recruitment period took place during approximately 2 months in hospitals with over 6000 annual births and approximately 3 months in those whose annual births range from 1000 to 6000. The Special Programme of Research, Development and Research Training in Human Reproduction (HRP) Specialist Panel on Epidemiological Research reviewed and approved the study protocol for technical content. The World Health Organization Multicountry Survey on Maternal and Newborn Health study protocol was approved by the World Health Organization Ethical Review Committee and the relevant ethical clearance mechanisms in all participant countries (ID: A65661; date: 27 October 2009).

For this analysis, we selected all the seven countries from Latin America that participated in the WHOMCS (Argentina, Brazil, Ecuador, Mexico, Nicaragua, Paraguay and Peru) and included all women aged 12 to 24 years who delivered vaginally or by C-section in any of the 83 participating hospitals. We excluded the records where information defining the type of mother-newborn dyad was not available, namely: vital status at the time of birth, vital newborn status at the time of hospital discharge, birth weight and gestational week. The cases in which the mother's gestational age was less than 22 weeks were also excluded. In the cases of multiple pregnancies, we used only the information on the first newborn. Finally, we eliminated the observations where the birth weight-gestational age relationship could not

be assessed. Our calculations were based on the procedure proposed by Mikolajczyk et al. (Mikolajczyk et al., 2011). The final analytical sample consisted of 29,282 observations (Fig. 1).

Definition of Variables

We defined maternal near miss (MNM) as the presence of any of the organic dysfunction criteria established by the WHO for any stage of pregnancy (Souza et al., 2013). We defined SMO as the presence of MNM or maternal death. No information was available on organic dysfunction for three women, so they were not considered in the SMO analyses.

We classified the presence of neonatal near miss (NNM) according to pragmatic and management criteria by Pileggi et al. (Pileggi-Castro et al., 2014). Pragmatic criteria of NNM were: birthweight < 1 750 g, five-minute Apgar score < 7 and gestational age < 33 weeks. Management criteria for NNM were: nasal CPAP; endotracheal intubation; phototherapy; cardiopulmonary resuscitation; administration of any of the following: intravenous antibiotics, vasoactive substances, anticonvulsive agents, surfactant, blood products; and any surgical intervention. We defined a NNM case as the presence of at least one pragmatic or management criterion. Furthermore, we defined SNO as the presence of NNM, stillbirth or early neonatal death (less than 7 days of age). No information was available on the cause of neonatal death for 11 cases, so they were excluded from the SNO analyses. The information on three newborns that died due to a congenital malformation before hospital discharge was also excluded from the SNO analyses.

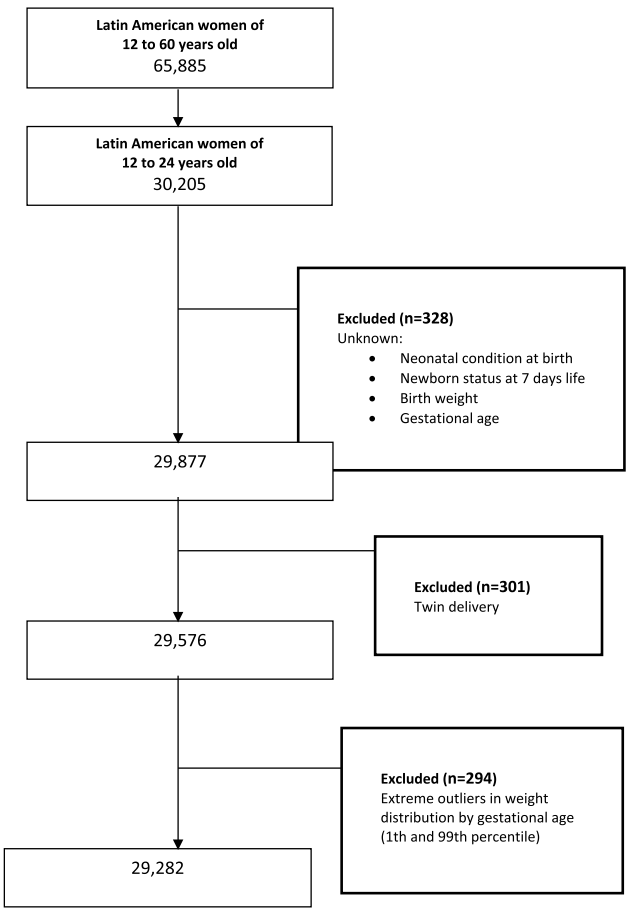

Fig. 1 Flow diagram

Statistical Analysis

Our unit of analysis was the mother-newborn dyad. We defined a composite outcome combining SMO and SNO status, where we classified dyads as non-severe outcome dyad (where both SMO and SNO were absent) and severe adverse outcome dyad (where at least one of SMO or SNO was present). We compared maternal demographic and reproductive characteristics (age, education level, parity, type of delivery) and neonatal characteristics between non-severe outcome and severe adverse outcome dyads. We assessed the frequency of SMO and SNO in severe adverse outcome mother-newborn dyads comparing adolescent women (aged 12–19), young adolescent women (aged 12–16) and older adolescent women (aged 17–19) with young women (aged 20–24). The neonatal outcomes indicators assessed were: low birth-weight, preterm birth, five-minute Apgar score < 7 and admittance to the intensive care unit (ICU). Furthermore, we examined the frequency of haemorrhage, infection, preeclampsia/eclampsia, anaemia and chronic hypertension by type of dyad and by age group.

We estimated odds ratios and 95% confidence intervals using a multilevel logistic regression model to evaluate if the age group and other characteristics were associated to the presence of SMO or SNO in the mother-newborn dyad. In addition, we created a polytomous outcome classifying each dyad into four categories: SMO and SNO, SMO and no SNO, no SMO and SNO and no SMO and no SNO, and estimated odds ratios and 95% confidence intervals using a multinomial logistic regression model to compare if a given type of dyad is more likely to occur for adolescent mothers. We adjusted regression models for married/cohabiting status, years of education, parity, onset of labour, presentation and sex of the newborn. All analyses considered the correlation by design among hospitals by including either a random intercept for countries or robust standard errors for clustered observations at the country level, as appropriate. Finally, acknowledging that age is only one characteristic defining adolescence, and that, from a physiological perspective, most women of legal age would have reached sufficient physical and mental maturity to widely be considered adults, we performed a sensitivity analysis comparing minors (aged 12–17 years) with near-adolescent legally-adult women

(aged 18–21) and with young women (aged 22–24). We carried out all the analyses using the statistical package Stata version 13 (StataCorp, College Station, TX, USA).

Results

Table 1 shows the maternal characteristics of mother-newborn dyads (n = 29,282) by type of dyad and age of mother. The percentage of dyads comprising adolescent women was 40.8%. Most women were married/cohabiting (73.3%), had nine or more years of school education (68.0%), were primiparous (67.5%), had a spontaneous onset of labour (75.8%) and a vaginal delivery (63.1%). Cephalic foetal presentation was reported in 95.4% of the dyads.

We observed several differences according to type of dyad and age of mother. In 12–16 year-old mothers, as compared to non-severe outcome mother-newborn dyads, severe adverse outcome dyads were more likely not married/cohabiting (49.2% vs 42.7%), multiparous (1.9% vs 0.4%), no labour (13.9% vs 7.6%), delivered by C-Section (47.5% vs 31.6%), had a male newborn (57.1% vs 48.8%) and had a non-cephalic presentation (8.5% vs 4.7%). In 17–19 year-old mothers, the differences between non-severe and severe outcome dyads were similar to those of the younger group, except for married/cohabiting status and parity. In young women, the differences between dyads were also similar to those of their younger counterparts; although remarkably severe outcome dyads were more likely primiparous (60.8% vs 55.3%), with induced labour (14.3% vs 12.7%), and delivered by C-Section (57.7% vs 37.8%).

Table 2 shows variables used to define the maternal and neonatal near miss in mother-newborn dyads by age of mother. Among conditions defined as maternal near-miss, the most common were clotting disorders (0.17%), cardiovascular disorders (0.11%) and respiratory insufficiency (0.10%). Respiratory and renal insufficiency were more frequent in adolescent than in young mothers. Overall maternal near-miss occurred in 0.43% of adolescent and in 0.29% of young mother-newborn dyads.

The most frequent conditions defining neonatal near miss were birth weight < 1750 g (1.45%) and gestational age < 33 weeks (1.35%). Any pragmatic maker of the severity was present in 2.45% of the dyads. Regarding the management set, the most frequent actions taken on neonates were therapeutic intravenous antibiotics (3.67%), phototherapy in the first 24 h (2.41%) and nasal CPAP (2.08%). About 6% of neonates underwent a management-based marker of severity action. Overall, markers of severity were more frequent in adolescent than in young mother-newborn dyads. Neonatal near-miss occurred in 7.52% of adolescent and in 6.45% of young mother-newborn dyads.

Table 3 shows the odds ratios of the main characteristics associated with severe adverse outcome mother-newborn dyad. After adjusting for covariates, the odds of the mother-newborn dyad presenting a maternal or a neonatal severe outcome were 14% higher in adolescents as compared to young women (OR 1.14; 95% CI 1.03, 1.26), 28% higher in induced labour and 63% higher in no labour as compared to spontaneous onset of labour (OR 1.28; 95% CI 1.12, 1.47 and OR 1.63; 95% CI 1.44, 1.86, respectively), 27% higher in dyads with male newborns in comparison to those with female newborns (OR 1.27; 95% CI 1.16, 1.39) and more than 78% higher for non-cephalic presentations. Conversely, having a partner and more than one child decreased the odds of presenting SMO or SNO. Risks were higher in those dyads where mothers were at age 12–16 than in those where they were 17–19 (OR 1.24 vs 1.11).

In Table 4, we show the odds ratios (OR) of a multinomial logistic model using the non-severe outcome dyad as base outcome category. After adjusting for covariates, the presence of SNO was 15% more likely in adolescent mothers than in young mothers (OR 1.15; 95% CI 1.06, 1.25). A combination of SMO and SNO was three times more likely in adolescent mothers than in young mothers (OR 3.56; 95% CI 1.67, 7.59). Interestingly, SNO either alone or in combination with SMO were more likely in adolescents aged 12–16 than in young women (OR 1.27 and 4.87, respectively); however, the risks of SMO were similar between adolescent and young women when SNO were absent.

In sensitivity analysis, we found fairly similar results to those of or main analysis: As compared to other age groups, risks of SMO or SNO and of SNO either alone or in combination to SMO were more frequent in minors aged 12 to 17 (Online Appendices 1 and 2).

Discussion

In this study we compare in adolescent mother-newborn and young mother-newborn dyads the risk of SMO and SNO, taken together by means of a composite indicator, and analyse their associated maternal characteristics. Our results suggest that adolescent mothers and their newborns are at an increased risk of severe adverse outcomes during child birth and in the first week postpartum compared to young mother dyads, with risks being further elevated among the dyads with mothers between 12 and 16 years of age. The maternal and neonatal characteristics with greatest influence in the presentation of SMO-SNO were adolescence, induced labour, transverse foetal position during delivery and male sex of the newborn. Meanwhile, being married/cohabiting and having a previous birth were protective characteristics in the dyads. Furthermore, adolescent mother dyads presented greater risk of a combination of both SMO and SNO

Table 1 Maternal and neonatal characteristics of mother-newborn dyads by age of the mother

Characteristics	Total, n (%)		Adolescent mothers														Young mothers				
			12–16 years old					17–19 years old					12–19 years old				20–24 years old				
			(n = 2986)					(n = 8956)					(n = 11,942)				(n = 17,340)				
			Non-severe outcome mother-newborn dyad, n (%)		Severe outcome mother-newborn dyad[a], n (%)		P-value	Non-severe outcome mother-newborn dyad, n (%)		Severe outcome mother-newborn dyad[a], n (%)		P-value	Non-severe outcome mother-newborn dyad, n (%)		Severe outcome mother-newborn dyad[a], n (%)		P-value	Non-severe outcome mother-newborn dyad, n (%)		Severe outcome mother-newborn dyad[a], n (%)		P-value
Number of deliveries	29,282	100	2727	9.3	259	28.3		8274	28.3	682	2.3		11,001	37.6	941	3.2		16,172	55.2	1168	4.0	
Mother																					
Married/cohabiting[b]																					
No	7783	26.7	1159	42.7	127	49.2	0.044	2594	31.5	211	31.1	0.832	3753	34.3	338	36.1	0.261	3436	21.4	256	22.0	0.610
Yes	21,333	73.3	1554	57.3	131	50.8		5637	68.5	467	68.9		7191	66.0	598	63.9		12,637	78.6	907	78.0	
Years of education																					
0 to 5	1856	6.4	293	10.7	36	13.9	0.255	497	6.0	46	6.7	0.555	790	7.2	82	8.7	0.222	910	5.6	74	6.3	0.429
6 to 8	7509	25.6	1238	45.4	118	45.6		2325	28.1	181	26.5		3563	32.4	299	31.8		3414	21.1	233	20.0	
9+	19,917	68.0	1196	43.9	105	40.5		5452	65.9	455	66.7		6648	60.4	560	59.5		11,848	73.3	861	73.7	
Parity[c]																					
None	19,774	67.5	2595	95.2	245	94.6	0.005	6720	81.2	555	81.4	0.583	9315	84.6	800	85.0	0.159	8948	55.3	711	60.8	< 0.005
One	6937	23.7	121	4.4	9	3.5		1370	16.6	108	15.8		1491	13.6	117	12.4		5021	31.1	308	26.4	
2+	2571	8.8	11	0.4	5	1.9		184	2.2	19	2.8		195	1.8	24	2.6		2203	13.6	149	12.8	
Onset of labour																					
Spontaneous	22,178	75.8	2097	77.0	185	71.4	0.002	6496	78.6	470	68.9	< 0.001	8593	78.2	655	69.6	< 0.001	12,145	75.2	785	67.4	< 0.001
Induced	3897	13.3	421	15.5	38	14.7		1101	13.3	110	16.1		1522	13.8	148	15.7		2060	12.7	167	14.3	
No labour	3182	10.9	207	7.6	36	13.9		672	8.1	102	15.0		87 9	8.0	138	14.7		1952	12.1	213	18.3	
Type of delivery																					
Vaginal	18,477	63.1	1865	68.4	136	52.5	< 0.001	5571	67.3	350	51.3	< 0.001	7436	67.6	486	51.6	< 0.001	10,061	62.2	494	42.3	< 0.001
Cesarean section	10,804	36.9	862	31.6	123	47.5		2703	32.7	332	48.7		3565	32.4	455	48.4		6110	37.8	674	57.7	
Newborn																					
Sex																					
Female	14,516	49.7	1395	51.2	111	42.9	0.010	4126	50.0	294	43.1	0.001	5,521	50.3	405	43.0	< 0.001	8065	50.0	525	45.1	< 0.01
Male	14,705	50.3	1328	48.8	148	57.1		4130	50.0	388	56.9		5,458	49.7	536	57.0		8072	50.0	639	54.9	
Presentation																					
Cephalic	27,903	95.4	2598	95.3	237	91.5	0.020	7922	95.9	625	91.9	< 0.001	10,520	95.8	862	91.8	< 0.001	15,471	95.7	1050	90.2	< 0.001
Breech	814	2.8	67	2.5	13	5.0		212	2.6	36	5.3		279	2.5	49	5.2		415	2.6	71	6.1	
Other	522	1.8	60	2.2	9	3.5		125	1.5	19	2.8		185	1.7	28	3.0		266	1.7	43	3.7	

[a]Defined as the presence of at least one severe maternal outcome or severe neonatal outcome

[b]"No" category includes single, divorced and widowed women

[c]Defined as the number of previous deliveries (excluding the current)

Table 2 Maternal and neonatal near miss characteristics in mother-newborn* dyads by age of the mother

	Total		Adolescent mothers		Young mothers		P-value
	N = 29,282		N = 11,001		N = 17,340		
	n	%	n	%	n	%	
Maternal near miss variables							
Cardiovascular disorders[a]	32	0.11	14	0.12	18	0.10	0.733
Respiratory insufficiency[b]	30	0.10	20	0.17	10	0.06	0.004
Renal insufficiency[c]	10	0.03	8	0.07	2	0.01	0.019
Clotting disorders[d]	50	0.17	20	0.17	30	0.17	0.910
Liver failure[e]	5	0.02	4	0.03	1	0.01	0.074
Neurological disorders[f]	14	0.05	8	0.07	6	0.03	0.213
Uterine dysfunction[g]	22	0.08	6	0.05	16	0.09	0.197
Maternal Near Miss	102	0.35	51	0.43	51	0.29	0.058
Neonatal near miss variables							
Pragmatic set							
Apgar score at 5 min < 7	303	1.03	134	1.12	169	0.97	0.220
Birth weight < 1750 g	425	1.45	199	1.67	226	1.30	0.011
Gestational age < 33 weeks	394	1.35	192	1.61	202	1.16	0.001
Any pragmatic marker of severity	718	2.45	327	2.74	391	2.25	0.009
Management set							
Use of therapeutic intravenous antibiotics	1076	3.67	494	4.14	582	3.36	< 0.001
Nasal CPAP	608	2.08	274	2.29	334	1.93	0.030
Any intubation (Anytime within the first week)	364	1.24	160	1.34	204	1.18	0.215
Use of phototherapy in the first 24 h	706	2.41	316	2.65	390	2.25	0.030
Cardiopulmonary resuscitation	173	0.59	90	0.75	83	0.48	0.003
Use of any vasoactive drug	162	0.55	80	0.67	82	0.47	0.026
Use of anticonvulsants	78	0.27	39	0.33	39	0.22	0.097
Surfactant administration	247	0.84	111	0.93	136	0.78	0.182
Use of any blood products	102	0.35	47	0.39	55	0.32	0.276
Use of steroids to treat refractory hypoglycaemia	51	0.17	16	0.13	35	0.20	0.171
Any surgery	39	0.13	17	0.14	22	0.13	0.721
Any management-based marker of severity	1791	6.12	796	6.67	995	5.74	0.001
Neonatal near miss	2016	6.88	898	7.52	1118	6.45	< 0.001

*Defined as the presence of at least one of severe maternal outcome or severe neonatal outcome

[a]Include shock, cardiac arrest, severe hypoperfusion, severe acidosis, use of vasoactive drugs (continuous administration of vasoactive agents) and cardiopulmonary resuscitation

[b]Include acute cyanosis, gasping for breath, severe tachypnea, sever bradypnea, severe hypoxemia and intubation & ventilation

[c]Include oliguria that does not respond to hydration or diuretics, severe acute azotemia and dialysis in case of acute renal failure

[d]Include clotting failure, severe acute thrombocytopenia and massive blood transfusion

[e]Include jaundice in the presence of preeclampsia and severe acute hyperbilirubinemia

[f]Include prolonged unconsciousness or coma, stroke, uncontrollable epileptic seizures and global paralysis

[g]Include hysterectomy after infection or uterine bleeding

Source:

For maternal near miss

Souza et al. (2013).

For neonatal near miss

Adapted from Pileggi-Castro et al. (2014).

Table 3 Multilevel logistic regression model: characteristics associated with the presence of severe maternal or neonatal outcomes

Characteristics	Crude OR	[95% CI]	Adjusted OR*	[95% CI]	Adjusted OR**	[95% CI]
Mother						
Age category						
Young (20 to 24)	Reference		Reference			
Adolescent (12 to 19)	1.16	[1.06, 1.26]	1.14	[1.03, 1.26]	–	
Young (20 to 24)	Reference				Reference	
Adolescent (12 to 16)	1.27	[1.10, 1.46]	–		1.24	[1.07, 1.45]
Adolescent (17 to 19)	1.12	[1.01, 1.23]	–		1.11	[1.00, 1.23]
Married/cohabiting[a]						
No	Reference		Reference		Reference	
Yes	0.84	[0.76, 0.93]	0.86	[0.78, 0.96]	0.87	[0.78, 0.96]
Years of education						
0 to 5	Reference		Reference		Reference	
6 to 8	0.92	[0.76, 1.11]	0.91	[0.75, 1.10]	0.91	[0.75, 1.10]
9+	0.98	[0.82, 1.17]	0.97	[0.81, 1.16]	0.98	[0.82, 1.18]
Parity						
None	Reference		Reference		Reference	
One	0.79	[0.71, 0.89]	0.86	[0.76, 0.96]	0.86	[0.77, 0.97]
2+	0.88	[0.74, 1.03]	0.98	[0.83, 1.17]	0.99	[0.83, 1.18]
Onset of labour						
Spontaneous	Reference		Reference		Reference	
Induced	1.32	[1.16, 1.51]	1.28	[1.12, 1.47]	1.28	[1.12, 1.47]
No labour	1.78	[1.58, 2.02]	1.63	[1.44, 1.86]	1.64	[1.44, 1.86]
Newborn						
Sex						
Female	Reference		Reference		Reference	
Male	1.28	[1.17, 1.40]	1.27	[1.16, 1.39]	1.27	[1.16, 1.39]
Presentation						
Cephalic	Reference		Reference		Reference	
Breech	2.45	[2.00, 2.99]	2.16	[1.76, 2.65]	2.16	[1.76, 2.65]
Other	2.08	[1.61, 2.70]	1.78	[1.37, 2.31]	1.78	[1.36, 2.30]

Age category variable was included in models either as a two (*) or as a three (**) categories variable

OR odds ratio, *CI* confidence interval

[a]"No" category includes single, divorced and widowed women

when compared with young mother dyads, particularly in adolescents aged 12 to 16. These findings offer the opportunity to delve into and compare between situations and/or events related to women and newborns with SMO-SNO versus otherwise healthy dyads, in addition to the comparison of severe-outcome mother-newborn dyads by age group. The association between adolescence and the presentation of SMO-SNO highlights the importance of focusing preventive efforts in the care of the adolescent mother-newborn dyad.

Some adolescent maternity studies have shown that both adolescent, under-aged mothers and their newborns are at higher risk of severe outcomes (Althabe et al., 2015; Bhutta et al., 2014; Conde-Agudelo et al., 2005; Ganchimeg et al., 2014; Igras et al., 2014; Neal et al., 2018). This risk increases further among mothers with severe maternal morbidity due to exacerbation of effects on the newborn caused by the mother's health status (Geller et al., 2018; Roos & von Xylander, 2016). However, other authors have found that, as compared to young women, adolescent mothers are at a similar risk of maternal complications (Tembo et al., 2020). Our findings suggest that while the risks of SMO are comparable between adolescent and young women when neonatal severe morbidity is absent, younger adolescents are at an increased risk of SNO either alone or in combination with maternal severe outcomes. Since some of the SNO indicators we used are related to prematurity, and adverse outcomes are, in turn, more frequent in the youngest adolescents (Jeha et al., 2015), possibly physical immaturity in the maternal-newborn dyad may act synergistically to increase the risk of adverse outcomes.

Table 4 Multinomial logistic regression model: association of adolescence with the presence of severe maternal or neonatal outcomes in mother-newborn dyads

Age categories	No severe maternal outcome and severe neonatal outcome		Severe maternal outcome and no severe neonatal outcome		Severe maternal and neonatal outcomes	
	OR	[95%CI]	OR	[95%CI]	OR	[95%CI]
Crude models						
Young (20 to 24)	Reference		Reference		Reference	
Adolescent (12 to 19)	1.17	[1.02, 1.34]	1.16	[0.68, 1.96]	2.94	[1.94, 4.46]
Young (20 to 24)	Reference		Reference		Reference	
Adolescent (17 to 19)	1.12	[0.93, 1.36]	1.30	[0.71, 2.41]	2.54	[1.49, 4.33]
Adolescent (12 to 16)	1.31	[1.16, 1.49]	0.71	[0.40, 1.26]	4.15	[2.53, 6.81]
Adjusted models[a]						
Young (20 to 24)	Reference		Reference		Reference	
Adolescent (12 to 19)	1.15	[1.06, 1.25]	1.13	[0.68, 1.88]	3.56	[1.67, 7.59]
Young (20 to 24)	Reference		Reference		Reference	
Adolescent (17 to 19)	1.12	[0.97, 1.28]	1.26	[0.71, 2.23]	3.23	[1.37, 7.61]
Adolescent (12 to 16)	1.27	[1.08, 1.50]	0.66	[0.36, 1.23]	4.87	[2.33, 10.20]

Base outcome for all ORs was non-severe outcome mother-newborn dyad. Age category variable was included in models either as a two or as a three categories variable

OR odds ratio, *CI* confidence interval

[a]Adjusted for marital status, years of education, parity, onset of labour, presentation and sex of the newborn

The higher risks for SMO and SNO in adolescent mother-newborn dyads, particularly in younger adolescents, could be explained by the fact that women who become pregnant in adolescence also have their first antenatal visit later in pregnancy than adult women, and that in unfavourable socioeconomic settings, adolescents generally receive less antenatal essential interventions compared to women who are mothers after adolescence (Suárez-López et al., 2022). Furthermore, the fact that adolescent women have not yet finished their biological development, poor health conditions when they start pregnancy, pre-existing diseases (Ganchimeg et al., 2014) and the quality of maternal and newborn care (Renfrew et al., 2014) may explain this finding. Women's cultural and socio-economic contexts are also determining factors that significantly influence pregnancy care (Loredo-Abdalá et al., 2017) and the health situations of women when they arrive at delivery (Mendoza Tascón et al., 2015). These findings are consistent with studies reporting increased adverse maternal outcomes and their impact on newborn outcomes due to unfavourable health conditions of women, especially in adolescence (Barrera-de Leon et al., 2014).

Higher frequency of labour induction in severe adverse outcome mother-newborn dyads could be related to the application of hospital protocols where, in order to prevent greater risks, an induced delivery is performed in the presence of maternal complications. Some authors have shown a higher incidence of maternal near miss among women with induced labour (Dias et al., 2014). Furthermore, induced labour may increase the likelihood of C-section and higher admission to neonatal intensive care unit (Tan et al., 2008; Vrouenraets et al., 2005).

Higher frequency of severe adverse outcomes (Barrera-de Leon et al., 2014) and higher perinatal mortality rates (Fernández Cantón et al., 2012) in male newborns has also been reported in other studies. This may be the result of male vulnerability, in which males, as compared to females, are more likely to present postnatal complications. In addition, in very preterm infants, male sex is also an important risk factor for poor neonatal outcome (Peacock et al., 2012).

The association between non-cephalic presentations and SMO or SNO could be a result of the high prevalence of C-sections among woman with non-cephalic presentations (90%), which carries greater risk of infection, haemorrhage, and prolonged hospital stay. This highlights the need for further investigation into this type of birth with relation to women with SMO (Lima et al., 2017), especially because this practice has become more prevalent in various Latin American countries (Guzman et al., 2015).

In contrast, we found that married/cohabiting status and parity are two protective factors against SMO-SNO in mother-newborn dyads. In women with a stable relationship, the reduced presentation of adverse maternal and neonatal outcomes could be a result of greater emotional support and economic stability. This relationship is important because it indicates a need for women to avoid stressful situations, especially adolescents that often face uncertainty and stress due to potential familial rejection as a result of their pregnancy (Loredo-Abdalá et al., 2017).

The reduced risk of SMO-SNO in multiparous women could be a result of changes in the birth canal that facilitate delivery as a result of their previous delivery. Previous findings have shown that multiparous women dilate more rapidly, use less analgesia and anaesthesia, and have obstetrically easier labours, shorter labours, fewer labour complications, less blood loss, and fewer lacerations. Newborns of multiparous women also have better Apgar scores at one minute postpartum (Norr et al., 1980).

The association between adolescence of the mother and the presence of SMO-SNO in mother-newborn dyads demonstrates the relevance of studying mothers together with their newborns. As was proposed by the WHO over two decades ago, it is important to focus maternal-infant care on the needs of the mother-newborn dyad in order to fully understand the health situation affecting both mother and child (WHO, 1996). Our results highlight the importance of reducing births among adolescents, particularly in the youngest age group, as a strategy for addressing the problem of SMO-SNO.

If the Sustainable Development Goals on maternal and infant health are to be reached in Latin America, it is of utmost importance that we trade the current paradigm of studying mother and newborn health in an isolated manner for one which focuses on the dyad. This change will contribute to better action planning towards improving mother-infant health.

Limitations

This study included routinely recorded information extracted by a standardized procedure, so our analysis relies on the completeness and accuracy of heath records and on the expertise of data collectors, which may vary across countries. The potential information bias resulting from missing key information or misclassification was addressed by local supervision and monitoring compliance to the data entry protocol. Another limitation is that the same weight was given to the different events we combined to define our composite measure of maternal and neonatal outcomes, which does not take into account the differing impact in morbidity they could have had. This study was conducted in secondary and tertiary facilities, predominantly located in urban settings where risks are larger than in small rural facilities that adolescents may prefer, thus limiting the generalisability of our results. The WHOMCS did not obtained information on antenatal visits or exposure to tobacco or other substances that may impact maternal and child health; therefore, future studies are needed in order to carry out more precise evaluations, which consider women's socioeconomic, cultural, and geographic conditions along with evaluations of prenatal care and pre-existing diseases. An additional limitation of our study was the sample size; specifically, having a small number of mothers under 15 years of age limited our ability to carry out more disaggregated analyses.

Conclusion for Practice

Our results show the importance of analysing the health status of the mother and newborn simultaneously, as a dyad, for comprehensive understanding of the predicament of extreme morbidity and mortality.

In order to provide care with a mother-newborn dyad focus in Latin America, it is necessary to devise and implement new internal coordination strategies in obstetric and paediatric hospital services. This must include collaboration between healthcare providers (Lira et al., 2005) to replace the traditional fragmented care strategies (Rodrigues et al., 2014). The current work of providers is invaluable to the needs of newborns and new mothers, but a new focus on the dyad and/or problem-oriented solutions facilitates a step towards integrated care which maximizes the health benefits of both mother and newborn.

This study provides valuable information for key stakeholders charged with decision-making in the health care of adolescent women. Continued efforts are needed to improve health care and prevention initiatives directed towards adolescent women and their newborns.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10995-022-03474-7.

Acknowledgements We would like to thank the WHO for making available the Latin American data of the WHO Multicountry Survey on Maternal and Newborn Health database. We are grateful to all members of the WHO Multicountry Survey on Maternal and Newborn Health Research Network, particularly to the country coordinators, data collection coordinators, facility coordinators, data collectors, and all staff of the participating facilities in Latin America. We thank Dr Juan Carlos Aranda-Neri for his advice to interpret results from a clinical point of view and Dr Franz Castro for his editorial assistance.

Author Contributions LS-L and EO-P conceptualised and performed the analysis. LS-L, EV-S, DG-H and LC wrote the first draft. GC revised the manuscript for important intellectual content. All authors contributed to the interpretation of the results and development of the article. All authors read and approved the final version of the article. LS-L and EO-P are the guarantors of the article.

Funding This study was partially funded by the National Institute of Public Health of Mexico through the National Strategy to Prevent Adolescent Pregnancy Fund (Anexo-13-E022-630).

Data Availability Analytical dataset available upon request.

Code Availability Available upon request.

Declarations

Conflict of interest The authors declare that they have no conflicts of interest to disclose.

Ethical Approval The Special Programme of Research, Development and Research Training in Human Reproduction (HRP) Specialist Panel on Epidemiological Research reviewed and approved the study protocol for technical content. The World Health Organization Multicountry Survey on Maternal and Newborn Health study protocol was approved by the World Health Organization Ethical Review Committee and the relevant ethical clearance mechanisms in all participant countries (ID: A65661; date: 27 October 2009).

Consent to Participate We used de-identified routinely collected data, thus consent from participants is not applicable.

Consent for Publication Not applicable.

References

Althabe, F., Moore, J. L., Gibbons, L., Berrueta, M., Goudar, S. S., Chomba, E., Derman, R. J., Patel, A., Saleem, S., Pasha, O., Esamai, F., Garces, A., Liechty, E. A., Hambidge, K., Krebs, N. F., Hibberd, P. L., Goldenberg, R. L., Koso-Thomas, M., Carlo, W. A., … McClure, E. M. (2015). Adverse maternal and perinatal outcomes in adolescent pregnancies: The Global Network's Maternal Newborn Health Registry study. *Reproductive Health, 12*(Suppl 2), S8. https://doi.org/10.1186/1742-4755-12-S2-S8

Barrera-de Leon, J. C., Higareda-Almaraz, M. A., Barajas-Serrano, T. L., Villalvazo-Alfaro, M., & Gonzalez-Bernal, C. (2014). Comparison of perinatal clinical profiles in newborns of adolescent and non-adolescent mothers. *Gaceta Médica De México, 150*(Suppl 1), 67–72. Comparacion del perfil clinico perinatal de recien nacidos de madres adolescentes y no adolescentes.

Bhutta, Z. A., Das, J. K., Bahl, R., Lawn, J. E., Salam, R. A., Paul, V. K., Sankar, M. J., Blencowe, H., Rizvi, A., Chou, V. B., Walker, N., Lancet Newborn Interventions Review Group, Lancet Every Newborn Study Group. (2014). Can available interventions end preventable deaths in mothers, newborn babies, and stillbirths, and at what cost? *The Lancet, 384*(9940), 347–370. https://doi.org/10.1016/s0140-6736(14)60792-3

Cluet de Rodríguez, I., Rossell-Pineda, M., Álvarez de Acosta, T., & Rojas Quintero, L. (2013). Factores de riesgo asociados a la prematuridad en recién nacidos de madres adolescentes. *Revista De Obstetricia y Ginecología De Venezuela, 73*(3), 157–170.

Conde-Agudelo, A., Belizan, J. M., & Lammers, C. (2005). Maternal-perinatal morbidity and mortality associated with adolescent pregnancy in Latin America: Cross-sectional study. *American Journal of Obstetrics and Gynecology, 192*(2), 342–349. https://doi.org/10.1016/j.ajog.2004.10.593

Dias, M. A., Domingues, R. M., Schilithz, A. O., Nakamura-Pereira, M., Diniz, C. S., Brum, I. R., Martins, A. L., Theme Filha, M. M., Gama, S. G., & Carmo, L. M. (2014). Incidence of maternal near miss in hospital childbirth and postpartum: Data from the birth in Brazil study. *Cadernos De Saúde Pública, 30*(Suppl 1), S1-12. https://doi.org/10.1590/0102-311x00154213

Fernández Cantón, S. B., Gutiérrez Trujillo, G., & Viguri Uribe, R. (2012). Principales causas de mortalidad infantil en México: Tendencias recientes. *Boletín Médico Del Hospital Infantil De México, 69*, 144–148.

Ganchimeg, T., Ota, E., Morisaki, N., Laopaiboon, M., Lumbiganon, P., Zhang, J., Yamdamsuren, B., Temmerman, M., Say, L., Tunçalp, Ö., Vogel, J. P., Souza, J. P., Mori, R., WHO Multicountry Survey on Maternal Newborn Health Research Network. (2014). Pregnancy and childbirth outcomes among adolescent mothers: A World Health Organization multicountry study. *BJOG, 121*(Suppl 1), 40–48. https://doi.org/10.1111/1471-0528.12630

GBD 2017 Causes of Death Collaborators. (2018). Global, regional, and national age-sex-specific mortality for 282 causes of death in 195 countries and territories, 1980–2017: A systematic analysis for the Global Burden of Disease Study 2017. *The Lancet, 392*(10159), 1736–1788. https://doi.org/10.1016/S0140-6736(18)32203-7

Geller, S. E., Koch, A. R., Garland, C. E., MacDonald, E. J., Storey, F., & Lawton, B. (2018). A global view of severe maternal morbidity: Moving beyond maternal mortality. *Reproductive Health, 15*(Suppl 1), 98. https://doi.org/10.1186/s12978-018-0527-2

Guzman, E., Ludmir, J., & DeFrancesco, M. (2015). High cesarean section rates in Latin America, a reflection of a different approach to labor? *Open Journal of Obstetrics and Gynecology, 5*, 433–435. https://doi.org/10.4236/ojog.2015.58062

Igras, S. M., Macieira, M., Murphy, E., & Lundgren, R. (2014). Investing in very young adolescents' sexual and reproductive health. *Global Public Health, 9*(5), 555–569. https://doi.org/10.1080/17441692.2014.908230

Jeha, D., Usta, I., Ghulmiyyah, L., & Nassar, A. (2015). A review of the risks and consequences of adolescent pregnancy. *Journal of Neonatal-Perinatal Medicine*. https://doi.org/10.3233/NPM-15814038

Lima, H. M., Carvalho, F. H., Feitosa, F. E., & Nunes, G. C. (2017). Factors associated with maternal mortality among patients meeting criteria of severe maternal morbidity and near miss. *International Journal of Gynaecology and Obstetrics, 136*(3), 337–343. https://doi.org/10.1002/ijgo.12077

Lira, J., Oviedo, H., Zambrana, M., Ibargüengoitia, F., & Ahued, R. (2005). Implicaciones perinatales del embarazo en la mujer adolescente. *Ginecología y Obstetricia De México, 73*(8), 407–414.

Loredo-Abdalá, A., Vargas-Campuzano, E., Casas-Muñoz, A., González-Corona, J., & Gutiérrez-Leyva, C. J. (2017). Adolescent pregnancy: Its causes and repercussions in the dyad. *Revista Médica Del Instituto Mexicano Del Seguro Social, 55*(2), 223–229.

Mason, E., McDougall, L., Lawn, J. E., Gupta, A., Claeson, M., Pillay, Y., Presern, C., Lukong, M. B., Mann, G., Wijnroks, M., Azad, K., Taylor, K., Beattie, A., Bhutta, Z. A., Chopra, M., Lancet Every Newborn Study Group, Every Newborn Steering Committee. (2014). From evidence to action to deliver a healthy start for the next generation. *The Lancet, 384*(9941), 455–467. https://doi.org/10.1016/S0140-6736(14)60750-9

Mendoza Tascón, L. A., Arias Guatibonza, M. D., Peñaranda Ospina, C. B., Mendoza Tascón, L. I., Manzano Penagos, S., & Varela Bahena, A. M. (2015). Influencia de la adolescencia y su entorno en la adherencia al control prenatal e impacto sobre la prematuridad, bajo peso al nacer y mortalidad neonatal. *Revista Chilena De Obstetricia y Ginecología, 80*, 306–315.

Mikolajczyk, R. T., Zhang, J., Betran, A. P., Souza, J. P., Mori, R., Gulmezoglu, A. M., & Merialdi, M. (2011). A global reference for fetal-weight and birthweight percentiles. *The Lancet, 377*(9780), 1855–1861. https://doi.org/10.1016/S0140-6736(11)60364-4

Neal, S., Channon, A. A., & Chintsanya, J. (2018). The impact of young maternal age at birth on neonatal mortality: Evidence from 45 low and middle income countries. *PLoS ONE, 13*(5), e0195731. https://doi.org/10.1371/journal.pone.0195731

Norr, K. L., Block, C. R., Charles, A. G., & Meyering, S. (1980). The second time around: Parity and birth experience. *The Journal of Vitaminology, 9*(1), 30–36. https://doi.org/10.1111/j.1552-6909.1980.tb01302.x

Peacock, J. L., Marston, L., Marlow, N., Calvert, S. A., & Greenough, A. (2012). Neonatal and infant outcome in boys and girls born

very prematurely. *Pediatric Research, 71*(3), 305–310. https://doi.org/10.1038/pr.2011.50

Pileggi-Castro, C., Camelo, J. S., Jr., Perdoná, G. C., Mussi-Pinhata, M. M., Cecatti, J. G., Mori, R., Morisaki, N., Yunis, K., Vogel, J. P., Tunçalp, Ö., Souza, J. P., WHO Multicountry Survey on Maternal and Newborn Health Research Network. (2014). Development of criteria for identifying neonatal near-miss cases: Analysis of two WHO multicountry cross-sectional studies. *BJOG, 121*(Suppl 1), 110–118. https://doi.org/10.1111/1471-0528.12637

Renfrew, M. J., McFadden, A., Bastos, M. H., Campbell, J., Channon, A. A., Cheung, N. F., Silva, D. R., Downe, S., Kennedy, H. P., Malata, A., McCormick, F., Wick, L., & Declercq, E. (2014). Midwifery and quality care: Findings from a new evidence-informed framework for maternal and newborn care. *The Lancet, 384*(9948), 1129–1145. https://doi.org/10.1016/S0140-6736(14)60789-3

Rodrigues, D. P., Dodou, H. D., Lago, P. N. D., Mesquita, N. S., Melo, L. P. T. D., & Sousa, A. A. S. D. (2014). Care for both mother and child immediately after childbirth: A descriptive study [postpartum period; rooming-in care; delivery of health care]. *Online Brazilian Journal of Nursing, 13*(2), 12. https://doi.org/10.5935/1676-4285.20144231

Roos, N., & von Xylander, S. R. (2016). Why do maternal and newborn deaths continue to occur? *Best Practice & Research: Clinical Obstetrics & Gynaecology, 36*, 30–44. https://doi.org/10.1016/j.bpobgyn.2016.06.002

Souza, J. P., Gülmezoglu, A. M., Vogel, J., Carroli, G., Lumbiganon, P., Qureshi, Z., Costa, M. J., Fawole, B., Mugerwa, Y., Nafiou, I., Neves, I., Wolomby-Molondo, J. J., Bang, H. T., Cheang, K., Chuyun, K., Jayaratne, K., Jayathilaka, C. A., Mazhar, S. B., Mori, R., … Say, L. (2013). Moving beyond essential interventions for reduction of maternal mortality (the WHO Multicountry Survey on Maternal and Newborn Health): A cross-sectional study. *The Lancet, 381*(9879), 1747–1755. https://doi.org/10.1016/s0140-6736(13)60686-8

Souza, M. A. C. D., Souza, T. H. S. C. D., & Gonçalves, A. K. D. S. (2015). Fatores determinantes do near miss materno em uma unidade de terapia intensiva obstétrica. *Revista Brasileira De Ginecologia e Obstetrícia, 37*, 498–504.

Suárez-López, L., Hubert, C., de la Vara-Salazar, E., Villalobos, A., de Castro, F., Hernández-Serrato, M. I., & Ávila-Burgos, L. (2022). Continuum of care for maternal, newborn and child health: Evidence from a national survey in Mexico. *Sexual & Reproductive Healthcare, 31*, 100690. https://doi.org/10.1016/j.srhc.2021.100690

Tan, P. C., Suguna, S., Vallikkannu, N., & Hassan, J. (2008). Predictors of newborn admission after labour induction at term: Bishop score, pre-induction ultrasonography and clinical risk factors. *Singapore Medical Journal, 49*(3), 193–198.

Tembo, T., Koyuncu, A., Zhuo, H., Mwendafilumba, M., & Manasyan, A. (2020). The association of maternal age with adverse neonatal outcomes in Lusaka, Zambia: A prospective cohort study. *BMC Pregnancy and Childbirth, 20*(1), 684. https://doi.org/10.1186/s12884-020-03361-5

UNICEF. (2016). *A fair chance for every child*. United Nations Children's Fund (UNICEF).

Verdura, M., Raimundo, M., Fernandez Coutinho, M., & Gerometta, R. (2011). Bajo peso al nacer y prematurez en hijos de madres adolescentes de un centro maternoneonatal de la Ciudad de Corrientes. *Revista De Posgrado De La VIa Cátedra De Medicina, 205*, 6–9.

Vrouenraets, F. P., Roumen, F. J., Dehing, C. J., van den Akker, E. S., Aarts, M. J., & Scheve, E. J. (2005). Bishop score and risk of cesarean delivery after induction of labor in nulliparous women. *Obstetrics and Gynecology, 105*(4), 690–697. https://doi.org/10.1097/01.AOG.0000152338.76759.38

WHO. (1996). *Mother-baby package: Implementing safe motherhood in countries: Practical guide*. World Health Organization. Retrieved from May 2, 2022, https://apps.who.int/iris/handle/10665/63268