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The costs of inadequate breastfeeding of infants in Mexico[1–3]

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ABSTRACT

Background: Breastfeeding is vital for child survival, health, and development. Mexico has very low rates of breastfeeding and experienced a severe decrease in the prevalence of exclusive breastfeeding from 21% in 2006 to 14% in 2012.

Objective: The objective of the article was to estimate the pediatric costs of inadequate breastfeeding in Mexico associated with the following acute health conditions: respiratory infections, otitis media, gastroenteritis, necrotizing enterocolitis (NEC), and sudden infant death syndrome (SIDS).

Design: The authors estimated the economic costs of inadequate breastfeeding as follows: the sum of direct health care costs for diseases whose risk increases when infants are non–exclusively breastfed <6 mo or are not breastfed from ages 6 to <11 mo, lost future earnings due to premature infant death, and the costs of purchasing infant formula. Incidence cases were retrieved from national surveillance systems, except for NEC and SIDS, which were estimated from the literature. A sensitivity analysis was carried out to provide a range of costs based on different assumptions of the number of incident cases of all infant health outcomes examined. The model applied to the cohort of 1-y-old children born in 2012.

Results: The total annual costs of inadequate breastfeeding in Mexico for the studied cohort ranged from $745.6 million to $2416.5 million, where the costs of infant formula accounted for 11–38% of total costs. A range of 1.1–3.8 million reported cases of disease and from 933 to 5796 infant deaths per year for the diseases under study are attributed to inadequate infant breastfeeding practices; altogether these represent nearly 27% of the absolute number of episodes of such diseases.

Conclusions: This study provides costs of inadequate breastfeeding that had not been quantified in Mexico. The costs presented in this article provide the minimum amount that the country should invest to achieve better breastfeeding practices. *Am J Clin Nutr* doi: 10.3945/ajcn.114.092775.

Keywords inadequate breastfeeding, cost analysis, Mexico, infant morbidity, infant mortality

INTRODUCTION

Breastfeeding is vital for child survival, health, and development and is also beneficial for maternal health (1). The WHO recommends exclusive breastfeeding (EBF)[4] during the first semester of life followed by the introduction of soft semisolid foods from 6 mo on and to continue to breastfeed for ≥2 y if the mother-infant dyad so decides (2). Non–breastfed neonates and infants experience increased risks of disease and death, particularly related to pediatric infectious diseases such acute diarrhea, respiratory infections, otitis media, and necrotizing enterocolitis (NEC) (1, 3, 4). They are also at a higher risk of some chronic diseases such as obesity and diabetes, a reduced intelligence quotient (4, 6), and probably an increased risk of epilepsy during adulthood (4–6).

The health risks associated with not breastfeeding result in economic costs for families, governments, and the society at large (4, 7). Recent evidence showed that achieving rates of 90% of EBF in the United States relative to the current prevalence of EBF at 6 mo of 12% would save up to 13 billion US dollars per year (8). A study conducted in 2 small cities in the United States and the United Kingdom showed that families of children who were never breastfed compared with children who were exclusively breastfed for 3 mo incurred additional expenditures of up to $475 per infant due to excess consultation visits, hospitalizations, and prescriptions (9). Other studies also estimated additional costs associated with the use of infant formula compared with EBF at ages <6 mo (10, 11).

Mexico is one of the countries with the lowest rates of breastfeeding in Latin America (12) and among the members of the Organization for Economic Cooperation and Development (13). In addition, the prevalence of EBF in infants <6 mo in Mexico has decreased severely in the years between surveys, from 21% in 2006 to 14% in 2012 (14).

Assessing the health and economic costs of inadequate breastfeeding practices is a necessary task to place this theme in the public heath agenda and is notoriously absent from the current heath priorities in Mexico. Estimated losses—in terms of lives lost, morbidity cases, and economic costs—due to inadequate breastfeeding practices is a necessary input for the formulation of cost-effective interventions to increase breastfeeding rates.

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[4] Abbreviations used: AG, acute gastroenteritis; ARI, acute upper respiratory infection; EBF, exclusive breastfeeding; EFF, exclusive formula feeding; ENSANUT, National Health and Nutrition Survey; LRTI, lower respiratory tract infection; OM, acute otitis media; NEC, necrotizing enterocolitis; PBF, partial breastfeeding; SIDS, sudden infant death syndrome.

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Such information could drive decisions relative to education policies, commercial monitoring of formula marketing, law modification or enforcement, research funding, and scaling-up small local successful programs toward a more breastfeeding-friendly country.

The overall objective of this study was to estimate the pediatric costs of inadequate breastfeeding practices in Mexico for infants aged <1 y. We constructed a model to estimate the number of morbidity cases and deaths attributable to inadequate breastfeeding practices, the direct health care costs associated, the lost future earnings due to premature death, and the costs of infant formula.

METHODS

Health outcomes (reported incidence)

We focused on the 4 most prevalent infectious diseases of infancy in Mexico for which information is available: acute upper respiratory infections (ARIs), lower respiratory tract infections (LRTIs), acute otitis media (OM), acute gastroenteritis (AG) (15), and 2 diseases not reported in the country's surveillance system but for which there is strong evidence of a protective effect of breastfeeding—NEC and sudden infant death syndrome (SIDS).

The age-specific incidence for ARIs, LRTIs, OM, and AG was retrieved from the 2010 Annual Morbidity Report of the National Epidemiologic Surveillance System, which includes weekly data on new cases of 114 mandatory reportable diseases receiving health care at primary care facilities and hospitals (15).

Case counts include a compilation of several codes of the *International Classification of Diseases, 10th edition* (16), corresponding to the same syndrome (**Appendix A**). Reported cumulative incidences for these diseases were estimated for the 2010 Census population (17). We estimated the number of new cases for each disease in 2012 using the projected population for that year (17) and assuming invariant incidence. In Mexico, the incidence of disease for infants <1 y is not reported monthly but aggregated into one single age category in the system, so we divided the cases into 2 age groups (<6 mo and 6 to <12 mo), assuming equal incidence by age. NEC cases were estimated by assuming an average weighted incidence among low and very low weight at birth in the United States of 1.03% (18) and an estimated prevalence of preterm births in the Latin American region of 8% (19). SIDS cases were derived from Global Burden of Disease country estimations (20).

Definitions

Following WHO age-specific recommendations (21), we defined EBF as being fed exclusively with breast milk, partial breastfeeding (PBF) as receiving breast milk along with other fluids or solids (which may include formula), and exclusive formula feeding (EFF) as not receiving breast milk and which may include other liquids or solids. Similarly, we defined inadequate breastfeeding as not following the WHO recommendations for infant feeding relative to breast-milk consumption. The number of children in each feeding category in the cohort of 2,643,908 (17) infants born in Mexico in 2012 was calculated by using estimates of current prevalences of feeding practices reported by participants of the household-based National Health and Nutrition Survey (ENSANUT 2012; Spanish abbreviation) (14). We assumed 95% as the maximal potential proportion of EBF for children <6 mo as well as for PBF for children 6 to <12 mo old, with 5% of no breastfeeding for children in both age groups (**Table 1**) due to health constraints to breastfeeding, allowing for the infrequent cases when breastfeeding is not possible, such as maternal cancer and other severe illness (e.g., tuberculosis or hemorrhagic fever, among others) or death, child adoption, or some infant metabolic diseases (e.g., galactosemia or phenylketonuria) (22).

Morbidity estimations

We adapted Weimer and Bartick models to estimate the number cases of ARIs, LRTIs, OM, AG, NEC, and SIDS attributable to not breastfeeding (8, 23). Given the high prevalence of PBF (receiving both breast milk and formula) in Mexico (14) (Table 1), to avoid overestimating the costs of inadequate breastfeeding practices if we considered these partially breastfed infants as not breastfed, we derived the number of cases of disease of the partially breastfed infants according to their estimated risk related to EBF. Therefore, to estimate the number of cases we assumed that the overall cumulative incidence of a specific disease is a weighted sum of the age-specific incidence in 3 mutually exclusive groups (EBF, PBF, and EFF):

$$S = x(b_{EBF}) + r_{PBF}x(b_{PBF}) + r_{EFF}x(1 - b_{EBF} - b_{PBF})(1)$$

where S is the overall incidence of a given disease in the population, b_{EBF} is the estimated proportion of EBF children in the ENSANUT 2012, x is the incidence of the disease in the EBF group, r_{PBF} is the OR of disease comparing PBF to EBF, r_{EFF} is the OR of disease comparing EFF with EBF, and b_{EFF} the estimated proportion of children who were EFF in the same survey.

We derived the incidence of each of the selected illnesses in the EBF group (x) from Equation 1 to estimate the incidence (deaths from SIDS) in each feeding group; then we multiplied each incidence by the number of births in 2012 (17) to obtain the number of cases of each condition. To estimate the number of cases attributable to not breastfeeding, we computed the difference between the number of cases under current feeding practices and those expected to occur with breastfeeding rates of 95% for the 2 age groups (EBF for children <6 mo old and PBF for those 6 to <12 mo old).

TABLE 1
Reported feeding patterns of Mexican infants in 2006 and 2012

	Proportion in the group, %	
Age group and feeding practices	2006	2012
First 3 d of life		
Exclusive breastfeeding	56	56
<6 mo		
Exclusively breastfed	22	14
Partially breastfed	56	58
6 to <12 mo		
Exclusive formula fed	22	28
Partially breastfed	68	61
Formula fed	32	39

The formula described above applies to all diseases modeled (including deaths from SIDS). For NEC, we slightly modified the formula because the risk of NEC was measured against a breastfeeding initiation (at birth) rate of 56.1%, estimated by using the master data files from the ENSANUT 2012 (Table 1).

In addition to estimating the costs of inadequate breastfeeding practices in 2012, we estimated the costs attributable to the observed reduction in breastfeeding rates in Mexico between 2006 and 2012 (Table 1) using the same methodology, assuming a linear decline in the prevalence of breastfeeding over the period and the midpoint population size over the same time span, and assuming constant incidences of disease over time.

Excess risk

Evidence on the increased risk of infant diseases associated with inappropriate breastfeeding practices was mainly obtained from 2 comprehensive publications with systematic reviews and meta-analyses summarizing the scientific evidence on the relation between breastfeeding and different health outcomes (1, 3). We reviewed several of the individual studies contained in these reviews as well as other sources (24–26). For all health outcomes, when information was available, we retrieved risk reductions expressed as ORs of disease of EBF and PBF both compared with formula-fed infants.

Estimation of costs

The model estimates the economic costs of inadequate breastfeeding practices as the sum of the direct health care costs of the 6 selected illnesses, lost future earnings due to premature infant death associated with inadequate breastfeeding practices, and the costs of purchasing nonspecial infant formula (or "first milk" formulas for <1-y-old infants, excluding the most expensive special formulas such as hydrolyzed, lactose free, nighttime formula, transition formula, formula with probiotics, or soy milk formula; from here on referred to as "formula"). We estimated direct health care costs by multiplying the number of cases attributable to inadequate breastfeeding practices by the cost of each case. Except for NEC, costs were retrieved from actuarial estimations conducted in 2001 for the Seguro Popular (People's Insurance), a government-run health insurance organization (27). These costs were estimated by mapping all procedures and activities recommended by the Mexican norms and from the international literature. Fixed costs included time-prorated health care professional costs; services such as electricity, water, and maintenance; infrastructure (building); furniture; and medical instruments. Variable costs included medications, laboratory tests, and other medical supplies. Costs were adjusted for inflation to reflect 2012 prices (28). For NEC, the cost of a surgical case was approximated by using information from a published study (29) and assuming the costs in the United States are, on average, 2.7 times higher than in Mexico (comparing costs for the other diseases modeled by using the costs from the Seguro Popular and Bartick's estimations) (8).

The estimated number of deaths associated with inadequate breastfeeding practices was the product of the estimated number of pediatric cases by the case fatality rate for each health outcome. The case fatality was obtained by dividing the number of reported infant deaths in 2010 related to the specific illness by the total number of estimated cases. The lost future earnings due to premature infant death were then computed by assuming an individual productivity loss equivalent to the annual gross national product per adult of working age in Mexico of $20,223 (2012 US dollars) (30) for 35 y of lost labor (31) starting at 16 y of life (by the time a newborn would have started working) and a 3% discount rate.

Sensitivity analysis to incidence cases (expected incidence)

A sensitivity analysis was carried out to provide a range of costs based on different assumptions of the number of incident cases of all infant health outcomes examined. Except for NEC and SIDS, we retrieved data on the incidence of health conditions from the Mexican National Surveillance System (ARIs, LRTIs, OM, and AG) (15). As in most countries, clinical practitioners in Mexico submit surveillance information on providing health care for new cases of disease. This approach results in structural underreporting and underestimation because only cases at health care facilities are reported and counted. Other sources of underestimation include suboptimal clinical or laboratory diagnostic capacity, missing or delayed reporting to public health authorities, negligent or intentional filtering of information, and other similar inaccuracies.

To explore how much our conclusions were affected by these information biases, we conducted sensitivity analyses using alternative sources of information, such as estimates derived from the Global Burden of Disease methods, which combine epidemiologic surveillance data with variables from systematic reviews of research literature under explicit assumptions. Alternatively, methods that calculate the proportion of underreporting in surveillance, such as the catchment-recatchment approach (32), would have allowed us to adjust our estimates, but these calculations are not readily available and are beyond the scope of this article. Our sensitivity analysis showed a range of costs associated with inadequate breastfeeding from reported incidence and expected incidence (derived from the literature).

Costs of infant formula

To estimate the costs of infant formula consumption partially or totally replacing breastfeeding, we multiplied kilograms of infant formula sold in the country in 2012 by the average price/kilogram of the 2 most commonly consumed types of infant formula during the first year of life: initiation and continuation formulas. The overall price of infant formula was calculated as a weighted average by using data on sales and kilograms by formula brand. We obtained the kilograms of infant formula sold by extracting 2012 sales of all infant formula brands reported by Nielsen infant formula retail data (33). We derived average monthly caloric requirements of formula for partially or totally formula-fed infants (34) on the basis of monthly weight of Mexican infants (infant weight by month; ENSANUT 2012 master data files for anthropometric measurements; 2012, JP Gutiérrez, J Rivera-Dommarco, T Shamah-Levy, S Villalpando-Hernández, A Franco, L Cuevas-Nasu, M Romero-Martínez, M Hernández-Ávila, unpublished data) and distributed the total sales in each age group (<6 mo and 6 to <12 mo) and by feeding practice (partially breastfed and formula-fed groups; specific results not shown). To avoid overestimating the costs of

formula, we used kilograms of infant formula sold instead of total caloric requirements. We did that because we observed that the estimated milk consumption requirements exceeded the estimated total infant formula consumption on the basis of national pediatric values of age and anthropometric data. Such differences could result from infants not consuming the recommended amount of milk, by overdiluting the formula, by not consuming infant formulas (e.g., cow milk), or by consuming less milk. We may have estimation errors due to errors in assumed energy requirements or in milk consumption. In terms of requirements errors, we know that breastfed infants have a lower energy requirement than do formula-fed infants (35–37), and we did not use different estimates. As for potential consumption errors, we might be mistaken in the assumed amount of breast milk consumed by partially breastfed infants (some might receive only 1 feeding/d and others almost all of their feedings from breast milk), but as long any formula is consumed, infants were considered partially breastfed, as recommended by the WHO indicators (21), and we assumed that partially breastfed infants consumed half their milk from the breast and the rest from formula. All prices reported in Mexican pesos were converted to US dollars by using the average currency exchange rate for 2012 (38).

RESULTS

Table 2 presents the variables used in the model: reported and expected incidence rates, case fatality rates, ORs of disease attributable to inadequate breastfeeding for the studied infectious diseases and SIDS, and direct health care costs for each health outcome. **Table 3** shows the estimated amount (kg) and costs of infant formula under current feeding practices (2012) and optimal breastfeeding. The cumulated cost of infant formula associated with inadequate breastfeeding practices in 2012 alone accounted for $289.9 million.

Table 4 presents the number of cases, deaths, and economic costs associated with not breastfeeding under the base case and sensitivity scenarios. The sensitivity analysis showed that direct and indirect costs associated with no breastfeeding (health care costs and lost future earnings due to premature death) range from $455.7 million to $2126.6 million. With the addition of infant formula costs, our model estimated that the total costs incurred by failing to breastfeed infants born in 2012 as recommended by the WHO (2012) range from $745.7 million to ~$2.41 billion.

Finally, assuming the same variables, we estimated that the decrease in the breastfeeding prevalence both exclusive and partial in Mexico from 2006 to 2012 was associated with a cost that ranges from approximately $3.7 billion/y (on average, $642.7 million/y) to $11.6 billion/y (on average, $1.9 billion/y), including morbidity, mortality, and infant formula costs (**Appendix B**).

DISCUSSION

We estimated the costs associated with inadequate breastfeeding practices in <1-y-old infants born in Mexico in 2012. These costs include both the cumulative number of cases of several acute infectious illnesses (ARIs, LTRIs, AG, OM, and NEC) and SIDS, as well as the economic costs related to these cases. Costs of inadequate breastfeeding practices included the following: *1*) direct health care costs of the diseases associated with suboptimal breastfeeding, *2*) lost future earnings due to premature death, and *3*) the costs of purchasing infant formula. We conducted a sensitivity analysis to address the underestimation of reported cases in the country using incidence estimates from the literature to obtain estimates of the expected incidence.

Our results show that the total pediatric costs of inadequate breastfeeding in Mexico, only for 2012, range from $745.5 million to $2.4 billion, where the costs of infant formula accounted for 11–38% of the total costs. A range of 1.1–3.8 million reported cases of disease and 933–5796 infant deaths/y for the diseases under study were attributed to inadequate infant breastfeeding practices, which altogether represent nearly 27% of the absolute number of episodes of such diseases. Our estimations also show that the country lost between $3.7 billion and $11.6 billion between 2006 and 2012 with the decrease in breastfeeding prevalence.

Our model is based on several assumptions. First, values for the variables of increased risk attributed to suboptimal breastfeeding were derived from pooled estimates in different meta-analyses

TABLE 2
Incidence, case fatality rate, increased odds associated with suboptimal breastfeeding, and direct health care costs by health outcome[1]

	Annual cumulative incidence (ref), %		ORs of disease (ref)[2]					
				EFF vs. EBF		PBF vs. EBF		
Acute health outcome	Reported incidence	Expected incidence	Case fatality rate	Point estimate	(95% CI)	Point estimate	(95% CI)	Direct health care costs/case, US$
Acute upper respiratory infection	138.6	158.0 (39)	0.02	2.70 (24)	(1.35, 5.55)	<6 mo: 1.18 (24) 6 to <12 mo: 1.14 (24)	(0.93, 1.49) (0.86, 1.51)	77.8
Lower respiratory infection	1.43	8.0 (40)	3.3	3.57 (25)	(1.85, 7.14)	2.08 (26)	(1.47, 2.90)	1505.8
Otitis media	1.24	27.6 (41)	0.01	2.00 (3)	(1.43, 2.78)	1.30 (3)	(1.10, 1.56)	80.9
Acute gastroenteritis	19.6	320 (40)	0.11	3.70 (43)	(0.95, 15.02)	<6 mo: 2.94 (43) 6 to <12 mo: 1.54 (43)	(0.51, 17.33) (0.26, 9.36)	43.7
Necrotizing enterocolitis	0.088 (17)	0.25 (42)	16.8	2.38 (3)		—	—	97,806 (29)
Sudden infant death syndrome	0.008 (19)		—	1.56 (3)	(1.23, 1.75)	1.56	(1.23, 1.75)	—

[1]EBF, exclusive breastfeeding; EFF, exclusive formula feeding; PBF, partial breastfeeding; ref, reference.
[2]ORs by age group (<6 mo and 6 to <12 mo) only when estimations were available in the literature.

TABLE 3
Estimated costs of infant formula

Feeding practices	Estimated share of total consumption[2] (0–12 mo), %	Total kg of infant formula, millions	Total costs of infant formula,[3] millions US$	Costs of inadequate breastfeeding associated with infant formula expenses, millions US$
Current feeding practices (2012)				
PBF	48.5	18.02	420.6	289.9
EFF	51.5			
Optimal breastfeeding[4]				
PBF	78.7	5.05	117.8	
EFF	21.3			

[1]EFF, exclusive formula feeding; PBF, partial breastfeeding.
[2]By feeding type.
[3]Average price per kg of formula: $23.34.
[4]95% breastfeeding.

(1, 3). We acknowledge that the comparison groups, follow-up times, breastfeeding duration, and methods to collect information on feeding patterns generating such estimates were heterogeneous. However, we chose pooled estimates over individual studies because interval estimates of risk quantify heterogeneity across studies.

Second, most published evidence on the increased risk of infant diseases associated with inappropriate breastfeeding practices comes from industrialized countries (1, 3). We expect larger risks of disease associated with inadequate breastfeeding in a developing country such as Mexico; therefore, our current cost estimates may be downward biased (44).

Other causes of underestimation of the burden of inadequate breastfeeding are as follows: we did not estimate costs related to nonregistered diseases for which breastfeeding offers protection during the first year of life, such as atopic dermatitis or inflammatory bowel disease (45); neither did we estimate disease and mortality protection offered to children by breastfeeding during the second year of life with these same diseases nor for other chronic diseases such as leukemia, types 1 and 2 diabetes, mental health (46), or lower intelligence quotient. When calculating the costs of purchasing formula, we estimated only those related to "first milk" formulas for <1-y-old infants and excluded the most expensive special formulas such as hydrolyzed, lactose free, night-time formula, transition formula, formula with probiotics, or soy milk formula, which are considerably more expensive than the most consumed first-milk formula.

Other underestimations include reduced costs and improved health related to the mother. It has been documented that breastfeeding offers protection against breast and ovarian cancer, type 2 diabetes, and postpartum depression (1, 3). On the other hand, we did not estimate costs of breastfeeding such as lost maternal salary should the mother decide not to work during lactation or the costs involved in purchasing more food due to her increased nutritional requirements during lactation (47). We believe that our case reduction and cost estimations are conservative and downward biased.

Finally, disease incidence and mortality data for infants in Mexico are not reported disaggregated by month. In our model, we divided cases into 2 age groups of equal span (<6 mo and 6 to <12 mo) assuming the same cumulative incidence in both. We acknowledge that the incidence of several childhood diseases, especially those with an infectious etiology, decreases over time and that much of the harm occurs when infants are not exclusively breastfed during the first semester of life. Therefore, our model underestimates the risk of disease and death in the younger group, providing a conservative scenario.

TABLE 4
Estimated annual number of cases, deaths, and economic costs of health care and milk formula during the first year of life associated with inadequate breastfeeding infants in Mexico: reported and expected incidence

	Cases, *n*		Deaths, *n*		Direct health care costs, millions US$		Lost future earnings, millions US$		Total costs for infectious diseases, millions US$	
Acute health outcome	Reported incidence	Expected incidence	Reported incidence	Expected incidence	Reported incidence	Expected incidence	Reported incidence	Expected incidence	Reported incidence	Expected incidence
Upper respiratory infection	1,019,403	1,161,782	159	182	79.3	90.4	43.1	49.2	122.4	139.6
Lower respiratory infection	13,838	77,203	458	2558	20.8	116.3	124.1	692.6	144.9	808.8
Otitis media	7092	157,349	0	10	0.5	12.7	0	2.7	0.5	15.4
Gastroenteritis	144,337	2,352,915	163	2653	6.3	102.8	44.1	718.4	50.4	82
Necrotizing enterocolitis	783	2214	132	372	76.5	216.6	35.7	100.7	112.3	317.3
Sudden infant death syndrome	209	209	21	21	—	—	24.2	24.2	24.2	24.2
Total	1,184,670	3,751,672	933	5796	183.6	538.8	272.1	1587.9	455.7	2126.6

[1]Total costs of inadequate breastfeeding (in millions US$): results for reported incidence = $455.7 (direct costs + lost future earnings) + $289.9 (infant formula); results for expected incidence = $2126.6 (direct costs + lost future earnings) + $289.9 (infant formula).

The model did not estimate the opportunity costs associated with the time mothers spend breastfeeding compared with time spent feeding a child with infant formula. Such estimation would require information on time allocation to feeding that is not available in the country. Although mothers may spend more time breastfeeding their infants compared with bottle-feeding, as has been suggested earlier (48), time budget estimations should include time spent in preparing/sterilizing the bottles and time spent by other caregivers responsible for feeding the child with a bottle (either with infant formula or mother's milk), plus the time spent in caring for the sick infant.

Mothers who work outside their homes and who choose to breastfeed might find it difficult to maintain their commitment to full-time employment. However, the lost income related to a reduced labor time may not correspond to the reduced salary received for part-time work. Research is needed to understand how to estimate these costs, which may well be zero.

Previous work in Mexico in this area has documented the cost-effectiveness of hospital-based breastfeeding promotion programs (49). Results showed substantial benefits in infant health and survival and that breastfeeding promotion can be one of the most cost-effective interventions. The estimations included only benefits from reduced diarrhea morbidity and mortality and ARI mortality, and our mortality reductions are similar to this previous study for these diseases.

The present study provides, for the first time to our knowledge, estimates on the costs of inadequate breastfeeding in Mexico. The costs presented in this article provide the minimum amount that the country should invest to achieve better rates of breastfeeding. Future research is needed to estimate the most cost-effective interventions to increase breastfeeding rates in Mexico. For instance, Brazil is an example of great success in increasing breastfeeding: the country went from 1 of 2 women who breastfed until the second or third month in 1975 to 1 of 2 women who breastfed for 10 mo in 1999 (50). Brazil has achieved these rates by using a combination of approaches from laws and regulation of baby food products, training programs at the federal and local levels, education campaigns, and several communication strategies. Government funding supports such efforts. Recent research has identified key components that national breastfeeding programs must have to be successful. These include advocacy, evaluation research, political will, legislation, funding, training programs, mass communications for promotion, and a decentralized national coordination to improve breastfeeding outcomes on a large scale (51, 52). This recent research contrasted the cases of Brazil and Mexico and pointed to those key elements that are absent in Mexico and which could explain Mexico's poor performance.

Mexico is now striving toward more equitable health care access for the neediest populations through the previously mentioned Seguro Popular. However, breastfeeding promotion, protection, and support efforts have traditionally been conspicuously absent from the national health care plans. In Mexico, there is a large social program targeted to the poorest families, the Human Development Program *Oportunidades*, which serves almost 6 million families. This program is currently scaling-up to the national level and includes an educational component focused on infant feeding practices, which contains breastfeeding as a major topic. It is highly desirable that such strong commitment be nationally scaled up, so that we can improve infant feeding practices, saving thousands of lives yearly and hundreds of millions of dollars.

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APPENDIX A

Health outcomes and ICD-10 codes[1]

Health outcome	Disease	ICD-10 codes
Gastroenteritis	Bacterial and viral intestinal infections	A04
	Viral and other specified intestinal infections, including rotaviral enteritis	A08
	Other gastroenteritis and colitis of infectious and unspecified origin	A09
	Other protozoal intestinal diseases	A07.0, A07.2, A07.9
Acute respiratory infections	Acute upper respiratory infections	J00–J06, J20, J21, except for J02.0 and J03.0
Child pneumonia	Lower respiratory infections	J12–J18, except for J18.2
Acute otitis media	Acute otitis media	H65.0–H65.1
NEC	Necrotizing enterocolitis	P77X
SIDS	Sudden infant death syndrome	R95

[1]ICD-10, *International Classification of Diseases, 10th edition*.

APPENDIX B

Estimated numbers of cases, deaths, and economic costs of health care and milk formula during the first year of life associated with change over 6 y (2006–2012) in inadequate breastfeeding practices in Mexico: reported and expected incidence

	Cases, *n*		Deaths, *n*		Total costs, millions US$	
Health outcome	Reported incidence	Expected incidence	Reported incidence	Expected incidence	Reported incidence	Expected incidence
LRTI	58,313	326,229	1932	10,808	611.0	3418.0
ARI	5,066,011	5,773,440	791	902	608.5	693.5
Gastroenteritis	687,935	11,214,429	775	12,641	240.0	3913.0
Otitis media	34,382	0	765,281	47	2.8	74.5
NEC	4024	11,385	678	1914	577.1	1631.8
SIDS	440	—	440	—	119.1	119.1
Total over 6 y	5,851,105	17,325,483	769,898	26,311	2,159	9850
Formula costs					1703.0	1780.0
Total costs of inadequate breastfeeding					3743.1	11,630.8

[1]ARI, acute upper respiratory infection; LRTI, lower respiratory tract infection; NEC, necrotizing enterocolitis; SIDS, sudden infant death syndrome.