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Original Article

Reconsidering childhood undernutrition: can birth spacing make a difference? An analysis of the 2002–2003 El Salvador National Family Health Survey

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Abstract

It is well understood that undernutrition underpins much of child morbidity and mortality in less developed countries, but the causes of undernutrition are complex and interrelated, requiring a multipronged approach for intervention. This paper uses a subsample of 3853 children under age 5 from the most recent family health survey in El Salvador to examine the relationship between birth spacing and childhood undernutrition (stunting and underweight). While recent research and guidance suggest that birth spacing of three to five years contributes to lower levels of infant and childhood mortality, little attention has been given to the possibility that short birth intervals have longer-term effects on childhood nutrition status. The analysis controls for clustering effects arising from siblings being included in the subsample, as well as variables that are associated with household resources, household structure, reproductive history and outcomes, and household social environment. The results of the multiple regression analyses find that in comparison to intervals of 36–59 months, birth intervals of less than 24 months and intervals of 24–35 months significantly increase the odds of stunting (<24 months Odds Ratio (OR) = 1.52; 95% confidence interval (CI): 1.21–1.92; 25–36 months OR = 1.30; 95% CI: 1.05–1.64). Other factors related to stunting and underweight include standard of living index quintile, child's age, mother's education, low birthweight, use of prenatal care, and region of the country where the child lives. Policy and program implications include more effective use of health services and outreach programs to counsel mothers on family planning, breastfeeding, and well child care.

Keywords: anthropometry, birth interval, child growth, international child health nutrition, stunting, wasting.

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Introduction

It is well understood that undernutrition underpins much of child morbidity and mortality in less developed countries (Lopez *et al.* 2006). In spite efforts to improve the nutritional status of high-risk children, it is not unusual for a large percentage of them to suffer some type and degree of undernutrition, based on anthropometrics indicators (Chevassus-Agnes 1999; Swinburn 2004). The damage of undernutrition, which can begin as early as pregnancy and last through 2 years of age, is largely irreversible and carries negative consequences through adulthood. Thus, the window for addressing the long-term consequences of childhood undernutrition is critical and short – from pre-pregnancy to 2 years of age (Shrimpton *et al.* 2001; Victora *et al.* 2008). While nutrition programs aimed to address food security and improved and increased food intake are a logical strategy for addressing undernutrition, there are other more complex strategies, such as access to and use of health services, improved hygiene, and poverty reduction, that are being addressed through new types of partnerships that confront the root causes of undernutrition (World Bank 2006).

One factor that may predispose children to childhood undernutrition that has received little attention is birth spacing, or the time elapsed between consecutive births of children. The relationship between birth spacing and infant and child mortality is well studied, but fewer studies have examined the link between birth spacing and childhood undernutrition. Evidence suggests that if pregnancies and births are spaced too closely, women may not have the opportunity to replenish their nutritional stores stressed during pregnancy and/or breastfeeding, which results in predisposing infants and children to adverse outcomes, including preterm birth, low birthweight, as well as stunting and underweight (Conde Agudelo 2002; Rutstein 2003). If in fact, birth spacing is significantly related to childhood undernutrition, efforts to increase support for family planning programs would also contribute not only to reductions in maternal and child mortality, but to improved child health and development as well.

This paper uses the 2002–2003 El Salvador National Family Health Survey [Encuesta Nacional de Salud Familiar (FESAL)] to determine the extent to which short birth intervals might be associated with stunting (low height-for-age) and underweight (low weight-for-age) among children under 5 years of age. Specifically, we hypothesize that short birth intervals may predispose children to a higher risk of childhood undernutrition. Our objectives are to explore how short birth intervals may increase the risk of stunting and underweight, and to identify policy and programmatic efforts that can contribute to reducing the risk of undernutrition, including healthy timing and spacing of pregnancies.

Background

As a region, Latin America and the Caribbean (LAC) has experienced decreasing levels of undernutrition over the last three decades. Despite advances, the prevalence of undernutrition is still of public health concern, as undernutrition plays an important role in childhood mortality, morbidity and ability to reach developmental potential (Schroeder & Brown 1994; Pelletier *et al.* 1995). According to the United Nations Children's Fund (2004), in the LAC region, 16% of children under the age of 5 years are stunted, 8% are underweight and 2% are wasted (low weight-for-height). While stunting has declined since 1980 in the sub-regions of South America and the Caribbean, Central America has seen little progress in this regard (de Onis *et al.* 2000). In El Salvador, between 1988 and 2002, stunting dropped slightly from 23% to 19%; over the same time, prevalence of underweight remained at approximately half that of stunting and dropped from 11% to 10% [Asociación Demográfica Salvadoreña (ADS) 1994, 2000, 2004].

Although relatively few researchers have examined the impact of preceding birth intervals, defined as the time elapsed between the birth of a previous child and the birth of a subsequent 'index child', on a child's nutritional status, a review of the available evidence confirms that birth intervals can affect nutritional outcomes, though the degree to which the relationship holds varies substantially (Dewey & Cohen 2007). Research drawing on data from 17 countries shows children born after preceding birth intervals between 3 and 5 years experienced substantially reduced nutritional risks compared to shorter birth intervals of less than 2 years (Rutstein 2005), but the relationship may be more complex and require controlling for potential confounders.

Stunting (low height-for-age)

Short birth intervals may increase the risk for stunting, which captures the long-term and cumulative effects of poor dietary intake and/or lengthy illness on nutrition status of the child (de Onis *et al.* 2000). Rutstein (2005) observed a strong relationship between stunting and birth interval, noting a nearly linear decrease in stunting with increasing birth interval length. In particular, children born following an interval of less than 18 months were 43% more likely to suffer from stunting than children born following an interval of 60 months or longer. Research by Boerma & Bicego (1992) on 17 Demographic and Health Surveys (DHS) surveys and Aerts *et al.*'s (2004) data from Brazil found that children with short preceding birth intervals were more likely to experience stunting than those with longer preceding birth intervals.

Longer intervals of more than 3 years can also provide protection against stunting. In particular, compared to intervals between 24 and 29 months, intervals between 36 and 41 months were associated with up to a 29% decrease in the risk of stunting (Rutstein 2003). Olinto *et al.* (1993) found similar results in Brazil, with children born after intervals of 3 years or longer experiencing a lower risk for stunting than their counterparts born after intervals shorter than 3 years.

Underweight (low weight-for-age)

Low weight-for-age represents a composite index of both weight-for-height and height-for-age and, thus, is a measure of both acute and chronic undernutrition. Short birth intervals can increase the risk for underweight, and as birth intervals grow longer, risk of underweight decreases. In Boerma & Bicego's (1992) analysis, the impact of short intervals on underweight was slightly larger than for stunting; however, birth intervals of more than 3 years offered a protective effect from underweight. Rutstein's (2003) findings were similar; in comparing intervals of 24–29 months and 36–41 months, the longer intervals were associated with a 29% decrease in underweight. Mozumder *et al.* (2000) also determined that birth intervals (either preceding or succeeding) of 2 years or less were associated with underweight in children.

Methodology

Data

The following analysis draws on data collected as part of the 2002–2003 El Salvador National Family Health Survey (FESAL) conducted by the ADS, with technical assistance from the US Centers for Disease Control and Prevention. The survey sample was determined through random probability sampling methods. A total of 10 689 women of reproductive age (ages 15–49) completed the interview. Because the outcomes are related to infant and child mortality, the dataset for these analyses was organized so that the unit of observation is the child, rather than the mother. Each observation includes information about both the mother and the child. The FESAL includes information on 5868 children born in the 5 years prior to the survey.

Because the analysis examines the relationship between preceding birth spacing and dependent variables stunting and underweight, first births are excluded from the sample because they lack a preceding birth interval. Similarly, we restricted the subsample to singleton births, thus eliminating the confounding effect of multiple births, which experience higher rates of mortality and other adverse outcomes (Ibraham *et al.* 1994). Anthropometric data were available for a total of 3853 index children in this subsample of second- and higher-order births.

The independent variables of stunting and underweight assessments are drawn from anthropometric measures in the 2002–2003 FESAL, which used normalized z-scores for height-for-age and weight-for-age. Using the National Center for Health Statistics (NCHS)/World Health Organization standards (World Health Organization Working Group 1986), children are classified as stunted or underweight if their z-score for the aforementioned categories is two or more standard deviations below the mean. Using these standards, 18.9% of the entire under-five population in the survey was stunted and 10.3% was underweight. In the subsample used in this analysis, we observe 843 cases (21.8%) of stunting and 386 cases (10.0%) of underweight. In total, 939 children (24.4% of the sample) present some form of undernutrition (including wasting).

Birth interval length in El Salvador has increased during the last two decades. Median intervals reported in the 1993 and 1998 FESAL surveys (29.9 and 39.6 months, respectively) are much shorter than the median found in the 2002–2003 survey (53.8 months) (ADS 1994, 2000, 2004). Approximately 23% of the index children in the sample were born following birth intervals of less than 24 months (referred to as 'short birth intervals'), 30% after intervals of 24–35 months, 26% after intervals of 36–59 months, and 21% after intervals of 60 months or longer (see Table 1).

Analysis

The analysis of the association between stunting and underweight and the independent variables began by examining frequency distributions, using SPSS Version 12.0. Two-way (bivariate) analyses of the independent categorical variables were conducted using chi-squared tests to determine if statistical associations with stunting and underweight existed. In the third stage of the analysis, we used multiple logistic regression as the statistical model to examine the relationship between birth intervals and dependent variables stunting and underweight. We selected this approach because stunting and underweight are dichotomous variables. The subsample included 3853 children, and information on those children was obtained through interviews with 3032 mothers, which means that some of the mothers had more than one child in the subsample. Because 821 children in the subsample also had siblings in the subsample and because siblings in the subsample share some of the same background characteristics (i.e. household and maternal characteristics), they are not independent observations. We controlled for this clustering by using the 'robust cluster' subcommand of the 'logistic'

Table 1. Frequency distributions of predictor variables for stunting and underweight

Variable	n ($n = 3853$)	Percentage
Birth intervals		
Birth interval <23 months	902	23.4
Birth interval 24–35 months	1152	29.9
Birth interval 36–59 months‡	998	25.9
Birth interval ≥60 months	801	20.8
Household resources		
Lowest SLI quintile	1610	41.8
Lower middle SLI quintile	840	21.8
Middle SLI quintile‡	578	15.0
Upper middle SLI quintile	428	11.1
Highest SLI quintile	397	10.3
Lives in rural area	2431	63.1
Lives in urban area‡	1422	36.9
No education	855	22.2
Education 1–3 years	902	23.4
Education 4–6 years‡	929	24.1
Education 7–9 years	624	16.2
Education 10 or more years	543	14.1
Household structure		
Birth order 6 or higher	616	16.0
Birth order 2 to 5‡	3237	84.0
0 to 11 months of age‡	678	17.6
12 to 23 months	713	18.5
24 to 35 months	821	21.3
36 to 47 months	790	20.5
48 to 59 months	852	22.1
Reproductive history and outcomes		
Previous child died	551	14.3
No previous child died‡	3302	85.7
Low birthweight	239	6.2
Normal birthweight‡	2038	52.9
Missing birthweight data	1576	40.9
Wanted pregnancy‡	2844	73.8
Did not want pregnancy	1009	26.2
Standard prenatal care‡	1553	40.3
Below-standard prenatal care	1734	45.0
No prenatal care	566	14.7
Delivery at home	1557	40.4
Delivery at health facility‡	2296	59.6
Social environment of household		
Occidental	771	20
Central	451	11.7
Metropolitan‡	643	16.7
Paracentral	1067	27.7
Oriental	921	23.9

SLI, standard of living index. ‡indicates reference group in logistic regressions.

command in STATA Version 9 to fit the logistic regression and obtain unbiased standard errors.

Predictor variables

In general, risk factors for adverse nutritional outcomes during infancy and childhood are largely determined by a child's prenatal and post-natal environment and health behaviours practiced within the environment, including socio-economic position, breastfeeding practices and size of household. This analysis considers similar predictor variables that are organized into similar conceptual categories similar to those used by Heaton *et al.* (2005): household resources, household structure, reproductive history and outcomes, and the social environment of the household (see Table 2 for predictor variables and evidence of their impact on nutritional outcomes). Additional variables such as breastfeeding, mother's exposure to violence, child's sex, mother's age and civil status were initially examined but are not statistically significant, and are therefore not included in subsequent analyses. Table 3 provides a description and treatment of the variables used in the analysis.

Results

Stunting

Frequencies for the predictor variables are shown in Table 1. Results of bivariate analysis and multiple logistic regression on stunting are shown in Table 4.

Birth intervals

Of central interest in this analysis is the relationship between preceding birth intervals and nutritional outcomes. As length of the birth interval increases, the risk of stunting decreases. Among children born after an interval of less than 24 months, 28% are stunted. Prevalence of stunting decreases as birth interval increases, and among children born after 60 months or more, only 14% are stunted. In the multiple logistic model, being born after an interval of less than 24 months increases the odds of stunting by more than 1.52 times, in comparison to intervals of 36 to 59 months. Similarly, intervals of 24 to 35 months are associated with an increase of 1.30 times the odds of stunting, in comparison with 36 to 59 months. There is little evidence that intervals of 60 months or more have significant association with stunting.

Household resources

The relationship between poor standard of living index (SLI) status (poorest 40% of population) and stunting is statistically significant and strong. Almost 33% of children in the lowest SLI quintile and 20% in the lower–middle quintile were stunted; as the SLI quintile increases, the risk of stunting decreases. In comparison to the middle SLI quintile, being in the lowest quintile more than doubled the odds of stunting. On the other hand, being in the highest quintile had a marginally significant effect of reducing the odds of stunting. Children living in rural areas have a higher prevalence of stunting, but the association was not significant in the multiple logistic regression.

Maternal education is also associated with stunting. In the bivariate analysis, as mother's education increases, the risk of stunting decreases; almost 30% of children whose mothers had 3 or fewer years of education experienced stunting. In the regression, children whose mothers had never attended school experienced a 1.51 times increase in the odds of stunting compared to children whose mothers had 4 to 6 years of schooling. Similarly, children whose mothers had 1 to 3 years of schooling had a 1.32 times increase in the odds of stunting. At the other end of the spectrum, children whose mothers had 10 or more years of school had a significantly lower odds of stunting that was 0.47 times that of children whose mothers had 4 to 6 years of schooling.

Household structure

Of the factors related to household structure, child age had a significant association with stunting. In comparison to infants, the odds of stunting were between 3.52 and 4.07 times higher for older children. Also related to stunting is high-birth order; in the bivariate analysis, higher-birth-order children experi-

Table 2. Predictor variables and evidence for inclusion in model

Variable	Impact on child nutrition status	Reference
Household resources		
Low standard of living index*	Poverty is associated with poor nutritional outcomes.	Nestel *et al.* 1999; Ricci & Becker 1996; Filmer & Pritchett 2001
Rural residence	Associated with undernutrition given seasonality of food availability	Madzingira 1995; Adair & Guilkey 1997; Larrea & Kawachi 2005
Low maternal education	Children are more likely to suffer from malnutrition when their mothers have lower levels of education; risk of child malnutrition decreases with mother's education.	Mozumder *et al.* 2000; Ojofeitimi *et al.* 2003; Nestel *et al.* 1999
Household structure		
Large family size; Higher-order births	Children of larger families are more likely to be malnourished. With more children, nutritional status of all children, particularly higher-order children worsens, especially in families with ≥5 children.	Jeyaseelan & Lakshman 1997; Mozumder *et al.* 2000; Paknawin-Mock *et al.* 2000; Reichenheim & Harpham 1990; de Carvalho Lima *et al*. 2004
Child age under 3 years	Period between the second half of infancy (6 months)–3 years, children are vulnerable to malnutrition, which may be related to weaning practices. Children <3 years suffer more from diarrhoea and respiratory infections than older children, which can cause, result from or exacerbate poor nutrition	Nestel *et al.* 1999
Reproductive history and outcomes		
Death of older sibling	Children living in homes where there has been a previous child death experienced an increased risk of malnutrition. Maternal stress brought about by the death of a child had negative consequences on health and well-being of surviving children	Reichenheim & Harpham 1990; Van den Broeck *et al.* 1996
Low birthweight (≤2500 gm)	Determinant of future nutritional status, especially during the first 6 months of life. Risk for low birthweight was highest among children born short and long intervals (i.e. <21 months and >69 months)	Arifeen *et al.* 2000; Kolsteren *et al.* 1997; Adair & Guilkey 1997; de Carvalho Lima *et al.* 2004; Conde-Agudelo 2002; Zhu *et al.* 1999, 2001
Unplanned pregnancy	An unplanned pregnancy may affect prenatal care seeking and other services, affecting child health outcomes. In the Dominican Republic, children from unplanned pregnancies were more likely to be stunted.	Joyce *et al.* 2000; Jensen & Ahlburg 1999; Safonova & Leparsky 1998; Montgomery *et al.* 1997
Receipt of prenatal care	Health and nutrition promotion during pregnancy via prenatal care can influence the health and nutrition of the newborn and throughout childhood. Late initiation of/lack of prenatal care can impact fetal development and impact birthweight and other outcomes.	Engle *et al.* 1999; Gülmezoglu *et al.* 1997
Home birth	Giving birth at home may indicate limited access to health services, which is associated with stunting and poverty.	Larrea & Kawachi 2005
Social environment of the household		
Geographic region of country	Geographic region may affect the social environment of the household and may provide a means of identifying priority areas for nutritional problems	Context specific

*Socio-economic status is estimated with standard of living index (SLI) quintiles (Filmer & Pritchett 2001). The SLI is calculated for the entire sample of women in the Encuesta Nacional de Salud Familiar, with 20% of the sample in each quintile regardless of whether they have had children in the past five years. In this subsample, SLI quintiles are not evenly distributed because the children are assigned the SLI value of their mothers.

Table 3. Predictor variable description and treatment in analysis

Variable	Description	Treatment
Birth spacing	Months between birth of index child and previous child	4 categories; 3 dummy variables
Household resources		
Low standard of living	Index based on household characteristics and assets	Mothers' responses serve as basis for creating 5 quintiles; 4 dummy variables
Rural residence	Urban or rural location of mother's home	2 categories, 1 dummy variable
Low maternal education	Mother's highest level of educational attainment	5 categories, 4 dummy variables
Household structure		
Large family size; higher-order births	Low (2 to 5) order and high (6 and higher) order	2 categories, 1 dummy variable
Child age	Age of index child (in months) at time of interview	5 categories, 4 dummy variables
Reproductive history and outcomes		
Death of older sibling	Whether or not the index child has had an older sibling die	2 categories, 1 dummy variable
Low birthweight (≤2500 gm)	Index child weighed 2500 g or less at birth or during the first week of life	3 categories, 2 dummy variables*
Unplanned pregnancy	Mother's report of whether or not she wanted to become pregnant with index child	2 categories, 1 dummy variable
Receipt of prenatal care	Extent to which mother received prenatal care when pregnant with index child (El Salvadoran Ministry of Health standard of care, some care, and no care)	3 categories, 2 dummy variables
Home birth	Whether or not the index child was born at home or at a health facility	2 categories, 1 dummy variable
Social environment of the household		
Geographic region of country	Region of country where mother resides	5 categories, 4 dummy variables

*Because of missing data for birthweight, a dummy variable for 'missing' was created so as not to exclude those cases from the analysis.

enced a higher odds of stunting, but in the multiple logistic regression, the result was not significant.

Reproductive history and outcomes

In the bivariate analyses, most of the factors related to reproductive history and outcomes increased the prevalence of stunting: the death of a previous child, low birthweight, an unplanned pregnancy, use of prenatal care and giving birth at home. In the multiple logistic model, children who had a low birthweight experienced almost a doubling in the odds of stunting compared to normal-birthweight children; bivariate analyses indicated that prevalence of stunting was also almost twice as high among low-birthweight children. Prevalence of stunting among children who received some prenatal care, but below Ministry of Health (MOH) norms, was higher than children whose mothers received MOH standard prenatal care; prevalence of stunting was highest among those children who did not receive any prenatal care. In the multiple logistic regression, below-standard prenatal care increased the odds of stunting by 1.27 times in comparison to children who received care according to MOH norms. Children who had an older sibling die and children born at home had higher prevalences of stunting, but neither was significant in the multiple logistic model.

Social environment of household

The social environment of the household was also associated with stunting. Children in the Western region have the highest prevalence of stunting (29%),

Table 4. Rate of stunting by predictor variables and odds ratios of predictor variables on stunting

Variable	*n* ($n = 3852$)	Rate per 100 children		Odds ratios	
		Value	*P*-value*	Value	*P*-value†
Birth intervals					
Birth interval <24 months	902	28.3	<0.001	1.52	<0.001
Birth interval 24–35 months	1153	25.4		1.30	0.018
Birth interval 36–59 months	995	18.3		1.00	
Birth interval ≥60 months	802	14.1		0.95	0.696
Household resources					
Lowest SLI quintile	1611	32.7	<0.001	2.11	<0.001
Lower middle SLI quintile	840	20.5		1.31	0.096
Middle SLI quintile	580	13.4		1.00	
Upper middle SLI quintile	426	9.9		0.83	0.405
Highest SLI quintile	394	6.3		0.62	0.058
Lives in rural area	2431	26.9	<0.001	0.83	0.131
Lives in urban area	1422	13.3		1.00	
No education	856	32.8	<0.001	1.51	0.001
Education 1–3 years	900	27.4		1.32	0.024
Education 4–6 years	929	20.1		1.00	
Education 7–9 years	623	15.1		0.96	0.808
Education 10 or more years	545	6.2		0.47	0.001
Household structure					
Birth order 6 or higher	617	30.3	<0.001	0.97	0.803
Birth order 2 to 5	3236	20.3		1.00	
0 to 11 months – child age	676	8.4	<0.001	1.00	
12 to 23 months – child age	714	24.8		3.81	<0.001
24 to 35 months – child age	820	23.8		3.52	<0.001
36 to 47 months – child age	791	24.3		3.63	<0.001
48 to 59 months – child age	852	26.1		4.07	<0.001
Reproductive history and outcomes					
Previous child died	551	27.2	0.001	0.97	0.818
No previous child died	3302	21.0		1.00	
Low birthweight	237	30.8	<0.001	1.97	<0.001
Normal birthweight	2039	18.4		1.00	
Missing data on birthweight	1577	25.0		0.93	0.484
Unwanted pregnancy	1011	24.4	0.022	1.08	0.402
Wanted pregnancy	2842	21.0		1.00	
Standard prenatal care	2301	18.3	<0.001	1.00	
Below standard prenatal care	984	25.3		1.27	0.018
No prenatal care	568	30.5		1.01	0.920
Delivery at home	1567	29.3	<0.001	1.16	0.126
Delivery at health facility	2286	16.8		1.00	
Social environment of household					
Western region	770	28.6	<0.001	1.05	0.782
Central region	451	24.2		0.82	0.306
Metropolitan region	645	16.6		1.00	
Paracentral region	1066	22.7		0.73	0.047
Eastern region	921	17.9		0.58	0.001

SLI, standard of living index. *Clustering was not controlled for in the bivariate analyses (shown as rate per 100 children), which means that the estimates of standard errors and *P*-values associated with the chi-squared tests are biased. †*P*-values for bivariate analyses based on chi-squared tests and *P*-values for odds ratio based on multiple logistic regression model that includes all predictor variables and takes account of clustering.

while children in Metropolitan San Salvador had the lowest prevalence of stunting (17%). In the multiple logistic model, children living in the Paracentral and Eastern regions experienced a significantly lower odds of stunting than children living in Metropolitan San Salvador.

Underweight

Results of bivariate analysis and multiple logistic regression on underweight are shown in Table 5.

Birth intervals

In the bivariate analysis, short birth intervals were significantly associated with underweight. As birth interval lengthened to 3 years and longer, the prevalence of underweight decreased. However, in the multiple logistic model, birth interval length was not significant.

Household resources

SLI quintile were associated with underweight, as well as the place of residence and the mother's education. In the bivariate analysis, as SLI quintile increased, the prevalence of underweight children decreased. However, only children in the lowest quintile experienced a significant increase in the odds of underweight; the odds of underweight among children in the lowest quintile were 1.86 times that of children in the middle quintile. The prevalence of underweight children living in rural areas was almost twice as high as that of children living in urban areas, but the relationship was not significant in the multiple logistic regression. Mother's education was also associated with underweight: children whose mothers had 3 or fewer years of schooling were most likely to have underweight children; as educational attainment increased, the proportion of underweight children decreased. In the multiple logistic model, the only significant effect was among women with 10 or more years of schooling: in comparison to children whose mothers had 4 to 6 years of education, the odds of underweight was 0.46, suggesting that higher levels of education reduces the odds of underweight.

Household structure

In the bivariate analyses, both child age and birth order were associated with underweight. In comparison to infants, older children experienced prevalences of underweight that were three to four times as high. In the multiple logistic model, the size and significance of the effects of being between ages 12 and 59 months indicated that age is a very important risk factor for underweight. In comparison to infants, children ages 12 to 23 months and 24 to 35 months experience very large increases in the odds of underweight (4.04 and 3.95, respectively). Although higher-order births experienced a higher prevalence of underweight in the bivariate analysis, birth order was not significant in the multiple logistic regression.

Reproductive history and outcomes

The only reproductive history or outcome variables associated with the prevalence of underweight were low birthweight and delivery at home. In the bivariate analysis, children with low birthweight had a prevalence of underweight that was twice as high as the rate among normal-weight children (16.5% vs. 7.9%). In the multiple logistic model, low birthweight remained large and significant: those children experienced an odds of underweight that was 2.27 times that of normal-weight children. Children born at home had a higher prevalence of underweight, but the variable was not significant in the multiple logistic model.

Social environment of the household

Again, region of country had a significant predictor. In the bivariate analysis, children in the Western region had the highest proportion of underweight children (14.3%), followed by the Central region (11.6%). In the multiple logistic model, being from the Paracentral region and, to a lesser degree, the Eastern region was associated with a significant reduction in the odds of underweight in comparison to children in the Metropolitan San Salvador region.

Table 5. Rate of underweight by predictor variables and odds ratios of predictor variables on underweight

Variable	*n*	Rate per 100 children		Odds ratio	
	(*n* = 3853)	Value	*P*-value*	Value	*P*-value†
Birth intervals					
Birth interval <24 months	902	11.5	<0.001	1.21	0.245
Birth interval 24–35 months	1153	12.1		1.26	0.115
Birth interval 36–59 months	995	8.8		1.00	
Birth interval ≥60 months	802	6.7		0.94	0.725
Household resources					
Lowest SLI quintile	1611	15.3	<0.001	1.86	0.002
Lower middle SLI quintile	840	8.5		1.10	0.644
Middle SLI quintile	580	6.6		1.00	
Upper middle SLI quintile	426	4.7		0.80	0.422
Highest SLI quintile	396	2.8		0.55	0.084
Lives in rural area	2431	12.3	<0.001	0.90	0.522
Lives in urban area	1422	6.2		1.00	
No education	856	14.6	<0.001	1.31	0.106
Education 1–3 years	900	13.1		1.31	0.092
Education 4–6 years	929	9.4		1.00	0.000
Education 7–9 years	623	6.6		0.88	0.517
Education 10 or more years	545	2.8		0.46	0.011
Household structure					
Birth order 6 or higher	617	13.0	0.008	0.93	0.650
Birth order 2 to 5	3236	9.5		1.00	
0 to 11 months – child age	676	3.6	<0.001	1.00	
12 to 23 months – child age	714	12.9		4.04	<0.001
24 to 35 months – child age	820	12.7		3.95	<0.001
36 to 47 months – child age	791	10.0		2.95	<0.001
48 to 59 months – child age	852	10.2		3.09	<0.001
Reproductive history and outcomes					
Previous child died	551	11.4	0.232	0.92	0.565
No previous child died	3302	9.8		1.00	
Low birthweight	237	16.5	<0.001	2.27	<0.001
Normal birthweight	2039	7.9		1.00	
Missing data on birthweight	1577	11.8		1.12	0.373
Unwanted pregnancy	1011	11.0	0.236	1.08	0.544
Wanted pregnancy	2842	9.7		1.00	
Standard prenatal care	2301	9.2	0.096	1.00	
Below standard prenatal care	984	11.5		1.06	0.636
No prenatal care	568	10.9		0.76	0.124
Delivery at home	1567	13.4	<0.001	1.18	0.209
Delivery at health facility	2284	7.7		1.00	
Social environment of household					
Western region	770	14.3	<0.001	1.12	0.577
Central region	451	11.6		0.85	0.480
Metropolitan region	645	8.3		1.00	
Paracentral region	1066	9.5		0.61	0.013
Eastern region	921	8.5		0.68	0.066

SLI, standard of living index. *Clustering was not controlled for in the bivariate analyses (shown as rate per 100 children), which means that the estimates of standard errors and *P*-values associated with the chi-squared tests are biased. †*P*-values for bivariate analyses based on chi-squared tests and *P*-values for odds ratio based on multiple logistic regression model that includes all predictor variables and takes account of clustering.

Discussion

Stunting and underweight are the two most common forms of undernutrition in El Salvador, with stunting being approximately twice as common as underweight. Stunting is associated with long-term factors and reflects the cumulative effects of chronic undernutrition and frequent illness since birth and even in the womb. As an indicator for policy and program development and planning, stunting is very sensitive to socio-economic inequalities, which provides insight into some of the findings in this analysis. Underweight, which is a composite indicator, fluctuates more over time than stunting, and reflects current and acute as well as chronic undernutrition (INDEPTH Network 2006). As indicators that draw on children's height, weight, and age, stunting and underweight are intrinsically linked. Although the analyses yield more statistically significant results for stunting, the findings and their implications may also be meaningful in addressing underweight, given the qualitative similarity in trends and patterns for stunting and underweight.

Although the FESAL offers the opportunity to conduct a preliminary examination of the relationship between birth spacing and undernutrition, it has a number of limitations due in part to being a cross-sectional general health survey. It does not include maternal characteristics, such as height or weight at the time of each pregnancy; that type of information is only available at the time of the survey. Recorded birthweight is based on the mother's recall and not verified by any external source, which explains the missing data (41%) on the variable. Information on breastfeeding was only collected on the last birth; therefore, information on breastfeeding is missing on 20% of the children because they did not represent the mother's last birth in the 5 years preceding the interview. In addition, the survey does not include specific information on dietary intake that would normally be part of a nutrition survey. Population-based surveys, such as the FESAL, have been improving collection and measurement of infant and young child feeding, including breastfeeding, so additional data will be available in future surveys. Without these data restrictions, the results of the analysis would be stronger. Nevertheless, the existing data are very useful for exploring the research hypothesis. In addition to these limitations with the data, we did not control for clustering during bivariate analysis and, as a result, have biased estimates of standard errors and P-values associated with the chi-squared tests; this issue, however, was addressed when fitting the multivariate logistic regression.

Short birth intervals are associated with an elevated risk of stunting, which is the most common form of childhood undernutrition in El Salvador. Intervals of 24 to 35 months are also associated with an increased risk of stunting. As a cross-sectional survey, the FESAL does not provide evidence to support a causal relationship. Nevertheless, the findings do suggest that birth intervals of less than 3 years are either directly related to stunting or act as a proxy for a risk factor that is either unobserved or not included in the analysis. These findings support previous studies that find an association between short intervals and undernutrition. Unlike some previous studies, we did not find that longer birth intervals are also associated with an increase in the odds of undernutrition.

Child age is also an extremely significant predictor of the adverse nutrition outcomes, and supports findings in the scientific literature related to children's risk of undernutrition increasing with age. In general, after infancy, our findings indicate that the odds of stunting are quite high and relatively consistent. As the literature suggests, part of the association between age and undernutrition may be related to breastfeeding during infancy, which provides children with high-quality nutrition. The results indicate that, in comparison to infancy, the odds of stunting and underweight are significantly higher, especially between ages 12 and 23 months. This relationship may be due to weaning and inappropriate or inadequate complementary feeding practices that contribute to lower resistance to pathogens related to diarrhoeal disease and acute respiratory infections – two common illnesses that contribute to and compound childhood weight loss. While breastfeeding status *per se* was not significant in the bivariate analyses, the FESAL data indicate that 94% were breastfed for some period of time.

A third predictor of stunting and underweight is low birthweight, which is associated with a broad range of adverse consequences on infants and children. We found statistically significant and independent relationships of both low birthweight and short birth intervals on stunting. Our findings corroborate previous studies in which low birthweight is associated with poor nutritional status during infancy and early childhood and support the need to intervene during pregnancy (or prior to) to prevent low-birthweight infants. The relationships between low birthweight, short birth intervals and child undernutrition are complex and further research is needed to better understand them.

Other significant associations with stunting, such as low maternal education, being in the lowest SLI quintile, and insufficient use of prenatal care may all be interrelated, as suggested earlier, reflecting ways that stunting is associated with socio-economic inequalities via limited access to health services, household food insecurity, and the likelihood of poor environmental conditions (access to clean water, hygienic conditions for food preparation) increasing the likelihood of illness. These results corroborate the scientific literature, with one exception that merits closer examination: while insufficient use of prenatal care was associated with stunting, the complete absence of prenatal care was not. By relying on the norms established by the Ministry of Health of El Salvador to guide our variable specification, we may have missed a better way of examining the association between undernutrition and use of prenatal care. Our findings also suggest that children living in the Paracentral and Eastern regions of El Salvador have a lower odds of being stunted and underweight. However, based on the results published in the FESAL final report, the Paracentral and Eastern regions do not necessarily have the highest levels of development nor the most advanced infrastructure (ADS 2004).

In the bivariate analyses for stunting, four additional variables (living in a rural area, sixth or higher birth order, death of a previous child and unwanted pregnancy) were statistically significant. However, when the multiple logistic regression was fit, these predictors were no longer statistically significant, likely due to confounding by including other predictor variables in the model and covariance between predictors. For example, the significant odds ratio for mothers not having attended school is likely to be associated with rural residence and birth order of six or higher. Similarly, death of a previous child and unwanted pregnancy are likely to be associated with being in the lowest SLI quintile. It is very difficult to tease out the relationships between several of the predictor variables: a poor child living in a rural area, born to a mother who never attended school and who has already had many children is likely to characterize many children at risk for undernutrition in El Salvador. In spite of the possible interrelatedness of the predictors in the multivariate model, the association between short intervals and stunting remains consistent and significant.

If there is a direct association between short birth intervals and undernutrition, then many of our findings have implications for the quality of care provided by the health care system and opportunities for outreach services and community health workers. The window for intervention in undernutrition is short (before pregnancy to 2 years of age), and the findings suggest opportune points of time to reach women of reproductive age to provide counselling and promote health behaviours to prevent child undernutrition risks – preconception, prenatal, post-partum, infancy and early childhood (2 years). Improving utilization of health facility and outreach services and promoting specific health behaviours such as breastfeeding, birth spacing, improved hygienic practices (clean water and food preparation), recognition and treatment of childhood diarrhoeal and respiratory infections could mediate many of the factors affecting stunting and underweight. For example, only 60% of children in the subsample received the level of prenatal care proscribed by MOH norms and only 48% of women seek postpartum care with 6 weeks of delivery. If use of these basic but important types of care was increased, providers could take advantage of more opportunities to promote health behaviours among mothers of young children. At the same time, although 67% of married women use family planning, approximately half of all users have chosen sterilization, which does not offer any benefits related to the spacing on future pregnancies (ADS 2004). Higher acceptance of temporary methods, such as oral contraceptives, injectables, condoms, intrauterine device, could, however, contribute to longer and healthier birth intervals.

Because many of the risk factors for stunting and underweight are also tied to poverty, an effective approach that could be used to address undernutrition is a strategy that targets the poor and provides education about and access to health services and incentives to use them. Since the completion of the 2002–2003 FESAL, the Government of El Salvador has begun implementing a conditional cash transfer program called the 'Solidarity Network'. Directed towards extremely poor families in priority areas, one of the program's objectives is the improvement of the health and nutritional status of children under the age of 5 years through improving food intake for children and pregnant and lactating women, vaccinations against childhood diseases, and growth monitoring. Although El Salvador's program was not initiated until 2006, conditional cash transfer programs in Latin America have generally been successful in stimulating use of health services, among other priority targeted behavioural changes (Rawlings & Rubio 2003). During the first year of implementation, use of health services for infants increased by 83% and use of post-natal care increased by 62% in the 15 poorest municipalities (Red Solidaria 2006). Conditional cash transfer programs have had positive effects on child nutritional status in Nicaragua (Maluccio & Flores 2004) and in Colombia (Attanasio *et al.* 2005). These advances may, in time, be reflected in national health surveys such as the FESAL. Nevertheless, by focusing on improved use of health services and nutritional status, the program addresses some of the critical risk factors identified in this analysis, including opportunities to promote healthy timing and spacing of pregnancies.

Through facilitating appropriate and healthy birth intervals, family planning may contribute to improving childhood nutrition, as well as reduce the number of unplanned pregnancies. Birth spacing can also contribute to a lower proportion of children born with low birthweight, which was found to be a significant predictor of both stunting and underweight. While the underlying causes of childhood undernutrition are numerous and complex, existing health programs can be better used to effectively promote healthy timing and spacing of pregnancies and contribute to a range of positive health outcomes for children.

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