

Maternal behavior and experience, care access, and agency as determinants of child diarrhea in Bolivia

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ABSTRACT

Objective. *In Latin America and the Caribbean, Bolivia has the third highest rate of mortality among children under five years of age (57 per 1 000), with 14.0% of under-five deaths attributable to diarrhea. Because a child's world is predominantly controlled by and experienced through his or her mother, this investigation aims to understand what maternal dimensions may determine child diarrhea.*

Methods. *Variables were selected from the 2003 Bolivia Demographic and Health Survey to create indices of three maternal dimensions using principal components analysis: behavior and experience, access to care, and agency. The three indices were included in a logistic regression model while controlling for economic status, maternal education, and residence type.*

Results. *A total of 4 383 women who had children less than 5 years old were included in the final sample and 25.0% of mothers reported that their most recent born child had experienced an episode of diarrhea in the 2 weeks before the survey. Mothers with high levels of maternal agency or of high economic status were significantly less likely to report their child experienced an episode of diarrhea than women of low levels. Women with primary education were significantly more likely to report that their child experienced diarrhea than women with no education.*

Conclusions. *High levels of agency have a significant protective effect even when controlling for other factors. Increasing maternal agency could have a positive impact on child health in Bolivia, and future work should aim to understand what accounts for different levels of agency and how it may be strengthened.*

Key words

Diarrhea; logistic models; maternal behavior; Bolivia.

More than 9 million children under age 5 years died worldwide in 2007 and two-thirds of those deaths were reported to be from preventable causes (1, 2). Of under-five child deaths globally, 17.0% are attributable to diarrheal diseases and 1.0% are attributable to neonatal diarrheal diseases, which translates to about

1.5 million under-five deaths per year or 5 000 preventable diarrheal deaths per day (1, 3). Bolivia has the third highest rate of under-five child mortality in Latin America and the Caribbean (57/1 000), with 14.3% of deaths attributable to diarrheal diseases (2, 4). Bolivia has the fourth highest percentage of deaths attributable to diarrheal diseases in Latin America and the Caribbean, which is also higher than the 10.1% of deaths attributable to diarrhea in Latin America and the Caribbean region (2, 4).

Child diarrhea needs to be understood through the mother because a child's

world is predominantly controlled by and experienced through the mother. Additionally, the extent to which a mother can care for her child is governed by various familial, social, and cultural factors. The mother is linked to her child biologically and also takes care of her child's basic needs. When a mother is absent due to maternal death, there is an increased likelihood of child morbidity and mortality (5–8). Low socioeconomic status, lack of maternal education, unsatisfactory health knowledge, short birth intervals, poor hygiene practices, inadequate disposal of child's stools, and in-

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sufficient breastfeeding are maternal factors that have been linked to an increased risk of child morbidity and mortality due to diarrhea (9–17). The influence of breastfeeding has been the most thoroughly studied maternal factor affecting a child's risk of diarrhea. Mothers who initiated breastfeeding early, exclusively breastfed, and gave sufficient quantities of breast milk to their children better protected them from diarrhea than women who did not breastfeed in the first few days of life, did not exclusively breastfeed, or did not give their children sufficient quantities of breast milk (18–24). Breastfeeding has also been shown to be beneficial to children already suffering from diarrhea. A case-control study in Nigeria found that there was a lower incidence of persistent diarrhea—lasting 14 days or more—among children who breastfed than among children who did not (25). Therefore, it is evident that mothers play an important role in keeping their children alive and healthy, and this role is increasingly important when considering preventable diseases like diarrhea. There is a need to identify and understand the specific factors in the mother's life that may protect or put her child at risk of morbidity or mortality due to diarrhea.

Some maternal factors have been demonstrated to influence child morbidity and mortality generally, but specific links to diarrheal diseases have been left unaddressed. For example, while it is known that the childbirth process, maternal nutrition, maternal decision-making power, and a woman's freedom of mobility all influence her child's health, it is not understood how these factors may influence a child's risk of diarrhea (26–29). These factors, as well as those already known to influence a child's risk of diarrhea, should be investigated collectively to understand the cumulative influence maternal factors have on a child's risk of diarrhea. Understanding the collective influence of maternal factors could inform prevention and treatment strategies and attempts to establish a continuum of maternal, newborn, and child health care to reduce morbidity and mortality related to preventable diarrheal diseases. No studies have engaged the cumulative influence of various maternal factors on a child's risk of diarrhea, and only a few studies have looked at the influence of multiple maternal factors on aspects of child health.

Those that do examine multiple maternal factors have limited their investigations to dimensions of maternal empowerment or autonomy (27, 28). There is a need to engage other dimensions of maternal influence—specifically, maternal behaviors and experience or access to care—and assess whether and how these dimensions may also contribute to a child's risk of diarrheal disease.

Investigating the cumulative effect of various maternal factors simultaneously is difficult because it requires a large number of variables to be included in a single logistic model. However, principal components analysis (PCA) allows for many variables to be condensed into indices representing singular dimensions. PCA has been used to create indices of wealth when income or expenditure data have not been available (30–32). Similarly, PCA can be used to create indices of different maternal dimensions using multiple maternal factors. Utilizing PCA to create indices of maternal dimensions has not been done before, and the use of it in this report represents a novel methodologic approach.

Using the 2003 Bolivia Demographic and Health Survey data, this investigation seeks to identify and understand the specific factors in a mother's life that may protect or put her child at risk of morbidity due to diarrhea. Attention was paid to those factors that have already been demonstrated to be determinants of diarrhea or child health in general, but factors that have yet to be studied were also included. Moving beyond simpler investigations of wealth, education, breastfeeding, and birth spacing, this investigation aggregates the many and varied factors in a mother's life into indices, using PCA, and aims to understand the cumulative effects of maternal behavior and experience, access to care, and agency to establish whether these maternal dimensions can determine a child's risk of diarrhea in Bolivia.

MATERIALS AND METHODS

Model

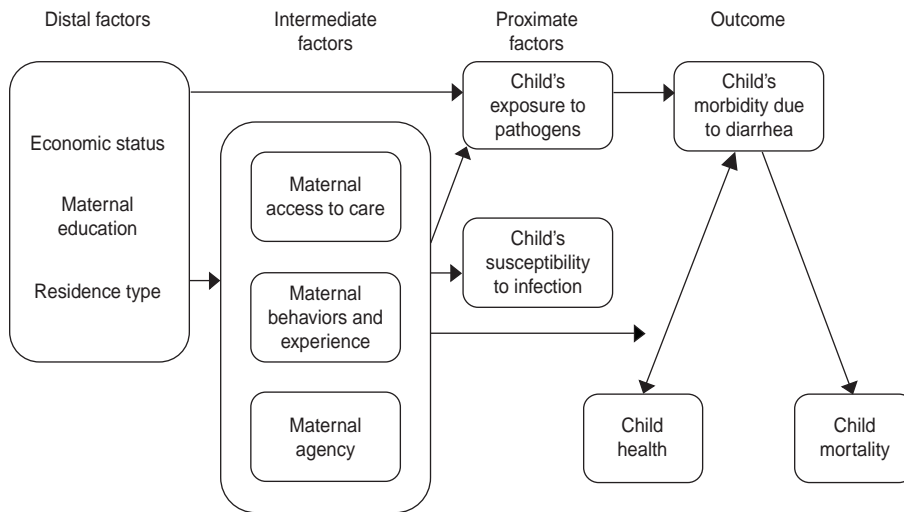
With the aim of improving child survival through informed policy and targeted medical intervention, Mosley and Chen presented a framework for child survival that merges social and biological influences on child health (33). Following the example of Davis and Blake,

they argue that distal, or socioeconomic and cultural, factors operate through proximate, or biological, determinants to influence child mortality (34). They also assert that child survival is not always a singular event but may be the cumulative effect of many events. Therefore, their outcome captures both morbidity and mortality. Building on this foundation, Millard proposed a framework with intermediate, or behavioral, factors, claiming that they function between the distal and proximate factors (35).

Distal factors must also operate through the mother in order to determine how the child may experience proximate factors because a child's world is predominantly controlled by and experienced through his or her mother. The framework in this paper (Figure 1) is based on the work of Mosley and Chen but emphasizes the intermediate factors as proposed by Millard. Following Hatt and Waters, it groups proximate factors and expresses them as exposure to pathogens, which includes variables like water, food, soil and air, and susceptibility to infection, which includes nutrition, age, gender, and genetic factors (36). Although proximate factors are indicated in the framework, the present work focuses exclusively on the mother and these factors are not considered here. The intermediate factors in this study, however, do not simply include behaviors. Rather, understanding what characteristics about the mothers who are still alive that are likely to influence the odds of positive or negative health despite distal factors—like economic status, education, and place of residence—is also of interest here.

The three intermediate factors of concern include maternal behavior and experience, maternal access to care, and maternal agency. Components of the maternal behavior and experience factor include those that point directly to a mother's behaviors in the present as well as experiences in the past. In previous studies, reproductive, childcare, and household behaviors and experiences have been identified as central themes for maternal behavior and experience from which to base variable selection (24, 37–39). Components of maternal access to care include factors that identify the resources and tools women use with regard to their own health and well-being. Reproductive care, personal care, and health knowledge have been identi-

FIGURE 1. Maternal factors including maternal access to care, maternal behaviors and experience, and maternal agency influence the likelihood of a child getting diarrhea



Note: arrows indicate direction of influence from one factor to the next; arrow from the three maternal factors interrupts the arrow linking child morbidity and child health to indicate how maternal factors can influence whether a child is healthy or sick.

fied as central themes from which to base variable selection (2, 40, 41). Components of the maternal agency factor include those that identify how a woman “formulate[s] strategic choices . . . control[s] resources that effect important life outcomes” (42). In addition, following Kishor, this paper considers agency not simply as an end product that measures a woman’s current extent of agency but as a process that incorporates access to factors that may increase their agency (27). Therefore, this paper defines agency as the ability to utilize and control resources, to make choices, and to formulate and act on ideas that prioritize personal opinion, needs, and well-being. With this definition in mind, mobility control, decision control, financial control, attitudes about domestic violence, and the nature of the woman’s relationship with her husband have been identified as central themes from which to base variable selection (27, 28, 43–45).

Data selection

Data from the 2003 Bolivia Demographic and Health Survey (DHS) were analyzed for this investigation. DHS data are nationally representative and are collected using a two-stage stratified multicluster sample. Data were collected from 9 August 2003 through 23 January 2004 by 300 interviewers trained in DHS standard procedures (46). For this inves-

tigation, the individual female data set was used and the original sample of 17 654 respondents was confined to include only the 9 987 women with children under 5 years of age.

Outcome variable

The Bolivia DHS asks mothers if their child has experienced diarrhea in the 2 weeks before the survey. For this investigation, whether the most recent child (the child most recently born to the mother interviewed) experienced an episode of diarrhea is of primary interest.

Distal factors

Distal factors include economic status, maternal education, and residence type. Income data are not collected by the DHS, although economic status is represented in the data by the wealth index variable that was created by assessing household assets using principal components analysis (47, 48). Maternal education is a categorical variable and assesses the level of education attained (none, primary, secondary, or higher). Place of residence is urban or rural.

Intermediate factors

The number of variables was determined by what was available in the DHS and aimed to include all variables rele-

vant to the theme without being redundant. Variables were then discarded if their sample sizes were low (< 3 000) or if other available variables were stronger indicators, based on the opinions and literature review of the authors, of the key themes they were chosen to represent (Table 1). For all variables with categorical responses, questions were reframed to generate only dichotomous responses indicating whether a woman answered positively to the optimal choice provided. Choices were deemed optimal or not optimal based on a review of the literature (21, 24, 27, 28, 38–46, 49, 50). A woman’s response became a 1 if she answered yes to the optimal choice indicated, and she received a 0 if she answered otherwise. In other words, an optimal response is defined as the best possible answer among the choices available. All questions about birth relate to the most recent birth (Table 1). Women who did not respond to each of the questions selected were eliminated from the sample, resulting in a final sample size of 4 383.

Creating the indices

Once variables were identified, recoded, and organized into indices, PCA was carried out using Stata (version 10) to reduce the variables in each index to a single variable. The PCA approach applies a factor score to each woman who answered all the questions in the index (30, 31). Essentially, the more positive, or 1, responses a woman provides, the higher her score. A higher score, therefore, indicates better access to care, maternal behaviors and experience, or maternal agency. The raw scores were recoded into quartiles so as to function on a relative scale. Dividing the scores into quartiles, as opposed to recording absolute values, enables future comparison with other countries and over time if the analysis is repeated (32, 51).

Statistical analysis

Using Stata, odds ratios (ORs), 95.0% confidence intervals (95.0% CI), and *P* values (< 0.05 was considered significant) were calculated for each of the variables in the indices as well as for each of the indices (exposures) themselves to determine their individual impact on whether a woman’s child experienced diarrhea in the 2 weeks before the survey

TABLE 1. Variables used in indices of maternal factors that affect a child's risk of diarrhea and how they were defined and categorized, Bolivia, 2003

| Variable | Optimal response | Theme |
|--|---|----------------------------|
| Access to health care | | |
| Health facility visit | 1 = visited health facility in last 12 months | Personal care |
| Barriers to health care ^a | 1 = does not have 2 or more of potential barriers to care | Personal care |
| Pap smear | 1 = has had a pap smear | Personal care |
| Unmet need for contraception ^b | 1 = does not have unmet need | Personal care |
| Prenatal care ^c | 1 = has had at least 3 prenatal visits with one in first 6 months | Reproductive care |
| Delivery location and assistance ^d | 1 = delivered at a medical institution with health professional | Reproductive care |
| Health check post-partum | 1 = health professional checked health | Reproductive care |
| Knowledge of sexually transmitted diseases | 1 = knowledge of sexually transmitted diseases | Health knowledge |
| Knowledge of AIDS | 1 = knowledge of AIDS | Health knowledge |
| Knowledge of oral rehydration solution | 1 = knowledge of oral rehydration solution | Health knowledge |
| Maternal behavior and experience | | |
| Respondent age at first birth | 1 = older than 18 at first birth | Reproductive behavior |
| Parity | 1 = parity is less than 4 (2003 DHS total fertility rate) | Reproductive behavior |
| Preceding birth interval ^e | 1 = preceding birth interval is greater than 24 months | Reproductive behavior |
| Child death in the family | 1 = does not have any children that have died | Childcare behavior |
| Breastfeeding initiation | 1 = breastfed immediately | Childcare behavior |
| Breastfeeding duration ^f | 1 = still breastfeeding or breastfed at least 6 months | Childcare behavior |
| Supplemental feeding in first 3 days of life | 1 = gave nothing supplemental in first 3 days of child's life | Childcare behavior |
| Child's stool disposal ^g | 1 = disposed of stools adequately | Household behavior |
| Maternal agency | | |
| Decision on visits to family/friends | 1 = respondent decides | Mobility control |
| Respondent works | 1 = works | Financial control |
| Respondent's income to household expenses ^h | 1 = half or >half income to household, not all | Financial control |
| Decision on how money is spent | 1 = couple jointly decides | Financial control |
| Decision on large purchases | 1 = couple jointly decides | Financial control |
| Decision on daily purchases | 1 = couple jointly decides | Financial control |
| Decision on contraceptive use | 1 = respondent decided | Decision control |
| Decision on own health care | 1 = respondent decides | Decision control |
| Decision on food to be cooked that day | 1 = couple jointly decides | Decision control |
| Pregnancy intention ⁱ | 1 = wanted last child | Decision control |
| Attitude toward domestic violence | 1 = believes domestic violence never justified | Domestic violence attitude |
| Respondent marital and living situation | 1 = married and living with husband | Nature of relationship |
| Age difference ^j | Continuous: -41 to 20 | Nature of relationship |
| Education difference ^k | Continuous: -16 to 12 | Nature of relationship |

^a Potential barriers to a woman seeking care included: does not know where to go, needs permission to seek care, needs money for treatment, lives far from health facility, lacks transportation to health facility, does not want to go alone, health provider is a man.

^b Respondent was considered to not have had unmet need for contraception if she was using contraception to space or limit births, if she wanted a child within the next 2 years, or if she was menopausal or infertile.

^c The World Health Organization recommends that women have four visits with one in the first 3 months. For this analysis, three visits in the first 6 months were sufficient to signify that a woman had access to care given that she went multiple times and did not wait until her last trimester.

^d A medical institution was a hospital, clinic, or health post and a medical professional was a doctor, nurse/midwife, or auxiliary midwife.

^e A recent DHS working paper (38) indicated that mortality risk increases significantly for children who had a preceding birth interval of < 24 months.

^f Breastfeeding duration was considered optimal if mother breastfed at least 6 months, regardless of child's age, or indicated she was still breastfeeding.

^g Adequate disposal included: uses toilet, throws in toilet, uses diapers, uses garbage disposal, buries in yard. Inadequate disposal included: throws in yard, rinses away stools, does not dispose of, throws in field or river, other.

^h In having more than half but not all of income going to the household, a woman was financially contributing but still had access to money for her own purposes.

ⁱ In reference to the most recent child, women who answered that they wanted their child but at a later time were not considered to have wanted their child at the time of pregnancy.

^j Calculated as respondent's age minus the age of her partner.

^k Calculated as number of years of education of the respondent minus number of years of education of her partner.

(outcome). Based on recoding the variables, all ORs > 1 indicate increased risk and ORs < 1 indicate a protective effect.

Logistic regression models that included each of the indices with all three distal factors (wealth, education, and residence) were created. Child age was categorized into six groups (< 6 months, 6–11 months, 12–23 months, 24–35 months, 36–47 months, and 48–59 months) and was also included in a logistic regression model with the three indices and the three distal factors. A test for interaction was also run against all three indices in the final model compared with the six

age categories. To determine whether there was a community effect on the outcome, hierarchical modeling was conducted with clustering at the primary sampling unit (52).

RESULTS

The goal of this investigation was to determine the effect of maternal factors—namely, access to care, behavior and experience, and agency—on a mother's likelihood to report that her child experienced diarrhea. In the final data set of 4 383 mothers with children under 5 years

of age, 25.4% (1 113) reported that their child experienced an episode of diarrhea in the 2 weeks before the survey compared with 22.0% in the complete data set.

Bivariate analysis

To understand how each optimal response might individually determine morbidity due to diarrhea, bivariate analysis was conducted (Table 2). For variables in the maternal access to care index, two responses (does not have two or more barriers to care, does not have an unmet need for contraception) demon-

TABLE 2. Prevalence rates and odds of mother reporting her child experienced diarrhea 2 weeks before the survey given exposure to the variable included in the indices, Bolivia, 2003

| Variable | No. | % | Odds ratio | 95% confidence interval |
|---|-------|--------------------|------------|---------------------------|
| Access to care index | | | | |
| Visited health facility last 12 months | 3 381 | 77.14 | 1.295 | 1.094, 1.532 ^a |
| Does not have 2 or more barriers to health care | 1 297 | 29.59 | 0.708 | 0.606, 0.827 ^a |
| Had a pap smear | 1 691 | 38.58 | 0.878 | 0.763, 1.011 |
| Does not have unmet need for contraception | 3 179 | 72.53 | 0.789 | 0.679, 0.915 ^a |
| Had at least 3 prenatal visits with one in first 6 months | 3 775 | 86.13 | 0.927 | 0.763, 1.126 |
| Delivered at medical institution with health professional | 3 475 | 79.28 | 0.851 | 0.722, 1.003 |
| Health professional checked health after birth | 448 | 10.22 | 1.351 | 1.092, 1.676 ^a |
| Heard of sexually transmitted diseases | 3 511 | 80.10 | 1.042 | 0.878, 1.237 |
| Heard of AIDS | 3 354 | 76.52 | 1.009 | 0.859, 1.185 |
| Heard of oral rehydration solution | 3 874 | 88.39 | 1.090 | 0.879, 1.353 |
| Behavior and experience index | | | | |
| Respondent is older than 18 at first birth | 3 204 | 73.10 | 0.691 | 0.596, 0.801 ^a |
| Parity is less than 2003 DHS total fertility rate (4) | 2 702 | 61.65 | 0.817 | 0.711, 0.938 ^a |
| Preceding birth interval greater than 24 months | 3 449 | 78.69 | 0.966 | 0.819, 1.140 |
| No child death in the family | 3 409 | 77.78 | 0.823 | 0.702, 0.966 ^a |
| Breastfeeding initiated immediately | 2 735 | 62.40 | 0.972 | 0.845, 1.118 |
| Breastfeeding duration | 4 171 | 95.16 | 1.356 | 0.963, 1.909 |
| Gave nothing supplemental during first 3 days of child's life | 2 717 | 61.99 | 1.180 | 1.024, 1.360 ^a |
| Child's stools disposed of adequately | 3 360 | 76.66 | 0.650 | 0.557, 0.758 ^a |
| Agency index | | | | |
| Respondent decides on visits to family/friends | 825 | 18.82 | 1.060 | 0.892, 1.260 |
| Respondent works | 2 284 | 52.11 | 0.886 | 0.774, 1.016 |
| Half or > half of respondent's income goes to household expenses, but not all | 1 015 | 23.16 | 0.891 | 0.757, 1.050 |
| Couple jointly decides how money is spent | 690 | 15.74 | 0.851 | 0.703, 1.032 |
| Couple jointly decides on large purchases | 2 968 | 67.72 | 0.745 | 0.646, 0.859 ^a |
| Couple jointly decides on daily purchases | 1 388 | 31.67 | 0.938 | 0.810, 1.086 |
| Respondent decides contraceptive use | 658 | 15.01 | 0.926 | 0.763, 1.123 |
| Respondent decides on own health care | 2 316 | 52.84 | 0.921 | 0.803, 1.055 |
| Couple jointly decides food to be cooked that day | 631 | 14.40 | 0.876 | 0.718, 1.068 |
| Respondent wanted last child at time of pregnancy | 1 660 | 37.87 | 0.764 | 0.662, 0.882 ^a |
| Respondent does not believe domestic violence justified in any situation | 3 398 | 77.53 | 0.797 | 0.680, 0.933 ^a |
| Respondent married and living with husband | 2 527 | 57.65 | 0.704 | 0.614, 0.807 ^a |
| | Mean | Standard deviation | | |
| Difference in age between respondent and partner ^b | -3.26 | 5.23 | 1.003 | 0.990, 1.016 |
| Difference in years of education between respondent and partner ^b | -1.36 | 3.44 | 0.996 | 0.976, 1.016 |

^a Indicates statistical significance: $P < 0.05$.

^b Continuous variables are part of the agency index.

strated significant protective effects, while two responses (visited health facility in the last 12 months, health professional checked health after birth) indicated significantly greater odds of diarrhea given these exposures. For the maternal behavior and experience index, four responses (respondent is older than 18 years at birth of first child, parity is less than four, no child death in the family, child's stools disposed of adequately) demonstrated significant protective effects, while one response (gave child nothing supplemental in the first 3 days of life) indicated significantly greater odds of diarrhea given the exposure. Finally, in the maternal agency index, four variables (couple jointly decides on large purchases, respondent wanted child at time of last pregnancy, respondent does

not believe violence is justified in any situation, respondent married and living with husband) demonstrated significant protective effects. In sum, 11 of the 31 optimal responses in the indices were protective, while three showed the child to be at increased risk given the exposure indicated.

Similarly, bivariate analyses were conducted to determine how the constructed indices in the intermediate dimension and factors in the distal dimension may be associated with the likelihood of a mother reporting that her child experienced an episode of diarrhea (Table 3). Two of the indices and all three of the distal dimensions exhibited significant components. For the maternal access to care index, the highest quartile demonstrated a significant protective effect

compared with the referent (lowest), while no significant association was demonstrated for the high quartile. For the maternal agency index, the high and highest quartiles both demonstrated a significant protective effect compared with the referent, while no significant association was demonstrated for the low quartile. For the distal factors, being in the richer and richest quintiles was significantly protective compared with the referent (poorest), having higher education was significantly protective compared with the referent (no education), and living in an urban area was significantly protective compared with living in a rural area. The highest-ranking components of two of the intermediate and distal factors of interest were significantly protective compared with their referent

TABLE 3. Prevalence rates and odds of a mother reporting her child experienced diarrhea in the 2 weeks before the survey given exposure to maternal indices and distal factors, Bolivia, 2003

| Variable | No. | % | Odds ratio | 95% confidence interval |
|---|-------|-------|------------|---------------------------|
| Maternal access to care index^a | | | | |
| Referent: lowest | 1 099 | 25.07 | 1.0 | NA ^b |
| Low | 1 101 | 25.12 | 0.916 | 0.758, 1.108 |
| High | 1 111 | 25.35 | 1.036 | 0.859, 1.249 |
| Highest | 1 072 | 24.46 | 0.749 | 0.615, 0.913 ^c |
| Maternal experience and behavior index^a | | | | |
| Referent: lowest | 1 144 | 26.10 | 1.0 | NA |
| Low | 1 199 | 27.36 | 0.886 | 0.737, 1.065 |
| High | 982 | 22.40 | 0.879 | 0.724, 1.067 |
| Highest | 1 058 | 24.14 | 0.831 | 0.686, 1.006 |
| Maternal agency index^a | | | | |
| Referent: lowest | 1 096 | 25.01 | 1.0 | NA |
| Low | 1 096 | 25.01 | 0.877 | 0.728, 1.057 |
| High | 1 096 | 25.01 | 0.741 | 0.612, 0.896 ^c |
| Highest | 1 095 | 24.98 | 0.661 | 0.545, 0.802 ^c |
| Wealth index | | | | |
| Referent: poorest | 759 | 17.32 | 1.0 | NA |
| Poorer | 948 | 21.63 | 0.837 | 0.679, 1.032 |
| Middle | 1 040 | 23.73 | 0.827 | 0.674, 1.016 |
| Richer | 964 | 21.99 | 0.651 | 0.525, 0.807 ^c |
| Richest | 672 | 15.33 | 0.436 | 0.338, 0.562 ^c |
| Education | | | | |
| Referent: no education | 259 | 5.91 | 1.0 | NA |
| Primary | 2 380 | 54.3 | 1.317 | 0.975, 1.779 |
| Secondary | 1 283 | 29.27 | 0.973 | 0.710, 1.334 |
| Higher | 461 | 10.52 | 0.571 | 0.389, 0.839 ^c |
| Place of residence | | | | |
| Referent: rural | 1 667 | 38.03 | 1.0 | NA |
| Urban | 2 716 | 61.97 | 0.763 | 0.664, 0.876 ^c |

^a Indexes were categorized into quartiles; however, because of natural clumping, not all indices break evenly at 25.0% intervals.

^b NA: not applicable.

^c Indicates statistical significance when compared with referent: $P < 0.05$.

groups, indicating benefits to those who had the highest maternal access to care and maternal agency factor scores as well as those who were living in urban areas or who had the highest levels of wealth or education.

Multivariate models

All three of the indices were considered simultaneously because this paper is particularly interested in the cumulative effect of the maternal factors on a mother's likelihood of reporting that her child experienced an episode of diarrhea (Table 4). A logistic regression model with the three indices plus wealth and years of education expressed as continuous variables was also conducted (data not shown). Maternal agency and wealth remained significantly protective, while education was associated with increased risk.

Most important, however, was how different levels of maternal dimensions, wealth, and education functioned in relation to each other. Further multivariate

analyses were conducted with the maternal dimensions separated into quartiles, wealth separated into quintiles, and education categorically divided (none, primary, secondary, higher). Considering the three indices together without distal factors, children were at significantly diminished risk of diarrhea, as reported by their mothers, if their mother was in the highest access to care quartile compared with children whose mothers had the least access to care (Table 4). Children were also at diminished risk of diarrhea if their mother was in the high or highest agency quartile compared with children whose mothers had the least amount of agency. Therefore, when considering the cumulative effect of maternal factors, while maternal behaviors and experience were not associated with decreased odds of diarrhea, high maternal access to care and maternal agency were significantly protective.

To control for distal factors, regression models were created with all three maternal factors and economic status, ma-

ternal education, and residence type added. In the full model, the highest levels of maternal agency and economic status were significantly protective. Having a primary education puts a mother's child at increased risk for diarrhea compared with mothers who have no education. This result differed from the bivariate analysis of maternal education, which indicated a significant protective effect of a secondary or higher education compared with mothers who have no education. Urban residency no longer had the significant protective effect that it had in the bivariate analysis. Therefore, in controlling for the three distal factors, the highest two levels of maternal agency maintained a significant protective effect, with the magnitude of the OR changing only nominally compared with the model without the distal factors included. The highest levels of economic status were also significantly protective, while maternal education seemed to be harmful at the primary level and urban residency no longer had an association.

TABLE 4. Multivariate analysis demonstrating odds of a mother reporting her child experienced diarrhea in the 2 weeks before the survey given exposure to the variables included in the following models, Bolivia, 2003

| | Model with three indices, unadjusted ^a | | Model with three indices and wealth, unadjusted ^a | | Model with three indices, wealth, education, unadjusted ^a | | Model with three indices, wealth, education, and residence type, unadjusted ^a | | Model with three indices, wealth, education, and residence type, adjusted for cluster effect ^b | |
|---|---|---------------------------|--|---------------------------|--|---------------------------|--|---------------------------|---|---------------------------|
| | OR ^c | 95% CI ^d | OR | 95% CI | OR | 95% CI | OR | 95% CI | OR | 95% CI |
| Maternal access to care index | | | | | | | | | | |
| Referent: lowest | 1.0 | NA ^e | 1.0 | NA | 1.0 | NA | 1.0 | NA | 1.0 | NA |
| Low | 0.928 | 0.767, 1.124 | 1.023 | 0.842, 1.243 | 1.030 | 0.846, 1.250 | 1.030 | 0.846, 1.254 | 1.032 | 0.845, 1.260 |
| High | 1.050 | 0.870, 1.267 | 1.164 | 0.960, 1.411 | 1.178 | 0.969, 1.432 | 1.178 | 0.969, 1.432 | 1.179 | 0.967, 1.438 |
| Highest | 0.786 | 0.644, 0.959 ^f | 0.935 | 0.760, 1.151 | 0.957 | 0.776, 1.181 | 0.957 | 0.776, 1.186 | 0.958 | 0.773, 1.186 |
| Maternal experience and behavior index | | | | | | | | | | |
| Referent: lowest | 1.0 | NA | 1.0 | NA | 1.0 | NA | 1.0 | NA | 1.0 | NA |
| Low | 0.908 | 0.755, 1.093 | 0.965 | 0.800, 1.163 | 0.972 | 0.805, 1.172 | 0.972 | 0.805, 1.172 | 0.972 | 0.803, 1.175 |
| High | 0.904 | 0.743, 1.099 | 0.963 | 0.791, 1.174 | 0.972 | 0.798, 1.185 | 0.972 | 0.798, 1.185 | 0.978 | 0.800, 1.196 |
| Highest | 0.874 | 0.720, 1.061 | 0.965 | 0.791, 1.176 | 0.984 | 0.806, 1.201 | 0.984 | 0.806, 1.201 | 0.987 | 0.748, 1.095 |
| Maternal agency index | | | | | | | | | | |
| Referent: lowest | 1.0 | NA | 1.0 | NA | 1.0 | NA | 1.0 | NA | 1.0 | NA |
| Low | 0.885 | 0.734, 1.066 | 0.891 | 0.739, 1.075 | 0.904 | 0.749, 1.090 | 0.904 | 0.749, 1.090 | 0.905 | 0.748, 1.095 |
| High | 0.761 | 0.629, 0.922 ^f | 0.784 | 0.647, 0.951 ^f | 0.795 | 0.655, 0.964 ^f | 0.705 | 0.655, 0.964 ^f | 0.795 | 0.653, 0.967 ^f |
| Highest | 0.690 | 0.567, 0.840 ^f | 0.731 | 0.600, 0.891 ^f | 0.759 | 0.622, 0.926 ^f | 0.758 | 0.621, 0.926 ^f | 0.760 | 0.621, 0.930 ^f |
| Economic status | | | | | | | | | | |
| Referent: poorest | | | 1.0 | NA | 1.0 | NA | 1.0 | NA | 1.0 | NA |
| Poorer | | | 0.834 | 0.675, 1.031 | 0.836 | 0.675, 1.034 | 0.836 | 0.672, 1.041 | 0.834 | 0.666, 1.044 |
| Middle | | | 0.831 | 0.674, 1.026 | 0.848 | 0.684, 1.051 | 0.849 | 0.660, 1.092 | 0.851 | 0.656, 1.102 |
| Richer | | | 0.664 | 0.531, 0.830 ^f | 0.706 | 0.559, 0.892 ^f | 0.706 | 0.534, 0.935 ^f | 0.705 | 0.529, 0.941 ^f |
| Richest | | | 0.470 | 0.358, 0.614 ^f | 0.557 | 0.414, 0.749 ^f | 0.558 | 0.397, 0.784 ^f | 0.555 | 0.391, 0.787 ^f |
| Maternal education | | | | | | | | | | |
| Referent: no education | | | | | 1.0 | NA | 1.0 | NA | 1.0 | NA |
| Primary | | | | | 1.388 | 1.022, 1.884 | 1.388 | 1.022, 1.884 ^f | 1.385 | 1.016, 1.889 ^f |
| Secondary | | | | | 1.187 | 0.847, 1.663 | 1.187 | 0.847, 1.664 | 1.179 | 0.837, 1.660 |
| Higher | | | | | 0.844 | 0.553, 1.289 | 0.845 | 0.553, 1.289 | 0.839 | 0.547, 1.287 |
| Residence type | | | | | | | | | | |
| Referent: rural | | | | | | | 1.0 | NA | 1.0 | NA |
| Urban | | | | | | | 0.999 | 0.824, 1.211 | 1.003 | 0.821, 1.226 |

^a Unadjusted for clustering effect.

^b For the adjusted model, there is evidence of an effect at the community level ($\sigma\mu = 0.258$, standard error = 0.112).

^c OR: odds ratio.

^d CI: confidence interval.

^e NA: not applicable.

^f Indicates statistical significance: $P < 0.05$.

The full model was run a second time, adjusting for a clustering effect in order to see if there was an effect at the local level. The same factors remained significant as in the full model (maternal agency, economic status, education), but the odds of reporting diarrhea varied among communities.

The full model was run a final time to control for a child's age. Compared with the referent group (< 6 months), three age groups emerged as significantly harmful (6–11 months: OR = 2.532, CI = 1.891, 3.387, $P = 0.000$; 12–23 months: OR = 3.127, CI = 2.402, 4.070, $P = 0.000$; 24–35 months: OR = 1.751, CI = 1.326, 2.313, $P = 0.000$). As with the previous models, the highest two levels of maternal agency and the highest level of economic status continued to emerge as significantly protective. The

second highest level of economic status (OR = 0.763, CI = 0.572, 1.017, $P = 0.065$) and the second lowest level of maternal primary education (OR = 1.360, CI = 0.995, 1.857, $P = 0.053$) were borderline significant in the model. Interaction was noted between age category 6 (48–59 months) and the highest level of maternal agency as well as between age category 2 (6–11 months) and the second highest level of maternal access to care.

In summary, improved access to care and optimal behavior and experience patterns did not determine a child's likelihood of diarrhea when adjusting for distal factors. Increasing economic status and maternal agency had a protective effect, while minimal amounts of maternal schooling seemed to place children at increased risk of having an episode of di-

arrhea. In addition, there was an effect at the community level.

DISCUSSION

The primary goal of this analysis was to determine whether maternal characteristics influence a child's risk of diarrhea. Maternal access to care, maternal behavior and experience, and maternal agency indices were constructed to understand how these specific maternal dimensions may affect a child's risk of diarrhea. In a logistic regression model with the three indices and controlling for other known factors associated with diarrhea, higher agency quartiles, higher economic status quintiles, and primary education emerged as significant. Mothers with higher levels of maternal agency or economic status were less likely to re-

port that their child experienced an episode of diarrhea than mothers with lower levels of maternal agency or economic status. Additionally, mothers who attended primary school were more likely to report that their child experienced an episode of diarrhea than mothers who had no schooling.

These findings that high levels of economic status were protective and that education was not always protective were consistent with previous literature (9, 10, 53, 54). However, the results pertaining to the maternal access to care, maternal behavior and experience, and maternal agency dimensions were not comparable to other studies investigating determinants of child diarrheal disease because the conceptualization of these three maternal dimensions and how they may influence child diarrhea was novel. To investigate child mortality generally, other studies either looked at the influence of various single maternal variables or used factor analysis to look at many maternal variables together (24, 27, 38). Using PCA, however, made it possible to select and examine several variables and discern the effect of those variables cumulatively and simultaneously.

In a logistic regression model (Table 4), high economic status was found to be protective against diarrhea, a finding supported by other studies. A case-control study in India found that children with diarrhea were more likely to be from a low-income family (10). Similarly, a longitudinal study in Brazil found that children in the lowest socioeconomic quartile had a significantly higher risk of diarrhea than children in the highest wealth quartile (9). Economic status in Bolivia likely serves to protect against diarrhea because it enables people to have services such as water and sanitation that reduce exposure to diarrhea-causing pathogens.

In the logistic regression analysis, children whose mothers had primary education emerged as significantly more likely to experience an episode of diarrhea than children whose mothers had no education. This finding was contrary to several previous studies that have found a protective relationship between schooling and reduced risk of diarrheal disease and mortality in general (10–13, 33, 36, 53–56). In accordance with this paper's finding, a study in a rural area of northern Zaire found that maternal education was associated with increased child mor-

tality (57). The authors posited that education may be a disadvantage if it detracts from girls learning or even accepting the need to participate in hard field labor, which was necessary for survival. In Bolivia, primary education may be a disadvantage for similar reasons. The amount of schooling girls receive may be both insufficient to confer any benefits while also placing them at a disadvantage by missing out on childcare or homecare knowledge learned at home.

The most striking finding from this investigation was that mothers who had high levels of maternal agency were significantly less likely to have reported that their child experienced an episode of diarrhea than mothers who had the lowest levels. There are several hypotheses about why maternal agency may have emerged as significantly protective, and the variables that independently emerged as significant from within the index are a source of guidance. In the bivariate analysis, "respondent married and living with her husband," "jointly decides on large purchases," "wanted last child at the time of pregnancy," and "respondent does not believe domestic violence justified" were all significantly associated with reduced odds of the mother having reported that her child experienced diarrhea.

First, mothers who were married with their husband living at home may have had more day-to-day support than if they were not married or if they were married with their husband living elsewhere. With a partner in residence, the mother potentially had less burden of caring for all domestic issues by herself and may therefore have had more time to devote to childcare specifically. In a study in Pakistan, Agha et al. found that children whose mothers did not receive support from husbands in caring for their children had greater odds of being stunted (43).

Second, mothers who had a voice in deciding on large purchases likely had an ability to settle other important household decisions, which may include the ability to negotiate on behalf of their children.

Third, women who wanted their child at the time of their last pregnancy may have been more prepared to have a child. Better preparation can allow a mother to provide better care and to devote more physical and emotional resources to a child than a mother who did not want her child. In their work in Bolivia, Shapiro-Mendoza et al. found that

29.0% of children who were not wanted by their mothers at the time of birth were stunted compared with 19.0% of wanted and 19.0% of mistimed children (44). They also noted that children aged 12–35 months were at a 30.0% greater risk of stunting if they were mistimed or unwanted compared with children who were intended.

Finally, a woman who did not believe domestic violence was justified may have had a stronger self-worth and that sense of value may extend to her children. She may have been more willing than a woman less defiant to stand up for herself and to stand up for what she believes to be right for her children. A woman's marital and living situation, her ability to control financial resources, her intention to have children, and her attitude toward domestic violence could all operate to decrease the odds of her reporting that her child experienced diarrhea.

Maternal agency remained an influential determinant of whether a mother reported that her child experienced an episode of diarrhea, while the maternal access to care and maternal behavior and experience dimensions had no significant influence in the final model. This research can conclude that a woman's ability to make strategic choices in her life provides an advantage to her child's health that outweighs what resources for care she had or what her behaviors and experiences may have been. The maternal access to care and maternal behavior and experience dimensions may not be influential because they may not have a lasting effect on a child's life in the same way that agency does. While the maternal access to care and maternal behavior and experience indices predominantly captured influential moments in time (place of birth, timing of breastfeeding initiation), maternal agency dealt with long-lasting sentiments (pregnancy intention), attitudes (domestic violence beliefs), abilities (control of financial resources), and situations (partner living at home) that could have influenced the mother and the child on a day-to-day basis. As a result, the other dimensions were probably not significant because they likely did not have the same persistent effect on the child as maternal agency did. Even if maternal access to care or maternal behavior and experience were optimal, the findings suggest that the mother's agency—her ability to

make choices, utilize resources, and act on issues that are important to her—outweighs previous experiences that ordinarily may have been a risk factor like her age at first birth or her parity.

Consistent with other findings, the inclusion of child age in the model indicated that children older than 6 months and under 3 years of age were at greatest risk of diarrhea compared with children under 6 months of age (58). In addition, the interactions noted in the results section indicate that the associations between the indices and diarrhea varied depending on the child's age.

The strengths of this investigation rest in its approach. First, mothers have a tremendous influence on the lives of their children and this investigation recognized that influence and attempted to understand how a mother affects her children's lives as well. Second, this study was the first to explore the dimensions of the mother—specifically, maternal access to care, maternal behaviors and experience, and maternal agency—and to understand how these dimensions function relative to one another. Other authors have asserted that the relative status of women is multidimensional (27, 28, 42, 59). However, women themselves are multidimensional and deeper investigation of the specific influences in these dimensions is warranted only after the influences of the dimensions as a whole are weighed. Third, this was the first study to consider various factors cumulatively and simultaneously and, as a result, the first to consider how a myriad of maternal factors influence child diarrhea as an outcome. Finally, this study provided a new perspective from which to understand child health—

a perspective that could influence future policy and programming.

Given the experimental nature of this methodology and the data used, there were various limitations that warrant further attention. First, the variables selected for the indices were limited to those available in the DHS data and particularly to those that were specific to the mother and had a large enough sample size to be included. Variables were excluded as a result, including “exclusive breastfeeding for six months” (only 1 438 respondents), which may have influenced the maternal behavior and experience index. Also, there were not enough variables about the mother's health status to create a maternal health index, which is another dimension of the mother that should be considered in relation to the dimensions studied above. Second, this study assumed that the DHS data on reported diarrhea were accurate, though there may have been reporting bias as it pertains to diarrhea and any of the other variables included. Third, this study did not consider households where men are the head of household and mothers are either absent or deceased. Therefore, the implications of not having a mother were not considered. Finally, because diarrhea is a common event among children under the age of 5 years, it would have been ideal to study the incidence of diarrhea over time, and not simply a point prevalence, to best correlate factors that either put a child at risk or protect the child. However, cohort studies are both complicated and expensive and therefore were not feasible for this investigation.

This investigation sought to identify and understand the specific factors in the

mother's life that may protect or put her child at risk of morbidity due to diarrhea in Bolivia. Specifically, the objective was to understand the cumulative effects of various maternal factors beyond simpler investigations of wealth and education and inclusive of behavior and experience, access to care, and agency. Through PCA, the cumulative effects of maternal factors were analyzed and maternal agency emerged as a significant determinant, which clearly demonstrates how integrated the mother's life is with that of her child.

In considering strategies to reduce child morbidity and mortality, approaches that also seek to increase the agency and engagement of the mother as well as that of her child are strongly encouraged. Similarly, programmatic work should consider the sensitization of husbands and other male family members that may influence aspects of agency including purchasing power, family planning, and attitudes toward domestic violence. This study looked exclusively at the influence of maternal dimensions on the most recent child. Future studies should consider the effect of maternal dimensions on all children under 5 years of age in the family. Additionally, controlling for various child susceptibility factors (child age, birth order, gender, birth weight) may indicate when and how the different maternal dimensions may influence the child. Finally, given that DHS data are collected in a fairly consistent manner across and within countries, this investigation can be replicated in other countries and it can be replicated within Bolivia with data from different years to see if there are similarities or differences in the results with regard to space and time.

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RESUMEN

Comportamiento y experiencia, acceso a la atención de salud y capacidad de acción de la madre como determinantes de la diarrea infantil en Bolivia

Objetivo. En América Latina y el Caribe, Bolivia ocupa el tercer lugar en términos de la tasa de mortalidad de los niños menores de 5 años (57 por 1 000); 14,0% de estas muertes son atribuibles a cuadros de diarrea. Dado que la madre es quien tiene casi todo el control sobre el mundo que rodea al niño y es a través de ella que el niño lo experimenta, esta investigación procura entender las dimensiones maternas que pueden determinar la aparición de diarrea infantil.

Métodos. Las variables de estudio se seleccionaron a partir de la Encuesta Nacional de Demografía y Salud efectuada en Bolivia en el año 2003 para elaborar índices representativos de tres dimensiones maternas empleando el análisis de componentes principales: el comportamiento y la experiencia, el acceso a la atención de salud y la capacidad de acción. Los tres índices se incluyeron en un modelo de regresión logística teniendo en cuenta la situación económica, el nivel de educación materna y el lugar de residencia.

Resultados. La muestra final estuvo compuesta por 4 383 mujeres que tenían al menos un hijo menor de 5 años; 25,0% de las madres informaron que su hijo menor había presentado un episodio de diarrea en las dos semanas anteriores a la encuesta. La probabilidad de que los niños presentaran un episodio de diarrea fue significativamente menor entre las madres que tienen gran capacidad de acción o una buena situación económica que entre aquellas cuya situación económica es mala o tienen escasa capacidad de acción, y significativamente mayor entre las mujeres que habían finalizado la escuela primaria que entre aquellas sin escolaridad.

Conclusiones. Una mayor capacidad de acción de la madre tiene un efecto protector importante aun cuando se consideran otros factores. Mejorar la capacidad de acción materna podría impactar de manera positiva la salud infantil de Bolivia, de modo que las futuras investigaciones deberían proponerse comprender los factores que determinan los diferentes grados de capacidad de acción de la madre y la manera en que pueden mejorarse.

Palabras clave

Diarrea; modelos logísticos; conducta materna; Bolivia.