



Maternal and Child Nutrition in Nepal: Examining drivers of progress from the mid-1990s to 2010s

Kenda Cunningham^{a,*}, Derek Headey^b, Akriti Singh^c, Chandni Karmacharya^d, Pooja Pandey Rana^a

^a Helen Keller International, Kathmandu, Nepal

^b International Food Policy Research Institute, Washington D.C., United States

^c Tufts University, Boston, United States

^d Johns Hopkins University, Feed the Future Innovation Lab for Nutrition, Kathmandu, Nepal

ARTICLE INFO

Keywords:

Nutrition
Undernutrition
Nepal
Stunting
Wasting
Underweight

ABSTRACT

This paper explores the drivers of Nepal's maternal and child nutrition success using document review, interviews with mothers, and quantitative analysis of DHS datasets. Our qualitative and quantitative analyses both highlight similar policy and community level changes but limited improvements in child feeding and care practices. Improvements in four key drivers of nutritional change emerged: health services, sanitation, education, and wealth. However, the relative contributions of each factor varied by indicator, with health services more important for linear growth among children, and sanitation more important for weight gain among both children and mothers. We conclude with a discussion bringing the qualitative and quantitative findings together into key lessons from Nepal's success.

1. Introduction

Undernutrition continues to affect millions globally, particularly in low- and middle-income countries (LMIC). Its consequences include mortality and morbidity, as well as both immediate and long-term cognitive, productive, and reproductive losses (Bhutta, 2013; Hoddinott et al., 2013). Encouragingly, however, the past decade or so has seen increasing political commitment to this crippling public health problem. The 2008 and 2013 Lancet series provided insights on both the nutrition-specific and nutrition-sensitive drivers of undernutrition, including potential policy and programmatic solutions (Bhutta, 2013; Bhutta et al., 2008; Black et al., 2008; Ruel and Hoddinott, 2008; Ruel and Alderman, 2013). This series, and many other reviews, demonstrate a growing consensus that solving the problem of undernutrition requires addressing the diverse underlying determinants of nutritional well-being, including the various deficiencies of health systems, food systems, childcare and feeding practices, family planning, and water, sanitation and hygiene (WASH) (International Food Policy Research Institute, 2014; International Food Policy Research Institute, 2015; Standing Committee on Nutrition, 2011).

Despite this consensus, the evidence on how countries actually achieve progress in reducing undernutrition is limited (Crum et al., 2013). Nepal is undoubtedly one of the more striking examples from

recent history. In the 1990s, Nepal had some of the highest levels of undernutrition globally, with almost two-thirds of young children being stunted. However, from 2001 to 2011 Nepal experienced the fastest recorded reduction in stunting in the world (by one measure at least) (Headey and Hoddinott, 2015). Identifying how Nepal achieved these improvements can shed light on what Nepal, and other countries facing similar issues and/or in similar contexts, can do to achieve rapid and sustained progress against undernutrition.

In this paper we aim to identify the drivers of Nepal's nutritional success through a combination of qualitative and quantitative techniques. Our qualitative analysis is used to identify plausible hypotheses for the kinds of policies, programs and socioeconomic trends that might be driving nutritional change. This analysis involves both a review of nutrition-related policies and programs in Nepal, as well as interviews with Nepalese mothers regarding major changes in their communities, as well as ongoing constraints to nutritional improvement. Our quantitative analysis takes a more macro perspective by employing the regression and decomposition techniques used by Headey and Hoddinott (2015) to analyze nutritional change in Nepal. However, we extend their approach by focusing on additional indicators of child and maternal nutrition and a longer time frame.

* Corresponding author.

2. Methods

This mixed-method study can primarily be divided into 3 methods: document review of policies and programs, interviews with mothers residing in rural Nepal, and quantitative analysis of national-level change in nutritional status and nutrition-related indicators.

2.1. Document review

First, we conducted a document review to collate and synthesize information on key nutrition-related programs and policies in Nepal from 1990 to present. This review covered both academic and grey literature on a wide range of sectors, including nutrition and health, WASH, and education as well as demographic changes and economic development (e.g. macroeconomic growth, agriculture, migration and remittances). A key objective of this review was to understand the policy factors that may have contributed to nutritional change, given that secondary data sources – such as the DHS – do not directly measure policy factors.

2.2. Interviews with mothers

Next, we collected qualitative data from 20 mothers living in rural, remote communities to give a bottom-up perspective on nutrition-relevant changes over time. We interviewed mothers from two *terai* districts – Rupandehi and Chitwan –, which were purposively selected to include one covered by *Suaahara* (a large-scale integrated nutrition program) and one without any large-scale health or nutrition program. Within each district, we purposefully selected the most disadvantaged village development committee (VDC) and within the VDC, two wards closest to each other. In each of the 4 wards, we interviewed one mother per “cohort”, with cohort referring to the five-year period during which the mother had given birth (1990–1995, 1995–2000, 2000–2005, 2005–2010, and 2010–2015). We modified the “life history method” (Davis, 2011) to understand wellbeing over the course of each woman's life. Using an open-ended interview guide, women were asked questions around nutrition specific programs as well as nutrition-relevant items including agriculture, income generation, literacy and education, WASH, demographic changes, and other local developments. Women were also asked about childcare and feeding practices and cultural beliefs about feeding and diets. This component of the study received ethical approval from the institutional review board of The International Food Policy Research Institute (IFPRI).

2.3. Quantitative analysis of DHS data

Lastly, we conducted an analysis of four rounds of data from Nepal's DHS: 1996, 2001, 2006, and 2011 (Ministry of Health and Population, 2006, 2001; Ministry of Health and Population et al., 2011, 1996). These surveys are nationally representative. Following Headey and Hoddinott (2015), we used multivariate regression analysis and decomposition techniques to identify which factors significantly explain changes in nutrition outcomes over time. This involved three steps. First, mean scores for nutrition outcomes and nutritional determinants were estimated across survey rounds using survey weights. Second, multivariate regression models (e.g. least squares, linear probability) were used to estimate coefficients of association between nutrition outcomes and these determinants. Third, a decomposition approach was used to estimate the potential contribution of changes in each determinant to changes in each nutrition outcomes. In a simple decomposition at means, wherein regression coefficients are assumed to be stable over time, the estimated contribution of a particular indicator is the product of its coefficient and the change in its mean over time (e.g. 1996–2011). Hence, a determinant will make a large contribution if its regression coefficient is large and if its mean score changes substantively over time.

While we closely follow the statistical methods of Headey and Hoddinott (2015), our analysis extends their study in several ways.

First, we go beyond height/length-for-age z scores (HAZ/LAZ) to additionally analyze child weight-for-height (WHZ) and the maternal body mass index (BMI). Whilst HAZ/stunting is certainly an important cumulative measure of exposure to nutritional insults, WHZ and BMI are also important indicators of undernutrition that reflect more recent nutritional insults.

Second, for stunting changes, we focus on children 0–2 years of age, rather than 0–5 years of age as done by Headey and Hoddinott (2015), as they identified some sensitivity of regression coefficients for the younger sample restriction and argued that including older children in the sample may lead to attenuation biases related to the phrasing of questions and recall problems.

Lastly, we included data from the 1996 DHS for child LAZ and WHZ, whereas Headey and Hoddinott (2015) excluded this round of data because this round only surveyed children 0–3 years of age and because there was minimal reduction in stunting over 1996–2001. We find that there was some improvement in the stunting rate for children 0–2 years of age and for other nutrition indicators. Maternal BMI regressions exclude 1996 because information on women's decision-making was not available for this round.

We used continuous outcome measures (LAZ, WHZ, and BMI) rather than dichotomous measures for our decomposition regression analysis because dichotomous variables reduce precision. Our selection of explanatory variables is guided by the UNICEF 1990 and Lancet 2013 frameworks, and includes household assets, parental education (years), access to antenatal, neonatal and postnatal healthcare, WASH factors, household demography and mother's decision-making power (Table 1). All regressions also included dummy variables for child age, location, caste, maternal age and survey round, though these are omitted for the sake of brevity, and because they are not time-varying indicators that could account for nutritional change across rounds.

3. Policies and programs: the enabling environment

Nepal's nutrition progress over the last several decades happened within an unstable political and economic context including an armed conflict known as the “people's war” from 1996 to 2006 and a difficult and drawn-out transition to a new constitution and more decentralized democratic system. Despite this, the government of Nepal (GoN) and its development partners were able to implement an array of effective social programs, and the country maintained solid and sustained growth in household incomes. Here we briefly describe some of the key policies and socioeconomic trends in the country from the late 1980s onwards.

In Nepal, as in many other countries, government efforts on nutrition have traditionally been embedded within the health sector, with a primary focus on addressing high levels of maternal and infant mortality. The GoN's first explicit focus on nutrition was the Vitamin A campaign, although there have also been significant efforts to reduce the incidence and severity of diarrhea and to promote iron and folic acid (IFA) supplementation for pregnant and lactating women as part of antenatal care (ANC) and postnatal care (PNC) (Ministry of Health and Population (MOHP), 2013). Isolation and poor physical access to services present major barrier for these and many other programs in Nepal (Government of Nepal National Planning Commission, 2012). To address this, a network of female community health volunteers (FCHVs) was created in 1988 to provide frontline basic health and family planning services (Pokharel et al., 2009). The Local Self Governance Act (LSGA) of 1999 also served to decentralize government functions and empower local bodies with resources and power for local level planning and programming, including health services and social inclusion programs (Ministry of Local Development and UNICEF, n.d).

Since the mid 1990s, most health and nutrition initiatives aiming to deliver messages and provide health information and advice to house-

Table 1

Definitions of indicators used in this study.

Determinant	Variable definition and type
Child HAZ/LAZ	Height/length for age z score measured against WHO (2006) norms.
Child WHZ/LAZ	Weight for height/length for age z score measured against WHO (2006) norms.
Maternal BMI	Maternal body mass index z score, standardized against the sample-specific mean and standard deviation.
Asset index (1–10)	A household-level composite index (ownership of radio; TV; and bicycle); use of improved cooking fuel (kerosene, biogas, electricity); basic flooring (earth, dung); and access to electricity (yes/no). The index is constructed with principal components analysis and scaled to vary between 0 and 10.
Maternal education	Number of years of formal schooling for the mother (continuous)
Paternal education	Number of years of formal schooling for the father (continuous)
4 or more ANC visits	Whether or not the mother received 4 or more antenatal care (ANC) visits (binary)
Iron supplementation	Whether or not mother took any iron supplements during pregnancy (binary)
Born in health facility	Whether or not the child was born in a hospital or medical clinic (binary)
All vaccinations	Whether or not the child received full vaccinations against BCG; measles; polio; and diphtheria, pertussis, tetanus (DPT) (binary)
Birth order	Birth order of child, 1 being firstborn (continuous rank)
Preceding birth interval	Interval between birth of present child and any previous child (continuous, years)
Community toilet use	Percentage of households in a survey cluster that regularly use a latrine (continuous)
Water source: tube well	Whether or not the household drinking water was from a tube well (binary)
Water source: piped	Whether or not the household drinking water was from a piped source (binary)
Maternal height	Mother's height, measured in centimeters (continuous)
Mother aged 15–19 years	Whether or not mother's age was between 15 and 19 years (binary)
Mother aged 20–24 years	Whether or not mother's age was between 20 and 24 years (binary)
Mother aged 35–39 years	Whether or not mother's age was between 35 and 39 years (binary)
Mother's empowerment	Whether or not mother was involved in all 4 decisions (large household purchases; her own healthcare; spending money she earned; and visit to relatives) (continuous index varying between 0 and 1)

holds and communities have operated via FCHVs, though expansion of these programs proved quite slow (Thapa, 2014). In 2004, the GoN adopted the first sectoral policy focusing specifically on undernutrition among women and children – the National Nutrition Policy and Strategy. In 2006, deworming after the first trimester was added and around the same time the government also induced cash incentives for mothers and health care providers to have children delivered in medical facilities. Many international and local NGOs have also played key roles in the implementation of nutrition-related programs in Nepal, including homestead food production (HFP) programs, behavior change communication (BCC) packages on essential nutrition and hygiene actions (ENA/EHA), infant and young child feeding (IYCF) capacity building of health workers, Community-Based Management of Acute Malnutrition (CMAM), Community Based Integrated Management of Childhood Illnesses (CB-IMCI), and nutrition advocacy work with policymakers and other key stakeholders. Overall, Nepal has seen mixed progress on nutrition-specific interventions, with notable successes in Vitamin A and iron supplementation, expansion of neonatal and ANC and PNC (from very low bases), but mixed progress on achieving behavioral change and improving diets, as reflected by limited changes in IYCF indicators.

Among other sectors, earlier health, education, and agricultural multisectoral plans often had explicit nutrition objectives, but these objectives were not translated into clear targets and programs. Nevertheless, many of these programs achieved substantial improvements in their primary sectoral targets that have likely indirectly benefited nutrition outcomes. Nepal increased its public expenditure on education in the early 1990s, and adopted its Education For All National Plan of Action (EFA/NPA) in 2001, which aimed to improve quality of education, provide education for vulnerable and disadvantaged children and eliminate gender disparity (Ministry of Education and Sports, 1995). Girls' education attainment increased rapidly in the 1990s and 2000s, and has nearly caught up to boys'.

In the WASH sector, Nepal began a transition process in 2004 away from costly and ineffective hard subsidies on toilet construction towards a softer approach based on school-led and community-led behavioral change. This approach engages the community to promote low-cost, homemade toilets that are easily assembled using locally-available materials (Bell, 2010; Goudel, n.d.; Ministry of Urban Development Government of Nepal, 2013). Nepal saw one of the fastest reductions in open defecation in the world from the mid 2000s onwards and many districts have now been declared open defecation

free.

The GoN and its major development partners have also implemented major family planning initiatives (Khanal et al., 2013). These initiatives could conceivably influence nutrition both by reducing overall fertility rates and increasing birth spacing, which may jointly influence parental resources per child and prolong breastfeeding. However, it is unclear what role family planning interventions played in demographic changes over recent years because desired fertility rates also declined steeply and because much of the decline in fertility observed in Nepal may be due to out-migration of men (Khanal et al., 2013). Indeed, from 2006 to 2011 the percentage of women whose husbands were away from home, at the time of the NDHS, increased from 21% to 32% (Khanal et al., 2013).

Finally, though still very poor, Nepal has made impressive progress against poverty, with national poverty rates falling from 68% in 1995 to 25% in 2010. Three factors likely explain this. First, despite modest macroeconomic growth (per capita GDP grew by just 2.5% per annum during the 2000s), there was strong growth in worker's remittances. From 1991–2011 the number of Nepalese who left the country rose from 658,290 to 1,917,903 (Sijapati, 2015). During the same time period, remittances sent back soared from 2.1 billion rupees to 434.6 billion rupees, with increasing numbers of migrants attaining more lucrative employment in the Gulf States rather than in India (Sharma et al., 2014). Survey-based estimates (Government of Nepal and World Bank, 2006) also suggest that remittance growth accounted for as much as half of the sizeable reduction in poverty rates during Nepal's conflict. Second, growth in the agricultural sector – the largest employer and one in which the poor mostly work – was surprisingly robust, growing at 3.8% per annum over 2001–2011 (United Nations, 2014). Third, tourism receipts recovered strongly after the war, growing by around 250% from 2006 to 2011 (World Bank, 2014).

4. Mothers' perspectives on nutrition-related changes over time

In the qualitative assessment of how rural women living in nutritionally vulnerable areas viewed nutrition-related changes in their communities in the last 25 years, mothers talked about a wide range of nutrition-related topics. Here we summarize a few key findings.

On health care, mothers described significant changes over time. Although only some mothers who gave birth from 1990 to 1995 had received ANC check-ups, all mothers who gave birth from 2010 to 2015

had done so. Older mothers gave several reasons for not having ANC check-ups: lack of services, shyness, or feeling that they did not need to visit a health care provider. With increased access to information and FCHVs, as well as ambulance services and cash incentives, use of services for neo-natal care, ANC and PNC was now reported to be much more common.

On other developments in their communities, all mothers, even many who had not gone to school themselves, spoke about sending their children of both sexes to school and some mothers mentioned the growing availability of private schools. Access to improved drinking water was also reported to have increased substantially, in the form of hand pumps in Rupandehi, but with piped water in Chitwan. Many mothers in both districts stated that they now have a toilet and that open defecation was much rarer.

Various indicators of improvements in living conditions and socioeconomic status were mentioned. Some mothers talked about houses now being larger and built from more permanent materials. Many mothers shared that their husbands or sons had gone abroad to work, though older mothers were more likely to have husbands working in India, while mothers who gave birth later mentioned countries in the Middle East, Malaysia, and Japan, which implies more remunerative remittance earnings. However, some mothers stated that remittance earnings were relatively modest.

Finally, mothers discussed food consumption habits. There were some indications that younger mothers had better nutritional practices/knowledge, such as eating more fruit and vegetables during pregnancy, initiating breastfeeding (including colostrum) immediately after birth, and avoiding breastmilk substitutes. However, not all mothers introduced complementary foods at 6 months, which is a widespread problem in South Asia (Senarath et al., 2012). Dietary diversification for children also remains problematic; solid or semi-solid foods largely consist of rice, *jaulo* (a rice and lentil porridge), soup, *lito* (a porridge made from cereals and pulses), Cerelac, and fruit juice in the early weaning period, while meat, fish, and egg tended to be given only after about 12 months. There was no difference in which complementary food(s) were given first across the 25 years, except for the fact that a few mothers who gave birth since 2000 started complementary feeding with Cerelac. Hence, these findings tend to corroborate the conclusion of Headey and Hoddinott (2015) that IYCF practices in Nepal have improved relatively little in recent decades.

5. Changes in nutrition-related indicators over time

The findings in the previous section suggest multiple drivers of nutritional changes in Nepal, spanning health, education, WASH, family planning and economic growth. In this section we use quantitative techniques to test these hypotheses for three different nutrition outcomes: child LAZ and WHZ, maternal BMI.

Table 2 reports mean scores and changes of the three nutrition indicators used in this study (child LAZ and WHZ and maternal BMI) along with their dichotomous undernutrition counterparts. Improvements in child growth for children under two years have been sustained and rapid over the entire 1996–2011 period. The prevalence of wasting among children under five years also fell fairly quickly. Maternal weight gain also improved over time, but this mostly occurred in the last five years.

Next we look at changes in IYCF indicators, which may indirectly be informative about the effectiveness of nutrition-specific interventions aimed at improving feeding practices (Table 3). Interestingly, Nepal has not made significant progress in IYCF indicators over time, with the exception of seeing some increase in the prevalence of children fed three or more times in the previous 24 h (although this might reflect improved socioeconomic status and food security rather exposure to health and nutrition programs).

There is much more indication of substantial improvements among nutrition-sensitive factors over time (Table 4), though this list includes

Table 2

Trends in maternal and child nutritional status indicators in Nepal, 1996–2011. Sources: Nepal DHS 1996, Nepal DHS 2001, Nepal DHS 2006, and Nepal DHS 2011

LAZ (Stunting), children 0–23 months	
1996	−1.89 (47.8%)
2001	−1.68 (41.1%)
2006	−1.37 (34.0)
2011	−1.16 (27.0%)
Change in LAZ	0.73
WHZ (Wasting), children 0–59 m	
1996	−0.82 (15.5%)
2001	−0.78 (11.7%)
2006	−0.84 (12.9%)
2011	−0.65 (11.3%)
Change in WHZ	0.17
BMI (Underweight), non-pregnant mothers	
1996	19.7 (30.0%)
2001	20.0 (28.3%)
2006	20.2 (27.5%)
2011	20.9 (21.0%)
Change in BMI	1.2

Note: Stunting and wasting are defined as having a < -2.0 SD from the median of the reference population, based on the 2006 World Health Organization growth standards for a length-for-age z-score (LAZ) and weight-for-height z-score (WHZ). Maternal underweight is defined as a body mass index of < 18.5 .

Table 3

Change in infant and young child feeding indicators, 2001–2011. Sources: Nepal DHS 2001, Nepal DHS 2006, and Nepal DHS 2011

	Exclusive breastfeeding, kids 0–6 months	Fed any solid foods yesterday, kids 6–8 months	Fed 4 types of food yesterday, kids 6–24 months	Fed 3 or more times yesterday, kids 6–23 months
2001	79.7%	61.1%	18.4%	72.7%
2006	72.0%	71.3%	19.5%	87.7%
2011	78.6%	61.9%	17.7%	85.5%
Change (%)	−1.1%	0.8%	−0.7%	12.8%

services that may have nutritional components (health care and WASH). We observed large improvements in the asset score. Maternal education also accelerated rapidly, and more so than paternal education. Some of the changes in access to health and sanitation services are particularly striking: ANC access rose from 6% to 30%, IFA supplementation during pregnancy from 12% to 82%, medical facility births from 9% to 41% and children being fully vaccinated from 26% to 51%. There was also a sizeable reduction in fertility (lower birth order) and longer intervals between births. There were dramatic changes in toilet use: open defecation fell from 82% to 48%. Changes in access to improved water sources were more modest, however, and women's empowerment (proxied by household decision-making power) only improved marginally from a very low base.

In Table 5 we examine which of these underlying determinants significantly predicts changes in nutritional outcomes. In the LAZ model for children under 2 years of age, the following variables were estimated with the expected signs across samples and were significant: asset index, parental education (mostly maternal as paternal education had a smaller and less robust coefficient), ANC visits, medical facility births, all vaccinations, community-level open defecation (a negative association), maternal height, and dummy variables for young mothers (15–19 and 20–24 years, negative associations).

In the WHZ models for children under 5 years of age, asset scores were significant. Health indicators continued to be significant. Birth order results, however, now suggest an association between higher fertility rates and acute undernutrition, and this finding was significant. Open defecation was again highly significant. Interestingly, piped water

Table 4

Trends in underlying drivers of nutritional change in Nepal, 1996–2011.

Sources: Nepal DHS 1996, Nepal DHS 2001, Nepal DHS 2006, and Nepal DHS 2011.

Asset index (1–10)	
1996	1.53
2011	4.90
Overall change	3.4
Maternal education (years)	
1996	1.20
2011	3.91
Overall change	2.7
Paternal education (years)	
1996	4.02
2011	5.70
Overall change	1.7
4 or more ANC visits (0–1)	
1996	6.3%
2011	29.6%
Overall change (%)	23.3%
Born in health facility (0–1)	
1996	8.6%
2011	41.1%
Overall change (%)	32.5%
All vaccinations (0–1)	
1996	25.9%
2011	51.2%
Overall change (%)	25.3%
Birth order (rank)	
1996	3.30
2011	2.53
Overall change	–0.8
Birth interval (years)	
1996	3.92
2011	4.64
Overall change	0.7%
Community toilet use (0–1)	
1996	81.8%
2011	48.4%
Overall change (%)	–33.4%
Water source: piped (0–1)	
1996	30.0%
2011	37.1%
Overall change (%)	7.1%
Maternal height (cm)	
1996	150.5
2011	151.1
Overall change	0.6
Maternal empowerment (0–1)	
2001	9.6%
2011	19.9%
Overall change (%)	10.3%

had a significant positive association with WHZ, which was not the case with the LAZ models.

Lastly, the maternal BMI models looked somewhat different, being estimated for 2001–2011, having child level factors excluded (e.g. vaccinations) and maternal empowerment included. A wide array of factors was significantly associated with BMI, including asset scores, parental education, health services, open defecation, and piped water (positively associated). Younger mothers were much more likely to have lower weight and maternal empowerment (decision-making) was reasonably strongly associated with maternal BMI.

Finally, Table 6 shows the results from the linear decomposition approach. Each cell shows the change in the nutrition score predicted

by changes in the explanatory variable over the relevant time period, which is the product of the relevant regression coefficient (“marginal effects”) and the change in the mean score over time. For example, mean asset scores increased by 3.4 points over 1996–2011 while the regression coefficient was 0.03. The product of these two values is a predicted increase in LAZ scores of 0.09 (top left cell in Table 6). For each indicator, we highlight in bold the three most significant predictors of nutritional change over the relevant period, whilst statistics in the bottom three rows show how much nutritional change is predicted by the model, how much change actually occurred, and the ratio of the two, an indication of how well the model performs in estimating overall change in nutrition.

The results for changes in LAZ for children 0–23 months over 1996–2011 broadly corroborate the findings of Headey and Hoddinott's (2015) HAZ results for children 0–59 months over 2001–2011, with some minor differences. Health services again emerge as a very important factor in the LAZ model, and were the single largest contributor to LAZ change, followed by asset accumulation or maternal education. Increased toilet use was moderately important (Table 5). Other factors – paternal education, maternal height, and demographic change – made very modest contributions to HAZ change. Overall, the LAZ model performed moderately well, explaining just over half of actual LAZ change.

The WHZ results for children 0–59 months are quite different, with toilet use a much more important factor. Health services were also an important factor. The WHZ model actually explained more change than was actually observed in practice (138%), though this is likely because of more noise in the dependent variable or some form of model misspecification (for example, climate can affect WHZ, but was not included in the model).

Finally, the maternal BMI results are somewhat similar to the child WHZ results, which is perhaps unsurprising given that both capture weight for height. As with the WHZ results, toilet use emerges as the single largest. The BMI models performed very well in terms of accounting for actual change, approximately explaining the full BMI change actually observed.

6. Discussion

Although it still faces many nutritional challenges, Nepal has made remarkable progress in reducing the prevalence of maternal and child undernutrition since the mid-1990s. Our qualitative findings highlighted the diverse sectoral changes at both the policy and community levels that have taken place over the last several decades, amidst ever-changing socio-political and economic contexts. Our quantitative findings confirmed that most of the maternal and child nutritional improvements in Nepal are due to 4 main factors: improved access to health services (particularly during pregnancy), increased coverage and use of toilets, improvements in levels of education, particularly among mothers, and wealth accumulation. Our results are consistent with Headey and Hoddinott (2015), although the results for WHZ and BMI point to a greater role for sanitation (cited as a secondary factor in their study) in reducing rates of acute undernutrition.

Our analysis of DHS datasets and maternal interviews suggested limited progress in improving IYCF indicators. The lack of any change in dietary diversity and exclusive breastfeeding found quantitatively is consistent with the maternal interview results, which indicate the persistence of poor IYCF knowledge and practices. The findings may signal low coverage of intensive IYCF programs, or that these programs have not been very effective. However, the IYCF findings are also perhaps somewhat consistent with the health-based focus of nutrition strategies (e.g. vitamin A and IFA supplementation) during the study period. IYCF capacity building only started in 2004 and scaled up after, meaning that FCHVs and health workers were trained for a maximum of 10 years of this study period. Also, unlike the other interventions mentioned, IYCF changes likely require more contact with trained

Table 5

Relative contribution of determinants to changes in child length-for-age, child weight-for-age, and maternal body mass in Nepal.
Sources: Nepal DHS 1996, Nepal DHS 2001, Nepal DHS 2006, and Nepal DHS 2011

	Length-for-age z-scores 1996–2011 Children < 2 years	Weight-for-height z-scores 1996–2011 Children < 5 years	Body Mass Index 2001–2011 Non-pregnant mothers
Asset index	0.03 ^{***}	0.01	0.03 ^{***}
Maternal education	0.03 ^{***}	0.01	0.01 [*]
Paternal education	0.01 ^{**}	0.01 [*]	0.01 ^{***}
4+ antenatal care visits	0.11 ^{**}	0.10 ^{***}	0.08
Born in health facility	0.24 ^{***}	0.010 ^{***}	0.20 ^{***}
All vaccinations	0.18 ^{***}	0.07 ^{***}	N/A
Birth order	–0.01	–0.03 ^{***}	N/A
Preceding birth interval	0.01	0.00	N/A
Community toilet use	0.14 [*]	0.28 ^{***}	0.49 ^{***}
Water source: piped	–0.07 [*]	0.15 ^{***}	0.19 ^{***}
Maternal height	0.06 ^{***}	0.00	–0.01 ^{***}
Mother 15–19 years	0.03 ^{***}	0.01	–0.31 ^{***}
Mother aged 20–24 years	–0.19 ^{***}	–0.07	–0.11 ^{***}
Mother's empowerment	N/A	N/A	0.14 ^{***}
R-squared	0.30	0.12	0.18
Sample size	7440	12757	5991

Note

* P < 0.10.

** P < 0.05.

*** P < 0.01.

individuals.

Our qualitative and quantitative data both showed a clear trend of increasing ANC use, reported by mothers to be about the increase in availability of services but that access is still not universal. Nepal's health policy developments are a prime contributor to these noted changes and exemplify how targeting can effectively address coverage gaps. The development and expansion of FCHVs was a crucial policy that allowed isolated rural communities basic access to health services and knowledge. These workers also provided an existing institutional platform to deliver additional services as new nutrition and health programs were designed. Furthermore, clear synergies across development goals can be seen. In Nepal, the main rationale for many health interventions in the 1990s – even those that might be retrospectively characterized as nutrition-specific – was to reduce child mortality rather than undernutrition rates. This suggests that there may be scope to motivate and design health strategies that effectively address both mortality and undernutrition burdens.

DHS data shows a steady increase in education and mothers also spoke about improvements in the availability of schools; related to this, our quantitative analysis highlights the comparative importance of

maternal education versus paternal education and nearly all women who gave birth recently spoke of the importance of educating girls. This highlights how deeply and rapidly the messages behind Nepal's 2001 EFA/NPA policy reached rural communities.

Community sanitation efforts, on the rise for at least a decade now in Nepal, have been effective in reducing open defecation. The importance of these policy moves can be seen in the relative contribution of toilet use to reductions in undernutrition and in how mothers discuss their satisfaction with increases in toilet and water facility availability in rural areas.

Finally, our findings on household wealth follow a similar pattern: consistency in qualitative and quantitative findings and policy analysis to provide context for why these changes emerged. Whether using asset ownership to represent wealth in our regression analysis or finding the frequency with which mothers reported to have larger homes built of more permanent materials, it is undeniable that socio-economic well-being is improving. Mothers also spoke of growth in remittances and migration to wealthier countries. Although it is difficult to ascribe growth directly to government policies or programs, evidence suggests that these improvements in socioeconomic status are likely to be

Table 6

Decompositions of predicted changes in maternal and child undernutrition in Nepal.
Sources: Nepal DHS 1996, Nepal DHS 2001, Nepal DHS 2006, and Nepal DHS 2011

	Length-for-age z scores 1996–2011 Children < 2 years	Weight-for-height z score 1996–2011 Children < 5 years	Maternal BMI z scores 2001–2011 Non-pregnant mothers
Asset accumulation	0.09	0.02	0.08
Maternal education	0.08	0.01	0.02
Paternal education	0.02	0.01	0.02
Health services ^a	0.15	0.07	0.07
Demographic change	0.01	0.02	0.00
Toilet use	0.05	0.09	0.15
Piped water	0.00	0.01	0.02
Maternal height	0.03	0.00	–0.01
Maternal empowerment	N/A	N/A	0.02
Total predicted change	0.42	0.25	0.37
Total actual change	0.73	0.16	0.35
Percentage explained	58%	158%	107%

Notes: Based on a linear decomposition in means approach used in [Headey and Hoddinott \(2015\)](#), where the predicted nutritional change due to each factor is the production of the changes in the factor's mean over the time period and the corresponding coefficient from [Table 5](#).

^a "Health services" refers to 4+ antenatal visits, Born in hospital, All vaccinations (child regressions only). For each dependent variable and region, the most quantitatively important factors are highlighted in bold.

significant drivers in nutritional improvement (Haddad et al., 2003; Headey and Hoddinot, 2015; Smith and Haddad, 2000).

The use of three approaches – document review, qualitative interviews, and regression analysis of nationally representative datasets – to explore drivers of change in Nepal's nutrition success is unique. These diverse methods are complementary. In-depth interviews with mothers allowed us to explore exposure to community based nutrition and development programs over time and to enquire about household-level nutrition practices, such as child feeding habits and the beliefs underlying them. Although the sample was small and purposive, this information could be triangulated with the quantitative data to understand various drivers of change. The macro-level policy analyses provided context and facilitated a deeper understanding of how and why certain changes happened and how policies and programs may have contributed to changes in nutritional status over time.

In addition to yielding insights into nutritional strategies for Nepal, Nepal's experience could provide at least two important lessons for other developing countries with high rates of undernutrition. First, achieving rapid reductions in undernutrition clearly requires the contributions of a diverse array of sectors, even if those sectors remain uncoordinated from a nutritional perspective. Indeed, international evidence suggests that even quite intensive nutrition education programs only have modest impacts on anthropometric outcomes (Dewey and Adu-afarwuah, 2008), highlighting the need for investments in other sectors. Investments made in health, WASH, and education in Nepal in previous decades, along with robust growth in household incomes/assets, contributed to improvements in nutritional status in Nepal. More coordinated approaches could perhaps achieve even more rapid or substantial improvements. Evidence now suggests that nutrition-specific interventions alone are not sufficient for rapidly reducing rates of undernutrition (Bhutta et al., 2013; Ruel and Alderman, 2013); indeed, recent nutrition success stories typically point to nutrition-sensitive sectors being the main drivers of nutritional change (Headey et al., 2015; Headey and Hoddinot, 2015). Second, there are potentially important lessons from Nepal, for the design of nutrition strategies for other countries characterized by high rates of undernutrition, predominantly rural populations and significant spatial heterogeneity. Nepal's experience shows that innovative programs with explicit attention to overcoming remoteness constraints will be needed. The use of transport subsidies for pregnant women to give birth in proper medical facilities is an excellent example of incentivizing behaviors that overcome the problems of isolation and cultural resistance to new practices and technologies. Many rural areas in Asia, Africa and Latin America suffer from similar problems, suggesting there is substantive scope to learn from Nepal's remarkably achievements in reducing undernutrition in remote rural communities.

Despite its progress, Nepal remains a poor country with very high levels of undernutrition, and some significant deficiencies in nutritional policies and programs. National political commitment to address undernutrition has not always translated into effective large scale nutrition programs, particularly programs to address the serious problems with IYCF practices in Nepal. Gaps in implementation, enforcement, and monitoring at a sub-national level might account for this, as might overburdening of frontline health workers with multiple responsibilities. Finally, while the importance of a multi-sectoral approach has only been recently recognized, implementation of the MSNP began less than 5 years ago and has chiefly focused on just 6 initial pilot districts. Thus, more targeted research is needed on why many nutrition-specific interventions have failed to deliver large scale impacts, and specifically on whether MSNP is having a significant impact on nutrition indicators in Nepal.

Declaration of interest

The authors do not have any financial, personal, or other conflicts of interest to disclose.

Funding

This work was supported by the Children's Investment Fund Foundation (CIFF), London, UK (Grant# Stories of Change) with background work supported by UKAID from the Department for International Development (DFID) through the Leveraging Agriculture for Nutrition in South Asia Research Consortium (PO5773) and Transform Nutrition Research Consortium (PO5243) and the CGIAR Research Program on Agriculture for Nutrition and Health (A4NH).

Acknowledgements

We are grateful for inputs provided by many individuals to this manuscript and the overall Nepal case study for the Stories of Change project, including the leadership of Stuart Gillespie, Mara Van Den Bold, and Purnima Menon. In Nepal, we received support and insights from many Government of Nepal and development partner colleagues, including USAID's Feed the Future Nutrition Innovation Lab as well as Dr. Madhu Devokta, Dr. Ramesh Adhikari, Dr. Pant, and Mr. Marisini. We are deeply indebted to the study participants; these mothers' time and energy to provide interesting insights into life in rural villages of Nepal over the last several decades made this study possible.

References

- Bell, B., 2010. Analysis of school-led total sanitation in Chitwan, Nepal.
- Bhutta, Z.A., 2013. Early nutrition and adult outcomes: pieces of the puzzle. *Lancet* 6736, 10–11. [http://dx.doi.org/10.1016/S0140-6736\(13\)60716-3](http://dx.doi.org/10.1016/S0140-6736(13)60716-3).
- Bhutta, Z.A., Ahmed, T., Black, R.E., Cousens, S., Dewey, K., Giugliani, E., Haider, B. a., Kirkwood, B., Morris, S.S., Sachdev, H.P.S., Shekar, M., 2008. What works? Interventions for maternal and child undernutrition and survival. *Lancet* 371, 417–440.
- Black, R.E., Allen, L.H., Bhutta, Z.A., Caulfield, L.E., de Onis, M., Ezzati, M., Mathers, C., Rivera, J., 2008. Maternal and child undernutrition: global and regional exposures and health consequences. *Lancet* 371, 243–260. [http://dx.doi.org/10.1016/S0140-6736\(07\)61690-0](http://dx.doi.org/10.1016/S0140-6736(07)61690-0).
- Crum, J., Mason, J., Pokharel, R., Hutchinson, P., Mebrahtu, S., Dahal, P., 2013. Trends and determinants of maternal and child nutrition in Nepal: Further analysis of the Nepal Demographic and Health Surveys, 1996–2011. Kathmandu.
- Davis, P., 2011. Vulnerability in rural Bangladesh: learning from life history interviews, Chronic Poverty Research Centre Working Paper, 196.
- Dewey, K.G., Adu-afarwuah, S., 2008. Systematic review of the efficacy and effectiveness of complementary feeding interventions in developing countries. *Matern. Child Nutr.* 4, 24–85.
- Goudel, C., n.d. National Sanitation Revolution in Nepal: Lessons Learned of RWSSP-WN.
- Government of Nepal, WorldBank, 2006. Resilience Amidst Conflict: An Assessment of Poverty in Nepal, 1995–96 and 2003–04 (Report No. 34834-NP). Central Bureau of Statistics, National Planning Commission Secretariat, Kathmandu, Nepal.
- Government of Nepal National Planning Commission, 2012. Multi-sectoral Nutrition Plan: For accelerating the reduction of maternal and child under-nutrition in Nepal.
- Haddad, L., Alderman, H., Appleton, S., Song, L., Yohannes, Y., 2003. Reducing child malnutrition: How far does income growth take us? *World Bank Econ. Rev.* 17, 107–131.
- Headey, D., Hoddinot, J., 2015. Understanding the rapid reduction of undernutrition in Nepal, 2001–2011. *PLoS One*, 10. <http://dx.doi.org/10.1371/journal.pone.0145738>.
- Headey, D., Hoddinot, J., Ali, D., Tesfaye, R., Dereje, M., 2015. The other Asian enigma: explaining the rapid reduction of undernutrition in Bangladesh. *World Dev.* 66, 749–761. <http://dx.doi.org/10.1016/j.worlddev.2014.09.022>.
- Hoddinot, J., Alderman, H., Behrman, J.R., Haddad, L., Horton, S., 2013. The economic rationale for investing in stunting reduction. *Matern. Child Nutr.* 9 (Suppl 2), S69–S82. <http://dx.doi.org/10.1111/mcn.12080>.
- International Food Policy Research Institute, 2014. Global Nutrition Report: Actions and Accountability to Accelerate the World's Progress on Nutrition. Washington, D. C.
- International Food Policy Research Institute, 2015. Global Nutrition Report. Washington DC.
- Khanal, M., Shrestha, N., Panta, P.D., Mehata, S., 2013. Impact of Male Migration on Contraceptive Use, Unmet Need and Fertility in Nepal: Further analysis of the 2011 Nepal Demographic and Health Survey. Nepal Ministry of Health and Population, New ERA, and ICF International, Calverton, Maryland, USA.
- Ministry of Education and Sports, 1995. Education for All: Nepal National Plan of Action. Kathmandu.
- Ministry of Health and Population (MOHP), 2013. Health Sector Strategy for Addressing Maternal Undernutrition (2013–17). Kathmandu.
- Ministry of Health and Population, 2006. Nepal Demographic And Health Survey 2006.

- Kathmandu; Calverton.
- Ministry of Health and Population, 2001. Nepal Demographic and Health Survey 2001. Kathmandu; Calverton. doi: (<http://dx.doi.org/10.1177/097152310100800209>).
- Ministry of Health and Population, New Era, ICF International, 2011. Nepal Demographic and Health Survey. Kathmandu, Nepal and Calverton, Maryland, U.S. A.
- Ministry of Health and Population, New Era, Macro International, 1996. Nepal Demographic and Health Survey. Kathmandu. doi: (http://dx.doi.org/10.1007/SpringerReference_29880).
- Ministry of Local Development, UNICEF, n.d. Improving Lives for Children and Women in Nepal Map of Nepal: Decentralized Action for Children and Women (DACAW). Kathmandu.
- Ministry of Urban Development Government of Nepal, 2013. Sanitation for All: All for Sanitation. Kathmandu.
- Pokharel, R.K., Houseon, R., Harvey, P., Bishwakarma, R., Adhikari, J., Dev Pant, K., Gartoulla, R., 2009. Nepal Nutrition Assessment and Gap Analysis.
- Ruel, M., Hoddinott, J., 2008. Investing in early childhood nutrition.
- Ruel, M.T., Alderman, H., 2013. Nutrition-sensitive interventions and programmes: how can they help to accelerate progress in improving maternal and child nutrition? *Lancet* 382, 536–551. [http://dx.doi.org/10.1016/S0140-6736\(13\)60843-0](http://dx.doi.org/10.1016/S0140-6736(13)60843-0).
- Senarath, U., Agho, K.E., Akram, D.E.S., Godakandage, S.S.P., Hazir, T., Jayawickrama, H., Joshi, N., Kabir, I., Khanam, M., Patel, A., Pusdekar, Y., Roy, S.K., Siriwardena, I., Tiwari, K., Dibley, M.J., 2012. Comparisons of complementary feeding indicators and associated factors in children aged 6–23 months across five South Asian countries. *Matern. Child Nutr.* 8, 89–106. <http://dx.doi.org/10.1111/j.1740-8709.2011.00370.x>.
- Sharma, S., Shibani, P., Pathak, D., Sijapati-Banett, B., 2014. State of Migration in Nepal, Centre for the Study of Labour and Mobility.
- Sijapati, B., 2015. Analysis of labour market and migration trends in Nepal.
- Smith, L.C., Haddad, L., 2000. Explaining Child Malnutrition in Developing Countries: A Cross-Country Analysis. International Food Policy Research Institute (IFPRI), Washington, DC.
- Standing Committee on Nutrition, 2011. Scaling Up Nutrition: progress report from countries and their partners in the movement to SUN.
- Thapa, S., 2014. High and equitable coverage of vitamin A supplementation program in Nepal. *J. Community Med. Health Educ.*, 4. <http://dx.doi.org/10.4172/2161-0711.1000272>.
- United Nations, 2014. National Accounts Main Aggregates Database.
- World Bank, 2014. World Development Indicators Online. The World Bank, Washington, DC.
- WHO Multicentre Growth Reference Study Group, 2006. WHO child growth standards: Length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: methods and development. www.who.int/childgrowth/standards/Growth_standard.pdf.