Title: The effects of governmental cash transfer programs on behavioral and health determinants of mortality: evidence from 37 low- and middle-income countries.

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Running Title: Cash Transfers and Health Outcomes

Keywords: Cash Transfers, Poverty Reduction, Social Protection, Mortality, Maternal and Child Health, Low- and Middle-Income Countries

Abbreviations: COVID-19, coronavirus disease 2019; DHS, Demographics and Health Survey; GDP, gross domestic product; LMIC, low- and middle-income countries; PPP, purchasing power parity; PEPFAR, President's Emergency Program for AIDS Relief

Word count: 4654
Number of references: 92
Number of tables: 1
Number of figures: 6

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Abstract

Poverty is strongly associated with numerous adverse health outcomes. Governmental cash transfer programs are a cornerstone of poverty reduction strategies in many low- and middle-income countries. While extensive research from individual programs exists on the effects of cash transfers on beneficiaries, evidence on their *population-wide* health impacts remains limited. In a recent study, we showed that cash transfer programs are associated with substantially reduced mortality rates among women and young children at the population level in low- and middle-income countries. In this study, we explore the mechanisms underlying these reductions by investigating how cash transfer programs affect a range of health behaviors and outcomes. By combining national survey data with a comprehensive database of cash transfer programs, we identified large effects of cash transfer programs on ten outcomes related to maternal health service use, fertility and reproductive decision-making, caregiver health behaviors, and child health and nutrition. We directly linked some of these outcomes to subsequent child survival data and reductions in mortality, and all outcomes are of considerable interest in their own right. Programs with the highest population coverage exhibited the strongest effects. As many countries consider the future of their cash transfer programs — including whether to embrace approaches such as basic or guaranteed incomes — these findings provide new evidence on the ways in which such programs can improve population health.

Introduction

Across the world, poverty is strongly associated with numerous adverse health outcomes.[1-5] After decades of global success in reducing poverty rates, the COVID-19 pandemic triggered a major reversal. In 2024, nearly 700 million people lived in extreme poverty ($2.15 per day in 2017 purchasing power parity [PPP]), and 1.73 billion people lived below the lower-middle-income poverty line ($3.65 per day), equivalent to 8.5% and 21.4% of the global population, respectively.[6] Extreme poverty rates in low-income countries are higher than they were in 2019, and the global goal of reducing the extreme poverty rate to 3% by 2030 now appears unlikely.[6] This sobering lack of recent progress underscores the pressing need to evaluate and implement evidence-based policies to alleviate poverty and improve health.

Large-scale, governmental cash transfer programs provide money to individuals or households and are a vital part of poverty reduction strategies in many countries.[7] These programs can be categorized into unconditional transfers (more common in sub-Saharan Africa) and conditional transfers (more common in Latin America). Over the past three decades, more than 100 low- and middle-income countries (LMICs) have introduced cash transfer programs as part of their poverty reduction and social protection strategies.[8] The COVID-19 pandemic further accelerated the expansion of these initiatives, with an estimated 1.36 billion people — 17% of the global population — receiving cash transfers during the pandemic. [9]

A large body of empirical research has examined the effects of cash transfers on a range of outcomes for beneficiaries, employing both experimental and quasi-experimental methods.[10-12] Studies show largely favorable impacts of cash transfers on children's schooling, nutritional status, healthcare utilization, and subjective well-being. However, unlike large-scale, multi-country evaluations of major health aid programs like the President's Emergency Plan for AIDS Relief (PEPFAR),[13,14] the vast majority of evaluations of cash transfer programs have been limited to individual countries and focused on beneficiary households.

Non-beneficiaries may also experience health benefits from large-scale cash transfer programs, as several studies have shown that transfers have positive spillover effects.[15] These effects may occur through mechanisms such as informal insurance networks or broader impacts on local economics. Additionally, in settings with high infectious disease prevalence, cash transfers may indirectly benefit non-beneficiaries by reducing transmission rates.[16] Despite this potential, *population-wide* evaluations of cash transfer programs remain scarce. Notable exceptions include single-country studies of conditional cash transfer programs in countries like Brazil and Mexico, which have examined their effects on some health outcomes, including mortality.[17-25]

This limited evidence base on the population effects of cash transfer programs constrains the ability to conduct rigorous cost-benefit evaluations on whether to expand the coverage or size of cash transfers in LMICs. Such evaluations are especially important considering policymakers' growing interest in approaches like basic or guaranteed income programs.

In recent work, we developed a comprehensive dataset that compiles publicly available information for governmental cash transfer programs in LMICs. This dataset includes details such as program start and end dates, population coverage, and cash transfer amounts.[26] We combined this dataset with numerous national surveys from 37 LMICs to generate longitudinal mortality datasets for about 7 million adults and children. Using a difference-in-differences approach, we found that cash transfer programs resulted in large and statistically significant reductions in mortality among adult females and children aged <5 years.

While these findings offer a broad understanding of the effects of cash transfer cash transfer programs on mortality across many countries, they also raise critical questions about the mechanisms driving these reductions among women and children. Possible pathways include behavioral pathways, such as increased engagement in health services, and health and nutrition pathways, such as lower rates of diarrheal illness. To provide further insights into the factors contributing to these mortality reductions, this paper examines the population-wide effects of cash transfers on a wide variety of plausible determinants of mortality across many LMICs — outcomes that are also valuable to assess in their own right. By combining population-representative survey data with our newly constructed database of cash transfer programs, we examined the associations between these programs and seventeen outcomes related to maternal health service use, fertility and reproductive decision-making, caregiver health behaviors, and child health and nutrition.

Methods

We analyzed changes in plausible determinants of mortality among women and young children in LMICs after implementation of large-scale, governmental cash transfer programs between 2000 to 2019, a time when many cash transfer programs were introduced.

Cash Transfer Program Data

We included the same 37 countries that were included in our prior analyses examining the relationship between cash transfer programs and mortality.[26] We also used the same database of governmental cash transfer programs within included countries. The construction of this database has been previously described,[16,26] including the calculation of the impoverished population coverage for each program. This was defined as the most recent estimate of the number of program beneficiaries divided by the number of individuals in a country with income less than the international extreme poverty line.

National Survey Data

We obtained individual-level data from national Demographic and Health Surveys (DHS).[13,14,27] The DHS are conducted about every 5 years in many LMICs using a two-stage cluster sampling design to produce national and sub-national estimates for a variety of indicators. These data are representative of their primary respondents, who are female household members of reproductive ages (15-49 years).[28] Procedures and questionnaires for DHS surveys have been reviewed and approved by the ICF Institutional Review Board. All analyzed data were anonymized.

We used data from all available surveys within included countries during the study period. We combined data from these surveys to generate two datasets — one with the unit of observation being all live births of each respondent during the study period, and the other with the unit of observation being all children under the age of 5 years residing in the household at the time of the survey. For both datasets, we obtained the following sociodemographic variables: rural or urban setting, mother's schooling attainment, household wealth quintile, and birth order. The wealth quintile is defined from a wealth index that is generated using a principal components analysis of assets, materials used for housing construction, and types of water access and sanitation facilities.[29] For the births dataset, we also included the mother's age at the time of birth. For the children dataset, we also included the mother's and child's ages at the time of the survey.

We developed a conceptual model to show the hypothesized effects (and mechanisms of effects) of large-scale, governmental cash transfer programs on the health of women and young children who were beneficiaries *or* non-beneficiaries of the program (Supplementary Figure 1). We used this conceptual model to select behavioral, health, and nutritional factors that could plausibly be impacted by cash transfers *and* be determinants of mortality (Supplementary Figure 1). These outcomes are also of considerable interest in and of themselves, and many of them are key national health indicators. Detailed descriptions of outcomes and sampling frames are in Supplementary Tables 1-2. For birth outcomes the observation-year was the year of birth, and for post-natal outcomes the observation-year was the year of the survey. We included the following primary outcomes in the births dataset: early antenatal care (during first trimester of pregnancy), delivery at a health facility, skilled birth attendant at delivery, desired pregnancy, intended pregnancy, age at first birth, interdelivery interval, whether a child was ever breastfed, measles vaccination, male twin live birth rate (a marker of fetal loss),[30] and subjective small birth size (based on mother's recall of five categories). We were unable to use the exact birth weight because of high rates of missingness in the survey data. We included the following primary outcomes in the children dataset: minimum acceptable diet (WHO definition),[31] recent diarrhea, underweight,[32] wasting,[32] and stunting.[32] We included one primary outcome that was at the survey respondent level — unmet need for contraception. As a secondary outcome, we considered the effects of cash transfers on stunting among children who were exposed to cash transfers during their first two years of life. Missingness was <10% for all variables except for measles vaccination (10.5%), minimum acceptable diet (15%), and ever breastfed (22%).

Additional Country-Level Data

We obtained additional time-varying covariates for each country and year: Gross Domestic Product (GDP) per capita,[33] total health expenditures per capita,[33] PEPFAR funding budgeted ,[34] and six Worldwide Governance Indicators from The World Bank that are composite indicators based on 30 data sources: Voice and Accountability, Political Stability and Absence of Violence, Government Effectiveness, Regulatory Quality, Rule of Law, and Control of Corruption.[33]

Primary Statistical Analysis

We employed a difference-in-differences approach, a quasi-experimental technique that estimates causal effects from observational data by subtracting the change in outcomes pre- to post-intervention in the comparison group from the change in outcomes pre- to post-intervention in the intervention group. A key assumption in this approach is that in the absence of cash-transfer programs, the trends in the intervention group's outcomes would be similar to those in comparison countries (i.e., parallel trends).

Recent advances in difference-in-differences analyses when there is variation in intervention timing have shown that estimates using traditional modeling techniques may be biased if there is heterogeneity in intervention effects over time or across groups of units.[35-37] To address this concern, we use a two-stage differences-in-differences method that is not vulnerable to this bias.[38,39] In the first stage, outcomes are regressed on country and year fixed effects, as well as other time-varying covariates, using the subsample of unexposed observations. During the second stage, country and year fixed effects (and effects from time-varying covariates) are subtracted from the observed outcomes, and these residualized outcomes are then regressed on exposure status.

We defined our primary exposure as a binary variable equal to 1 if a cash transfer program (or combination of programs) with total impoverished population coverage greater than 5% was active in a given country and observation year (birth year for the birth-related outcomes, survey year for the post-natal outcomes). We excluded country-years during which cash transfer programs (or combination of programs) were implemented with coverage between 2% and 5%.[26] Comparison country-years were therefore defined as those in which there were no active cash transfer programs, or cash transfer programs (or combination of programs) had coverage <2%. We discuss the selection of this exposure definition in previous work.[16,26] We explore different levels of program coverage in our secondary heterogeneity analyses, described below.

Our models included country fixed effects to control for time-invariant differences between countries, and year fixed effects to control for common temporal patterns in outcomes across countries. We also included additional country- and individual-level covariates that were likely to confound the relationships between cash transfer programs and mortality. At the country-level, the covariates we included were GDP per capita, budgeted PEPFAR funding, health expenditures per capita, and three Worldwide Governance Indicators: Control of Corruption, Political Stability and Absence of Violence, and Voice and Accountability.[26] At the individual level, we included rural/urban setting, birth order, mother's age (at the time of birth for the birth outcomes, at the time of the survey for post-natal outcomes), and child's age at the time of the survey (for post-natal outcomes). As in our prior analyses,[26] we did not include individual-level variables that were likely to mediate relationships between cash transfer programs and our outcomes (e.g., wealth quintile).

For the post-natal child health outcomes (diarrhea, underweight, wasting, stunting), we note that since our previous study suggests that cash transfer programs increased post-natal survival,[26] it is possible that children with marginal health were more likely to survive and be included in the sample during intervention country-years. This type of selection could lead to estimates for some child health outcomes being biased towards the null, and therefore we consider them to be lower-bound estimates of the impacts of cash transfer programs. To partially address concerns about selection, we controlled for (subjective) birth size, which can be considered a summary measure of mother's perceptions of children's endowments at birth.[40-43]

Our effect measures of interest were the absolute changes in primary outcomes in the years when cash transfer programs were in place. We used robust standard errors clustered at the country level. For each of our co-primary outcomes we reported unadjusted p-values, and p-values adjusted for seventeen multiple comparisons using the Benjamini-Hochberg method.[44] We considered $p<0.05$ to be statistically significant.

In addition to overall estimates, we evaluated the temporal relationship between cash transfer programs and mortality by defining the cash transfer exposure as a series of binary indicators for each year before and after the cash transfer period began. Because the outcomes that had the *survey* year as the observation-year did not have observations available during every year, we grouped these observations into three-year categories (-6 to -4, -3 to -1, 0 to 2, 3 to 5, and 6 to 8) relative to cash transfer program implementation These temporal estimates also allowed us to evaluate possible violations of the parallel trends assumption by examining for the presence of substantially differential trends between comparison and cash countries during the years prior to cash transfer program implementation.

We performed statistical analyses using SAS V.9.4, R V.3.5.2, and STATA V.17.

Secondary Analyses

We explored effect heterogeneity of cash transfer programs using sub-group analyses at the level of the beneficiary (child's age, mother's schooling attainment), cash transfer program (coverage and maximum transfer amounts above or below the median; cash transfer type being unconditional, conditional, or mixed), and region (sub-Saharan Africa or outside of sub-Saharan Africa).

While we did not conduct a formal mediation analysis,[45,46] given our hypothesis that the outcomes assessed in this study might explain, in part, our prior findings of cash transfers leading to decreased mortality rates, we explored associations between outcomes associated with cash transfers and subsequent child mortality. This was possible for the following variables: early antenatal care, facility delivery, skilled birth attendant, desired pregnancy, interdelivery interval, and age at first pregnancy. To do this, we replicated the approach described in our previous analysis of the effects of cash transfer programs on mortality rates for children less than 5 years of age,[26] except that we replaced the cash transfer exposure with the potentially mediating outcomes. We were unable to use the same approach for adult female mortality because adult mortality estimates were derived from sibling survival, which cannot be directly linked to the outcomes in this study.

Data Availability

Individual-level data can be requested from the DHS program website (https://www.dhsprogram.com/Data/). Country-level data are available for download from the Harvard Dataverse (https://doi.org/10.7910/DVN/SAE7YG).

Results

There were 37 countries and 108 national surveys included in the study (Figure 1). Twenty of these countries introduced cash transfer program(s) with impoverished population coverage >5% during the study period, and 17 of these countries had available survey data during their cash transfer period. This includes one country (Niger) that was considered a comparison country in our prior evaluation of the effects of cash transfer programs on mortality because it lacked mortality data during its cash transfer period.[26] These 17 intervention countries included a total of 30 cash transfer programs, which we have previously described in detail.[26] These programs had a median most recent impoverished population coverage of 27% (IQR 16-100%) and a median most recent maximum transfer amount of 10% GDP per capita (IQR 7-13%). Fifteen (50%) of the cash transfer programs were unconditional.

There were 2,156,464 births included in the births dataset, 957,400 (44%) of which were within 5 years of the survey and 14% of which occurred during intervention country-years. There were 946,085 children under the age of 5 years included in the children dataset, 577,980 of which were in households selected for anthropometric measurements and 40% of which were evaluated during intervention country-years. In general, observations during intervention country-years were characterized by higher GDP per capita, health expenditures per capita, and percentiles for each of the Worldwide Governance Indicators, and a lower proportion of observations from sub-Saharan Africa (Supplementary Tables 3-9).

For maternal health services outcomes, we found that cash transfer programs were associated with improvements in early antenatal care (5.0 percentage point increase, 95% CI 2.1 to 7.9; adjusted p=0.003), facility delivery (7.3 percentage point increase, 95% CI 3.2 to 11.3; adjusted p=0.006), and delivery by a skilled birth attendant (7.9 percentage point increase, 95% CI 3.2 to 12.6; adjusted p=0.003) (Table 1). Temporal plots for these outcomes showed no evidence of differential pre-trends and immediate and generally increasing effects over time (Figure 2).

For outcomes related to fertility and reproductive decision-making, cash transfer programs were associated with improvements in desired pregnancies (1.9 percentage point increase, 95% CI 0.5 to 3.2; adjusted p=0.02), interdelivery interval (2.5 month increase, 95% CI 1.8 to 3.1; adjusted p=0.02), and unmet need for contraception (10.3 percentage point decrease, 95% CI -15.2 to -5.3; adjusted p=0.004), but not age at first pregnancy (2.1 month increase, 95% CI -0.4 to 4.7; adjusted p=0.13) or intended pregnancies (0.2 percentage point decrease, 95% CI -2.8 to 2.3; adjusted p=0.86). Temporal plots for these outcomes showed generally increasing effects over time (Figure 3). In contrast to our overall estimate, the temporal plot for age at first pregnancy suggested an increase over time since cash transfer program implementation.

For caregiver health behaviors, we found that cash transfer programs were associated with improvements in rates of children having a minimum acceptable diet (6.9 percentage point increase, 95% CI 4.9 to 8.8; adjusted p=0.009) and measles vaccination (5.1 percentage point increase, 95% CI 0.7 to 9.5; adjusted p=0.03), but not breastfeeding (0.4 percentage point decrease, 95% CI -1.5 to 0.6; adjusted p=0.48) (temporal trends in Figure 4).

Finally, for child health and nutrition outcomes, cash transfer programs were associated with an increase in male twin birth rates (0.8 per 1000 male live births, 95% CI 0.3 to 1.4; adjusted p=0.009) and decreases in recent diarrhea (-5.9 percentage points, 95% CI -10.9 to -0.9; adjusted p=0.03) and underweight nutritional status (-2.2 percentage points, 95% CI -3.7 to -0.8; p=0.007). Cash transfer programs were not associated with significant changes in subjective small birth size (0.4 percentage point decrease, 95%

CI -0.7 to 1.4; adjusted p=0.54), wasting (2.7 percentage point decrease, 95% CI -5.8 to 0.4; adjusted p=0.13), or stunting (3.7 percentage point increase, 95% CI -0.7 to 8.2; adjusted p=0.13). In contrast to our overall estimates, temporal plots were consistent with potential improvements in subjective small birth size and wasting over time since cash transfer program implementation (Figure 5). In a secondary analysis, cash transfer programs were not associated with changes in stunting among children who were exposed to cash transfers during the first two years of life (4.6 percentage point increase, 95% CI -0.1 to 9.2; p=0.06).

We next explored effect heterogeneity through subgroup analyses. These should be interpreted with caution due to multiple comparisons and confidence intervals that were generally wide and overlapping. Our findings suggested that programs with higher population coverage generally have stronger effects on our outcomes (Figure 6; Supplementary Table 10). Conditional programs may be more effective for some outcomes, particularly related to nutrition (Supplementary Figure 2; Supplementary Table 11). There were no evident differences in cash transfer effectiveness by region (Supplementary Figure 3; Supplementary Table 12). Cash transfer programs may be more effective for outcomes among children aged <2 years (Supplementary Figure 4; Supplementary Table 13). We saw no clear gradient in effect by schooling attainment (Supplementary Figure 5; Supplementary Table 14).

We next explored associations between outcomes affected by cash transfers and subsequent child mortality (Supplementary Table 15). After adjustment, facility delivery (adjusted risk ratio [ARR] 0.89, 95% CI 0.84 to 0.93), skilled birth attendant (ARR 0.86, 95% CI 0.82 to 0.91), interdelivery interval (ARR 0.987 per month increase, 95% CI

0.985 to 0.989), and desired pregnancy (ARR 0.88, 95% CI 0.81 to 0.96) were associated with mortality, suggesting that these factors may partially mediate the effects of cash transfers on child mortality (Supplementary Table 16). Early antenatal care (ARR 1.00, 95% CI 0.95 to 1.05) was not associated with mortality.

Discussion

In this analysis of over two million births and nearly one million children under the age of five from 37 countries over 20 years, we found that large-scale, governmental cash transfer programs led to substantial improvements in ten outcomes related to maternal health service use, fertility and reproductive decision-making, caregiver health behaviors, and child health and nutrition. A causal relationship between cash transfer programs and these outcomes is further supported by an apparent dose-response relationship, with programs with higher population coverage exhibiting the strongest effects. Some of the pregnancy-related outcomes were also associated with subsequent child mortality risk, suggesting that these improvements may partially explain the population-wide mortality benefits of cash transfer programs we previously documented.[26] Even beyond potential mortality benefits, the outcomes evaluated in this study are of considerable interest in and of themselves and represent important health indicators. Our findings provide one of the first comprehensive assessments of the effects of cash transfer programs across many different countries on population-wide health outcomes in LMICs. Capturing the effects of cash transfer programs on entire populations, rather than solely on direct beneficiaries, is important because cash transfers are often pooled,[47,48] and there is evidence that large-scale cash transfer programs have favorable impacts on local economies.[15] Consequently, understanding the *overall* effects of cash transfer programs is most relevant for policymakers weighing the costs and benefits of such programs.

We found that cash transfer programs were associated with about a 10% relative improvement in access to important maternal health services like antenatal care, delivery at a health facility, and delivery by a skilled birth attendant. These factors were, in turn, associated with reductions in subsequent child mortality rates. Accessing antenatal care during pregnancy allows for the provision of preventative health interventions, such as iron or folate supplementation, and facilitates the early detection and management of pregnancy complications.[49] Similarly, delivery at a facility by a skilled birth attendant, particularly with the staff and equipment necessary to perform Caesarean sections and respond to obstetric emergencies, can be associated with improvements in maternal and neonatal health.[50-55] These findings align with prior studies examining the effects individual cash transfer programs on healthcare service utilization among beneficiaries,[56-62] including maternal health services.[63-65]

We also observed associations between cash transfer programs and fertility outcomes, including higher rates of pregnancies being desired and longer interdelivery intervals, both of which were linked to a reduced risk of child mortality. Additionally, cash transfers led to large reductions in unmet need for contraception. Although not evident in our primary analysis, temporal analyses suggested that age at first pregnancy may increase over time following the implementation of cash transfer programs. These findings can be placed within the context of prior research showing that shorter interdelivery intervals are associated with increased risk of a variety of adverse health outcomes,[66,67] and that pregnancy intentions are also associated with maternal and child health outcomes.[68,69]

While studies of individual cash transfer programs have found heterogeneous effects on contraception use and birth rates among beneficiaries, they have been shown to reduce pregnancies during adolescence,[70,71] a risk factor for poor outcomes.[72]

Given the observed changes in maternal health service use and fertility behaviors, we would expect to see improvements in perinatal health outcomes. These were assessed in several ways. First, we evaluated fetal loss due to environmental stressors by examining male twin live birth rates. Research has shown that male twin gestations are particularly vulnerable to selection *in utero*, making male twin live birth rates a sensitive marker for fetal loss under adverse conditions.[30,73-75] We found that cash transfer programs were associated with a nearly 10% relative increase in the male twin live births, indicating a generalized improvement in the *in utero* environment for pregnant women in the context of cash transfer programs.

Second, we evaluated mothers' subjective assessment of birth size and found no association between cash transfers and changes in the prevalence of subjective small birth size. However, we caution against concluding that cash transfer programs do not affect low birth weight, a leading driver of morbidity and mortality among young children that can be a consequence of preterm birth or intrauterine growth restriction.[76] First, our temporal analyses suggest that rates of subjective small birth size may decline over time following cash transfer implementation. Second, cash transfers appear to lead to more marginal pregnancies resulting in live births, as evident by changes in male twin birth rates, which may bias estimates of changes in birth size toward the null. Third, because of high rates of missing data for exact birth weights, our analysis relied on maternal recall of inexact birth size, which is less precise. Finally, several other studies of individual cash transfer programs have found improvements in birth weight among beneficiaries.[63,77,78]

Childhood vaccinations are among the most impactful public health interventions ever implemented,[79] and we found that cash transfer programs resulted in about a 10% relative improvement in measles vaccination rates. Among vaccinations, we focused specifically on measles vaccination because of its large and well-documents effects on childhood morbidity and mortality through direct effects (through reductions in measles-related mortality)[80-85] and indirect effects (through reductions in measles-mediated immunosuppression).[86,87] Prior studies of beneficiaries of individual cash transfer programs have found mixed, but generally positive, impacts on vaccination.[10] Our findings highlight the broader potential of cash transfer programs to enhance vaccination coverage at the population level.

Diarrheal illness is a major contributor to childhood morbidity and mortality, ranking as the 5th leading cause of death among children under 5 years of age.[88] We found that cash transfers were associated with a nearly 40% relative decline in reports of recent diarrhea. This reduction may result from decreased exposure to contaminated water or food, or improved nutritional status.

Finally, we evaluated outcomes related to diet and nutrition, and found that cash transfer programs were associated with greater rates of infants having a minimum acceptable diet, and a lower risk of children being underweight, which measures a combination of acute and chronic undernutrition. Temporal analyses were also potentially consistent with reductions in child wasting (acute undernutrition).

Undernutrition is a leading cause of childhood morbidity and mortality worldwide,[89-91] and a minimum acceptable diet is linked to better nutritional outcomes in children.[92] We did not find improvements in rates of ever breastfeeding, although there were very high rates of breastfeeding at baseline. We also did not find improvements in rates of stunting, although this chronic form of undernutrition is likely to be slower to respond to effective interventions at the population level. Most studies of cash transfers find improvements in dietary diversity among beneficiaries, and there have been mixed but generally positive impacts on child anthropometrics.[7,10]

There are several important limitations to this analysis in addition to those already described. We were unable to include several populous countries with prominent cash transfer programs (e.g., Mexico, Brazil, and India). Because of the nature of the available data on cash transfer programs, we were unable to evaluate heterogeneity by implementation quality or additional program features (e.g., sex of cash transfer recipients), although this is likely to be an important determinant of individual programs' effectiveness. The DHS data also lacked information on whether participants' household were direct recipients of cash transfers or not, which prevented us from estimating separate effects on beneficiary and non-beneficiary households. Because of limitations inherent to the survey data, we were unable to link outcomes with subsequent adult female mortality.

Conclusion

We found that large-scale, governmental cash transfer programs led to large improvements in ten outcomes related to maternal health service use, fertility and reproductive decision-making, caregivers' health behaviors, and child health and nutrition. We directly linked some of these outcomes to subsequent child survival data and reductions in mortality, and all are of considerable interest in their own right. This study offers one of the first comprehensive assessments of the population-wide effects of cash transfer programs across many different countries on key health-related indicators in LMICs. As many countries contemplate scaling back or expanding cash transfer programs, these findings can be used by policymakers to better inform the likely health benefits of cash transfer programs.

Funding

This work was supported by the United States National Institutes of Health — the National Institute of Child Health and Development under Award Number R03HD113974 (to AR) and the National Institute of Mental Health under Award Number K23MH131464 (to AR).

Competing Interests

The authors declare no conflicts of interest.

Author Contribution Statement

Conceptualization — AR, HT, JRB

Methodology — AR, HT, EFB, JRB

Formal Analysis — AR, CB

Data Curation — AR, CB

Supervision — AR, HT

Visualization — AR, CB

Writing – Original Draft — AR

Writing – Review and Editing — AR, CB, EFB, JRB, HT

Table 1. The effects of cash transfer programs on maternal health service use, fertility and reproductive decision-making, caregiver health behaviors, and child health and nutrition outcomes. Effect estimates are absolute changes in the outcome with 95% confidence intervals. Estimates were generated using two-stage difference and differences models with country and year (of birth) fixed effects, country-level covariates (GDP per capita, PEPFAR funding budgeted, total health expenditures, and three Worldwide Governance Indicators: control of corruption, political stability and absence of violence, and voice and accountability), and individual-level covariates (mother's age, child's age [post-natal outcomes], rural or urban setting, and birth order). Standard errors were clustered at the country level. Unadjusted p-values and p-values adjusted for 16 multiple comparisons (Benjamini-Hochberg method) are shown.

Outcome	**Mean in control observations**	**Absolute change with cash transfers (95% CI)**	**p-value**	**p-value adjusted for 16 comparisons**
Maternal health services				
Early antenatal care	0.56	5.0% (2.1 to 7.9)	0.001	0.003
Facility Delivery	0.53	7.3% (3.2 to 11.3)	<0.001	0.006
Skilled birth attendant	0.57	7.9% (3.2 to 12.6)	0.001	0.003
Fertility and reproductive decision-making				
Age at first pregnancy	20.4 years	2.1 months (-0.4 to 4.7)	0.11	0.13
Intended pregnancy	0.77	-0.2% (-2.8 to 2.3)	0.86	0.86
Desired pregnancy	0.93	1.9% (0.5 to 3.2)	0.009	0.02
Interdelivery interval	37 months	2.5 months (1.8 to 3.1)	<0.001	0.02
Unmet need for contraception	0.39	-10.3 (-15.2 to -5.3)	<0.001	0.004
Caregiver health behaviors				
Ever breastfed	0.95	-0.4% (-1.5 to 0.6)	0.42	0.48
Minimum acceptable diet	0.19	6.9% (4.9 to 8.8)	<0.001	0.009
Measles vaccination	0.55	5.1% (0.7 to 9.5)	0.02	0.03
Child health and nutrition outcomes				
Male twin birth	10 per 1000 male live births	0.8 per 1000 male live births (0.3 to 1.4)	0.004	0.009
Subjective small birth size	0.18	0.4% (-0.7 to 1.4)	0.51	0.54
Recent diarrhea	0.16	-5.9% (-10.9 to -0.9)	0.02	0.03
Underweight	0.21	-2.2% (-3.7 to -0.8)	0.003	0.007
Wasting	0.11	-2.7% (-5.8 to 0.4)	0.09	0.13
Stunting	0.36	3.7% (-0.7 to 8.2)	0.1	0.13

Figure 1. Study timeline. with the study period (2000-2019) along the x-axis, included countries listed on the y-axis, the red points representing DHS surveys, the blue point representing the first complete year of cash transfer program(s) covering >5% impoverished population, and the blue line representing the cash transfer period.

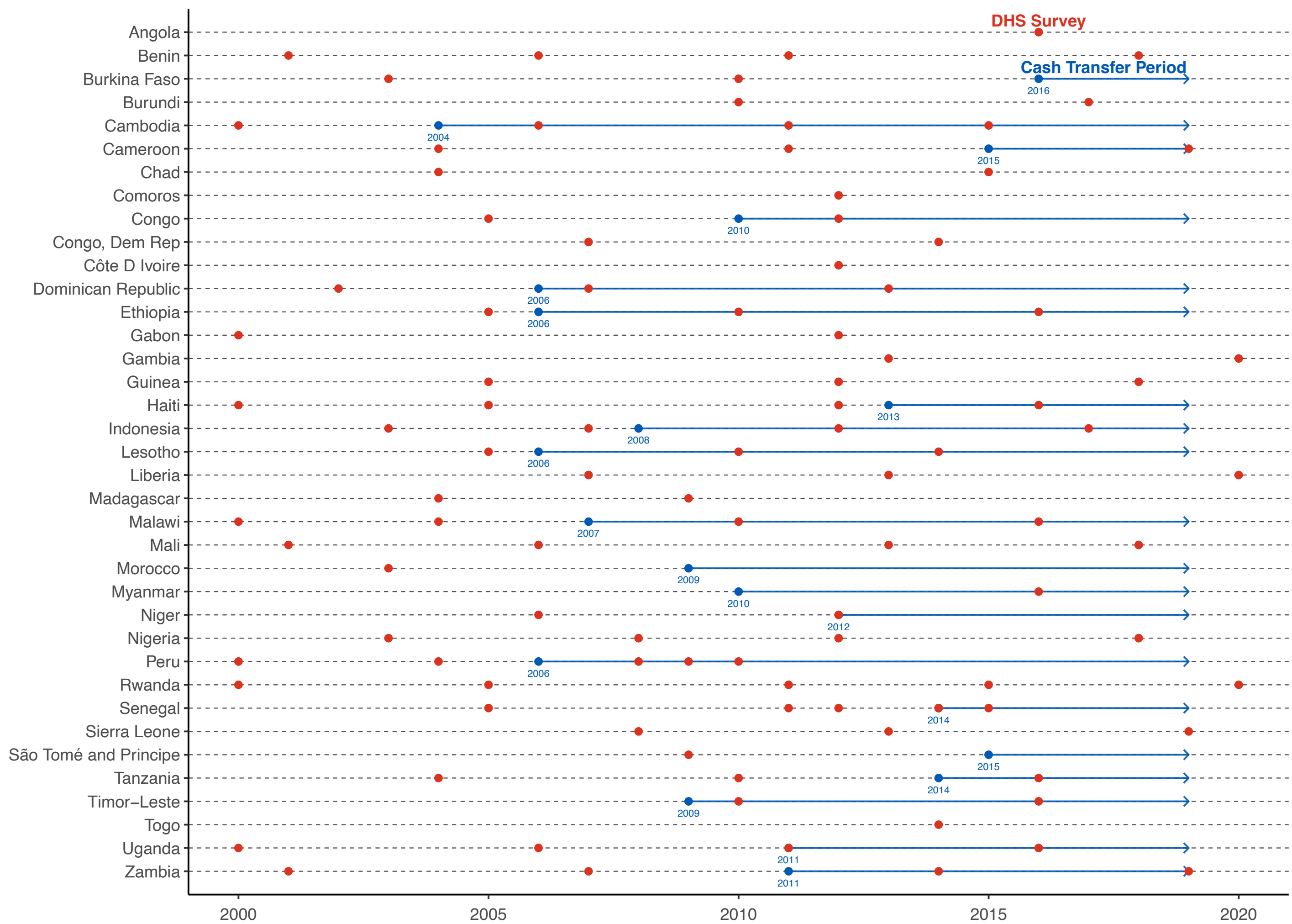


Figure 2. The effects of cash transfer programs on maternal health services over time. Temporal plots showing the associations between cash transfer programs and maternal health services use as a function of the year of the cash transfer period. Effect estimates are absolute changes in the outcome and error bars show 95% confidence intervals. Estimates were generated using two-stage difference and differences models with country and year (of birth) fixed effects, country-level covariates (GDP per capita, PEPFAR funding budgeted, total health expenditures, and three Worldwide Governance Indicators: control of corruption, political stability and absence of violence, and voice and accountability), and individual-level covariates (mother's age, rural or urban setting, and parity). Standard errors were clustered at the country level.

Figure 3. The effects of cash transfer programs on fertility and reproductive decision-making over time. Temporal plots showing the associations between cash transfer programs and fertility and reproductive decision-making outcomes as a function of the year of the cash transfer period. Effect estimates are absolute changes in the outcome and error bars show 95% confidence intervals. Estimates were generated using two-stage difference and differences models with country and year (of birth) fixed effects, country-level covariates (GDP per capita, PEPFAR funding budgeted, total health expenditures, and three Worldwide Governance Indicators: control of corruption, political stability and absence of violence, and voice and accountability), and individual-level covariates (mother's age [except for the Age at First Birth outcome], rural or urban setting, and parity). Standard errors were clustered at the country level.

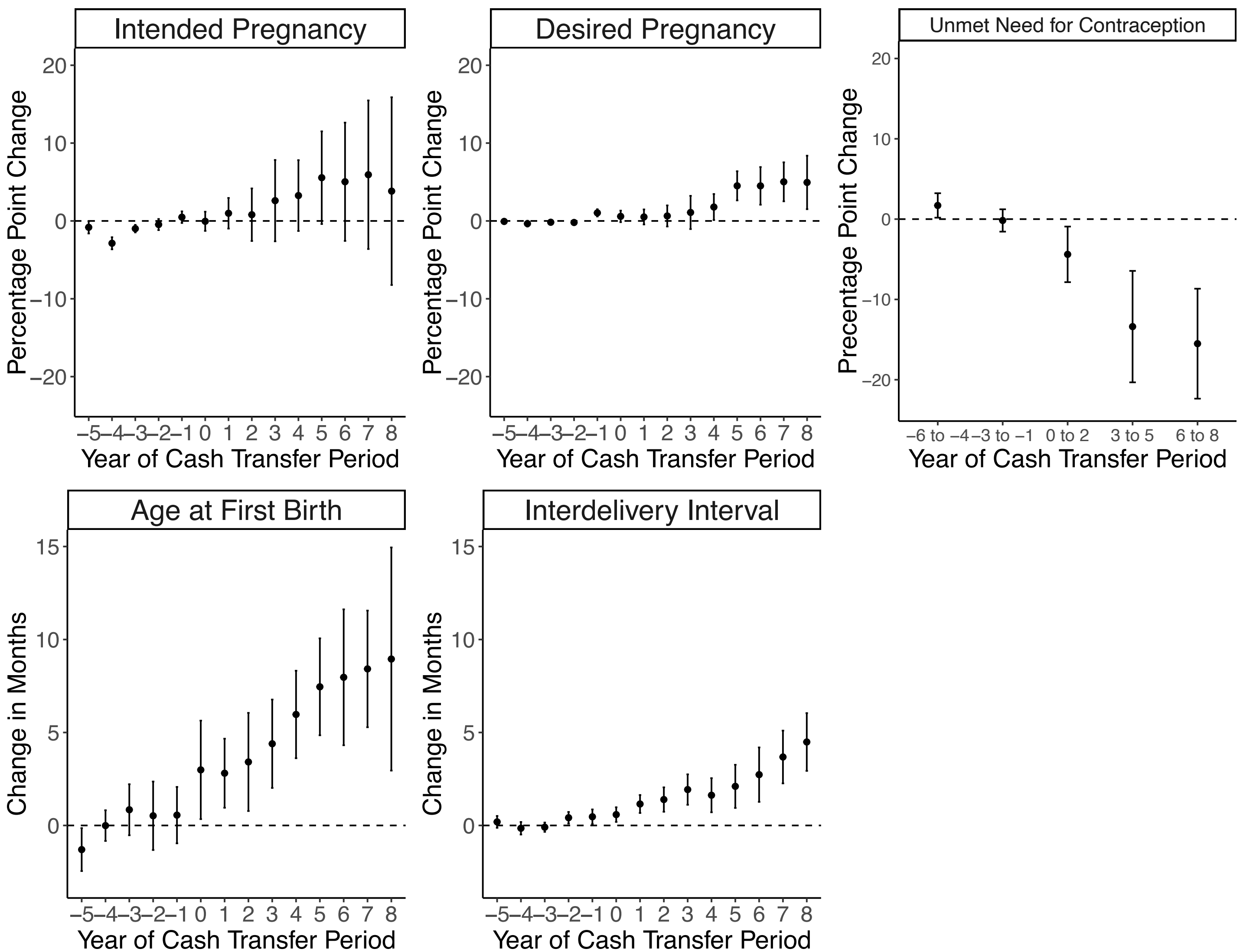


Figure 4. The effects of cash transfer programs on caregiver health behaviors. Temporal plots showing the associations between cash transfer programs and caregiver health behaviors as a function of the year of the cash transfer period. For the minimum acceptable diet outcome, estimates are groups over three-year periods. Effect estimates are absolute changes in the outcome and error bars show 95% confidence intervals. Estimates were generated using two-stage difference and differences models with country and year (of birth for breastfeeding; of the survey for measles vaccination and minimum acceptable diet) fixed effects, country-level covariates (GDP per capita, PEPFAR funding budgeted, total health expenditures, and three Worldwide Governance Indicators: control of corruption, political stability and absence of violence, and voice and accountability), and individual-level covariates (mother's age, child's age [minimum acceptable diet, measles vaccination], rural or urban setting, and birth order). Standard errors were clustered at the country level.

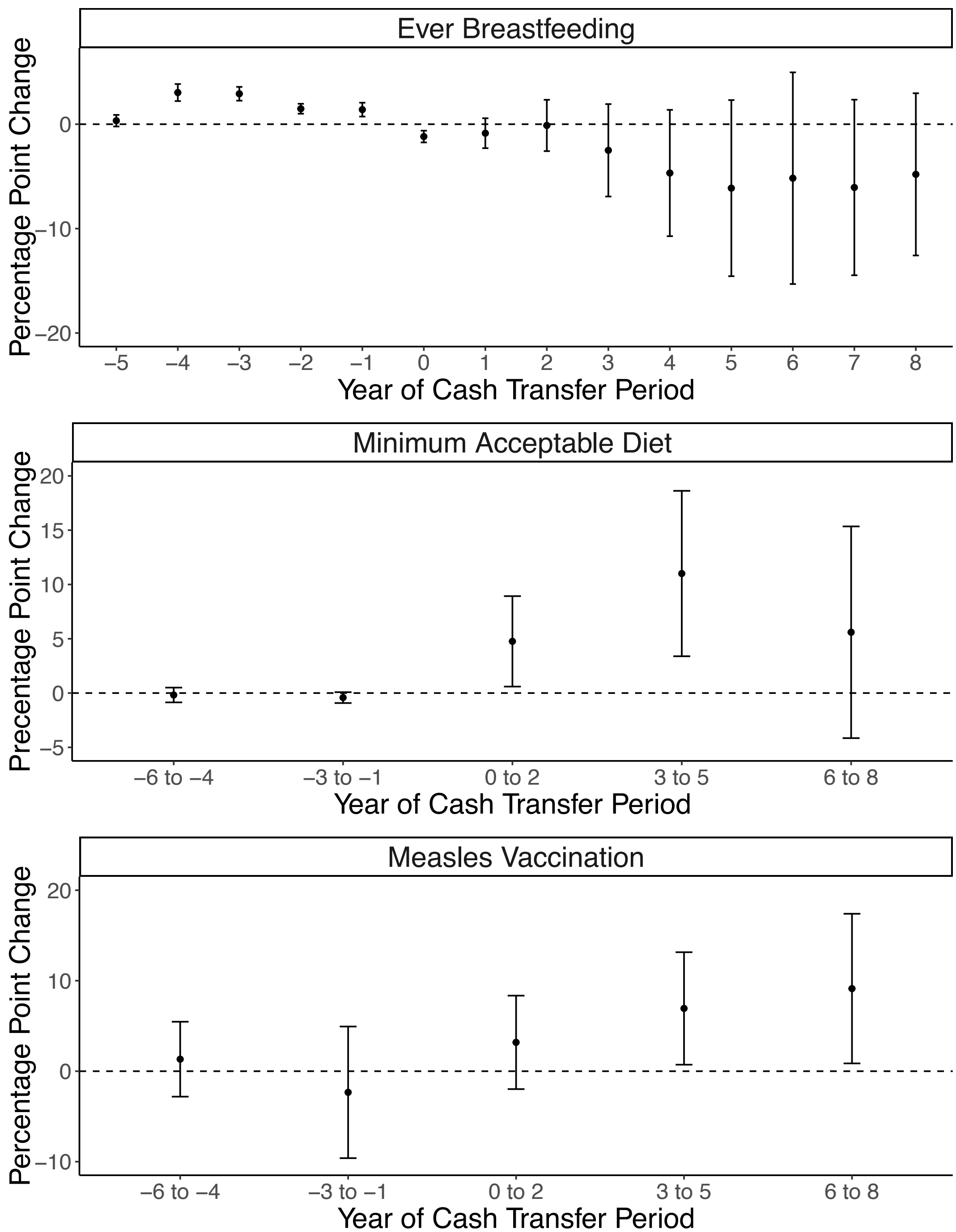


Figure 5. The effects of cash transfer programs on child health and nutrition outcomes. Temporal plots showing the associations between cash transfer programs and child health and nutrition outcomes as a function of the year of the cash transfer period. For the diarrhea, underweight, wasting, and stunting outcomes, estimates are groups over three-year periods. Effect estimates are absolute changes in the outcome and error bars show 95% confidence intervals. Estimates were generated using two-stage difference and differences models with country and year (of birth for male twin birth, small birth size; of the survey for diarrhea, underweight, wasting, and stunting) fixed effects, country-level covariates (GDP per capita, PEPFAR funding budgeted, total health expenditures, and three Worldwide Governance Indicators: control of corruption, political stability and absence of violence, and voice and accountability), and individual-level covariates (mother's age, child's age [diarrhea, underweight, wasting, stunting], rural or urban setting, and birth order). Standard errors were clustered at the country level.

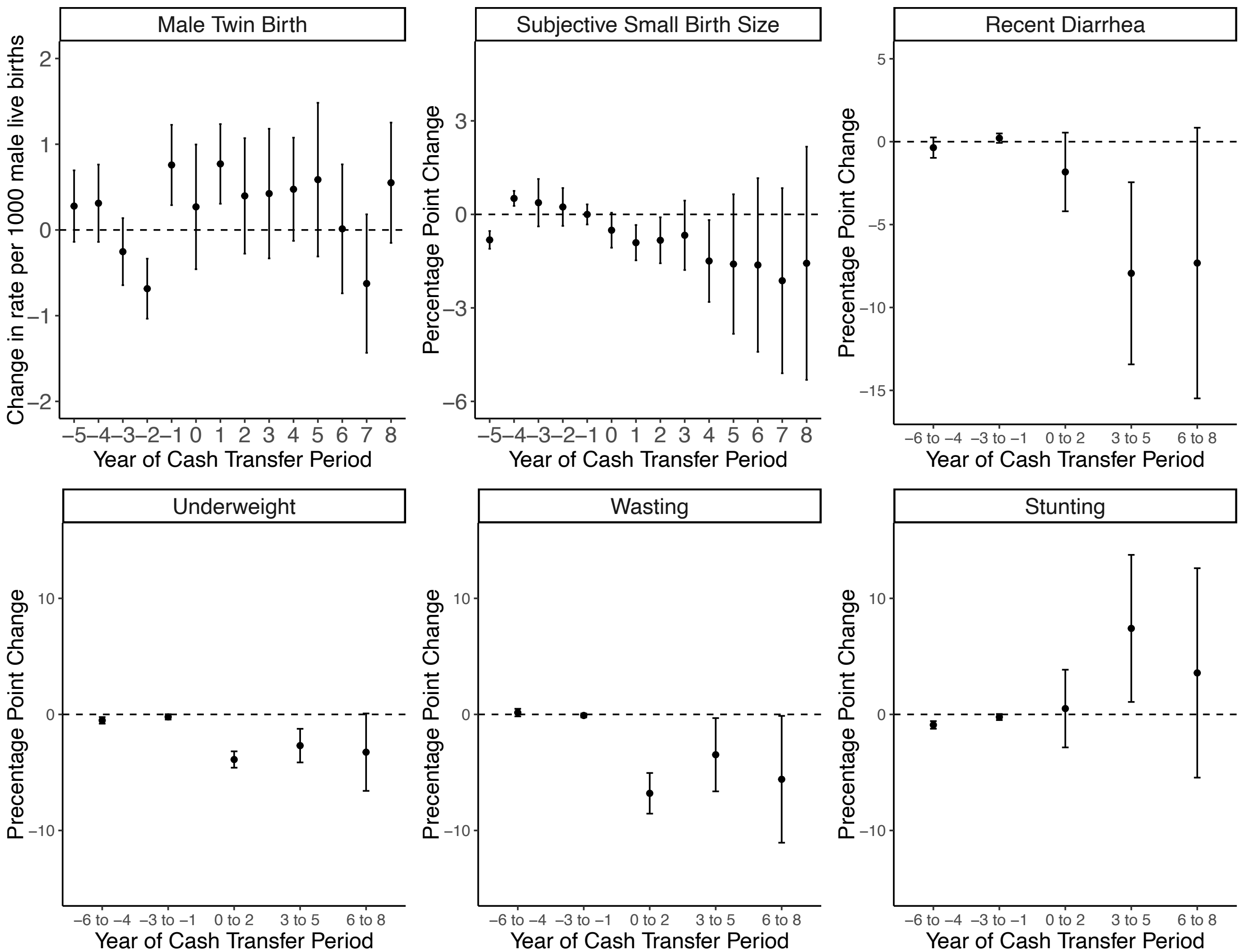
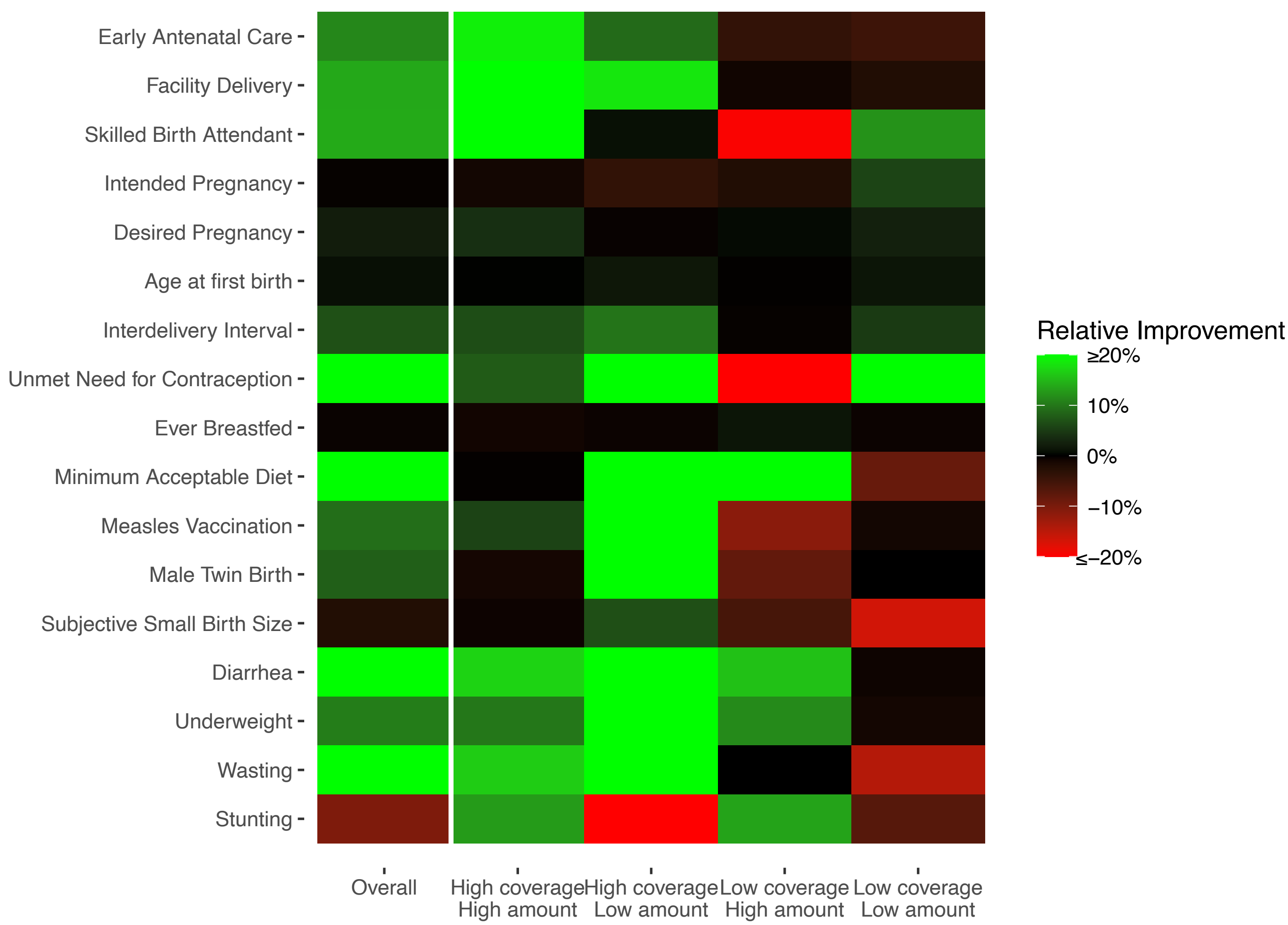


Figure 6. Heat map showing heterogeneity analyses by coverage level and transfer amount. Subgroup analyses by cash transfer coverage level and transfer amount (above or below the median) showing improvement in the primary outcome relative to the mean among comparison observations based on fully adjusted effect estimates generated using two-stage difference and differences models with country and year fixed effects, country-level covariates (GDP per capita, PEPFAR funding budgeted, total health expenditures, and three Worldwide Governance Indicators: control of corruption, political stability and absence of violence, and voice and accountability), and individual-level covariates (mother's age, child's age [post-natal outcomes], rural or urban setting, and birth order).



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Supplementary Materials for

The effects of governmental cash transfer programs on behavioral and health determinants of mortality: evidence from 37 low- and middle-income countries.

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Supplementary Table 1. Description of outcome variables from the births dataset, generated using Demographic and Health Survey data.

Outcome	Description	Sample Population	Time Variable	Missing
Early antenatal care	ANC during first trimester	Last birth in last 5 years	Year of birth	12.5%
Facility delivery	Birth was at a health facility	All births in last 5 years	Year of birth	0.5%
Skilled Birth Attendant	Birth attended to by a doctor, nurse, other health professional	All births in last 5 years	Year of birth	0.8%
Desired pregnancy	Pregnancy was wanted at time of birth OR wanted later	Last 3 births in last 5 years	Year of birth	0.2%
Intended pregnancy	Pregnancy was wanted at time of birth	Last 3 births in last 5 years	Year of birth	0.2%
Age at first birth	Respondents' age at the time of first birth	All first births during study period	Year of birth	0%
Interdelivery interval	Time between births in months (excluding firstborn)	All births during study period	Year of birth	0%
Ever breastfeeding	Child was ever breastfed	Last birth in last 5 years	Year of birth	22%
Measles vaccination	Ever received measles vaccination as reported on vaccine card or mother's recall	Last birth in last 5 years	Year of survey	10.5%
Male twin live birth	Twin (or multiplet) birth of all male sex infants	All births, after excluding births	Year of birth	0%

		with female sex infant		
Subjective small birth size	Birth size recalled by mother to be “smaller than average” or “very small”	Last birth in last 5 years	Year of birth	2.4%
		Survey respondents with a need for family planning (married, sexually active, fecund). One observation per respondent.		

Supplementary Table 2. Description of outcome variables from the children dataset, generated using Demographic and Health Survey data.

Outcome	Description	Sample Population	Time Variable	Missing
Minimum Acceptable Diet	Minimum dietary diversity *and* minimum meal frequency (*and* minimum milk feed for non-breastfed children), 24hr dietary recall. (WHO definition)[31]	Youngest child aged 6-23 months	Year of survey	15%
Recent Diarrhea	Mother reports that child had diarrhea in the last 2 weeks	Children <5 years of age, most recent 3 births	Year of survey	8%
Underweight (acute + chronic caloric deficiency)	*Weight-for-age* ≤ -2.0 standard deviations below the mean (WHO Child Growth Standards)[32]	All children <5 years of age in households selected for anthropometrics	Year of survey	5%
Wasting (acute caloric deficiency)	*Weight-for-height* ≤ -2.0 standard deviations below the mean (WHO Child Growth Standards)[32]	All children <5 years of age in households selected for anthropometrics	Year of survey	8%
Stunting (chronic caloric deficiency)	*Height-for-age* ≤ -2.0 standard deviations below the mean (WHO Child Growth Standards)[32]	All children <5 years of age in households selected for anthropometrics	Year of survey	8%

Supplementary Table 3. Characteristics of births dataset including last birth in the last five years before the survey, used for the antenatal care, small birth size, measles vaccination, and ever breastfeeding outcomes.

	Intervention	Control
Total births (row %)	196,538 (29)	478,111 (71)
Mother's Age, median (IQR)	26 (22-32)	27 (22-32)
Parity, median (IQR)	3 (1-4)	3 (2-5)
Rural	127,370 (65)	319,565 (67)
Mother's Education		
None	37,273 (19)	215,521 (45)
Primary	78,955 (40)	147,611 (31)
Secondary	64,020 (33)	99,430 (21)
Higher	16,280 (8)	15,519 (3)
Wealth Quintile		
Poorest	52,261 (27)	113,901 (24)
Poorer	44,941 (23)	103,417 (22)
Middle	39,147 (20)	96,715 (20)
Richer	32,512 (17)	86,850 (18)
Richest	27,677 (14)	76,848 (16)
GDP Per Capita, median (IQR)	3,204 (2128.74-8505.75)	2,177 (1321.62-3934.84)
PEPFAR Funding ($5) Per Capita, median (IQR)	0.01 (0-0.75)	0.00 (0-0.09)
Health Expenditure Per Capita, median (IQR)	61 (49.22-1092)	36 (22.34-602)
Worldwide Governance Indicators (percentile), median (IQR)		
Control of Corruption	37 (24-51)	23 (13-37)
Political Stability and Absence of Violence	31 (21-42)	26 (8-43)
Voice and Accountability	48 (36-53)	35 (23-45)
Government Effectiveness	37 (29-42)	23 (13-37)
Regulatory Quality	40 (33-50)	27 (19-42)
Rule of Law	38 (27-47)	27 (13-39)
Region (column %)		
Asia	51,616 (26)	33,757 (7)
Latin America/Caribbean	43,142 (22)	36,047 (8)
North Africa	0 (0)	4,127 (1)
Sub-Saharan Africa	101,780 (52)	404,180 (85)

Supplementary Table 4. Characteristics of births dataset including all births in the last five years before the survey, used for facility delivery, skilled birth attendant, intended pregnancy, and desired pregnancy outcomes.

	Intervention	Control
Total births (row %)	238,034 (25)	719,406 (75)
Mother's Age, median (IQR)	26 (21-32)	26 (21-31)
Parity, median (IQR)	2 (1-4)	3 (2-5)
Rural	157,706 (66)	496,260 (69)
Mother's Education		
None	46,679 (20)	337,529 (47)
Primary	97,783 (41)	224,088 (31)
Secondary	74,840 (31)	137,529 (19)
Higher	18,719 (8)	20,212 (3)
Wealth Quintile		
Poorest	66,293 (28)	181,256 (25)
Poorer	54,890 (23)	160,189 (22)
Middle	46,702 (20)	145,189 (20)
Richer	38,162 (16)	126,209 (18)
Richest	31,987 (13)	106,162 (15)
GDP Per Capita, median (IQR)	3,084 (2092.48-8026.61)	2,107 (1274.2-3690.84)
PEPFAR Funding ($5) Per Capita, median (IQR)	0.01 (0-0.75)	0.00 (0-0.09)
Health Expenditure Per Capita, median (IQR)	61 (49.22-1082)	36 (21.94-602)
Worldwide Governance Indicators (percentile), median (IQR)		
Control of Corruption	36 (23-51)	23 (12-37)
Political Stability and Absence of Violence	32 (21-42)	26 (8-43)
Voice and Accountability	47 (36-53)	35 (22-44)
Government Effectiveness	37 (29-42)	22 (12-37)
Regulatory Quality	40 (33-50)	27 (18-41)
Rule of Law	39 (27-48)	25 (12-40)
Region (column %)		
Asia	61,713 (26)	44,284 (6)
Latin America/Caribbean	50,306 (21)	48,098 (7)
North Africa	0 (0)	4,938 (1)
Sub-Saharan Africa	126,015 (53)	622,086 (86)

Supplementary Table 5. Characteristics of births dataset including all births during the study period, used for the male twin birth and interdelivery interval outcomes.

	Intervention	Control
Total births (row %)	307, 029 (14)	1,849,435 (86)
Mother's Age, median (IQR)	26 (22-32)	25 (21-31)
Parity, median (IQR)	2 (1-4)	3 (2-5)
Rural	204,455 (67)	1,279,254 (69)
Mother's Education		
None	56,133 (18)	880,649 (48)
Primary	130,136 (42)	586,396 (32)
Secondary	97,126 (32)	328,021 (18)
Higher	23,621 (8)	54,250 (3)
Wealth Quintile		
Poorest	84,436 (28)	477,865 (26)
Poorer	69,599 (23)	417,672 (23)
Middle	59,548 (19)	375,206 (20)
Richer	50,164 (16)	321,190 (17)
Richest	43,282 (14)	257,101 (14)
GDP Per Capita, median (IQR)	3,076 (2014.27-8026.61)	2,064 (1203.21-3105.32)
PEPFAR Funding ($5) Per Capita, median (IQR)	0.01 (0-0.64)	0.00 (0-0)
Health Expenditure Per Capita, median (IQR)	59 (40.35-1072)	31 (19.73-512)
Worldwide Governance Indicators (percentile), median (IQR)		
Control of Corruption	34 (21-48)	22 (12-37)
Political Stability and Absence of Violence	31 (21-42)	24 (7-41)
Voice and Accountability	47 (32-52)	34 (21-44)
Government Effectiveness	37 (28-42)	23 (12-39)
Regulatory Quality	39 (33-49)	28 (17-42)
Rule of Law	34 (26-47)	27 (12-40)
Region (column %)		
Asia	100,479 (33)	154,884 (8)
Latin America/Caribbean	56,326 (18)	133,302 (7)
North Africa	0 (0	4,938 (0)
Sub-Saharan Africa	150,224 (49)	1,556,311 (84)

Supplementary Table 6. Characteristics of births dataset including all first births during the study period, used for the age at first birth outcome.

	Intervention	Control
Total births (row %)	95,671 (4)	802,450 (37)
Mother's Age, median (IQR)	21 (18-25)	23 (19-28)
Parity, median (IQR)	1 (1-1)	1 (1-3)
Rural	55,917 (58)	523,081 (65)
Mother's Education		
None	8,721 (9)	316,249 (39)
Primary	33,500 (35)	271,039 (34)
Secondary	41,200 (43)	180,415 (22)
Higher	12,248 (13)	34,703 (4)
Wealth Quintile		
Poorest	20,970 (22)	189,135 (24)
Poorer	20,687 (22)	172,184 (21)
Middle	19,458 (20)	161,628 (20)
Richer	17,693 (18)	146,869 (18)
Richest	16,863 (18)	132,254 (16)
GDP Per Capita, median (IQR)	3,423 (2128.74-8505.75)	1,999 (1134.54-3467.11)
PEPFAR Funding ($5) Per Capita, median (IQR)	0.01 (0-0.3)	0.00 (0-0)
Health Expenditure Per Capita, median (IQR)	65 (49.22-1102)	25 (16.81-432)
Worldwide Governance Indicators (percentile), median (IQR)		
Control of Corruption	34 (21-50)	25 (13-39)
Political Stability and Absence of Violence	28 (21-42)	22 (9-41)
Voice and Accountability	48 (35-52)	36 (21-47)
Government Effectiveness	37 (28-45)	27 (14-42)
Regulatory Quality	39 (33-49)	33 (19-43)
Rule of Law	33 (26-45)	29 (13-41)
Region (column %)		
Asia	36,630 (38)	100,541 (13)
Latin America/Caribbean	23,097 (24)	88,555 (11)
North Africa	0 (0)	4,127 (1)
Sub-Saharan Africa	35,944 (38)	609,227 (76)

Supplementary Table 7. Characteristics of children dataset including all children less than 5 years of age in the household who were one of the last 3 births of the respondent, used for the recent diarrhea outcome.

	Intervention	Control
Total children (row %)	366,919 (39)	576,993 (61)
Mother's Age, median (IQR)	28 (24-34)	28 (24-34)
Birth order, median (IQR)	3 (1-4)	3 (2-5)
Child's Age in months, median (IQR)	29 (14-44)	27 (12-42)
Rural	246,044 (67)	398,032 (69)
Mother's Education		
None	94,061 (26)	283,034 (49)
Primary	145,312 (40)	171,674 (30)
Secondary	103,274 (28)	107,494 (19)
Higher	24,235 (7)	14,767 (3)
Wealth Quintile		
Poorest	101,453 (28)	141,570 (25)
Poorer	85,126 (23)	126,789 (22)
Middle	71,990 (20)	117,071 (20)
Richer	58,820 (16)	103,910 (18)
Richest	49,528 (13)	87,254 (15)
GDP Per Capita, median (IQR)	3,153 (2092.48-8857.86)	2,135 (1442.76-4170.73)
PEPFAR Funding ($5) Per Capita, median (IQR)	0.01 (0-0.78)	0.00 (0-0.37)
Health Expenditure Per Capita, median (IQR)	61 (42.2-1102)	38 (25.41-802)
Worldwide Governance Indicators (percentile), median (IQR)		
Control of Corruption	31 (23-51)	21 (12-34)
Political Stability and Absence of Violence	34 (21-44)	19 (6-41)
Voice and Accountability	47 (31-54)	33 (23-43)
Government Effectiveness	37 (28-42)	19 (13-34)
Regulatory Quality	40 (30-49)	27 (20-38)
Rule of Law	35 (26-46)	21 (12-36)
Region (column %)		
Asia	92,983 (25)	29,395 (5)
Latin America/Caribbean	71,689 (20)	26,632 (5)
North Africa	0 (0)	4,934 (1)
Sub-Saharan Africa	202,247 (55)	516,032 (89)

Supplementary Table 8. Characteristics of children dataset including all children less than 5 years of age in households selected for anthropometrics, used for the underweight, wasting, and stunting outcomes.

	Intervention	Control
Total children (row %)	231,825 (41)	338,613 (59)
Mother's Age, median (IQR)	28 (24-34)	28 (24-34)
Birth order, median (IQR)	3 (2-5)	3 (2-5)
Child's Age in months, median (IQR)	28 (14-44)	25 (11-40)
Rural	151,855 (66)	232,428 (69)
Mother's Education		
None	69,455 (30)	174,097 (51)
Primary	85,639 (37)	98,598 (29)
Secondary	61,173 (26)	57,566 (17)
Higher	15,536 (7)	8,337 (2)
Wealth Quintile		
Poorest	65,187 (28)	80,497 (24)
Poorer	55,577 (24)	73,841 (22)
Middle	46,318 (20)	69,172 (20)
Richer	36,022 (16)	62,239 (18)
Richest	28,720 (12)	52,507 (16)
GDP Per Capita, median (IQR)	3,204 (2479.33-8026.61)	2,135 (1442.76-4170.73)
PEPFAR Funding ($5) Per Capita, median (IQR)	0 (0-0.78)	0 (0-0.37)
Health Expenditure Per Capita, median (IQR)	61 (54.07-1902)	38 (25.41-812)
Worldwide Governance Indicators (percentile), median (IQR)		
Control of Corruption	38 (25-53)	22 (12-37)
Political Stability and Absence of Violence	36 (19-44)	28 (6-46)
Voice and Accountability	52 (35-54)	33 (25-47)
Government Effectiveness	37 (28-42)	19 (14-33)
Regulatory Quality	46 (30-50)	27 (20-38)
Rule of Law	35 (26-47)	24 (12-38)
Region (column %)		
Asia	37,683 (16)	303 (0)
Latin America/Caribbean	64,830 (28)	17,041 (5)
North Africa	0 (0)	4,664 (1)
Sub-Saharan Africa	129,312 (56)	316,605 (94)

Supplementary Table 9. Characteristics of children dataset including the youngest child aged 6-23 months in the household, used for the minimum acceptable diet outcome.

	Intervention	Control
Total children (row %)	102,554 (38)	164,354 (62)
Mother's Age, median (IQR)	27 (23-33)	27 (23-33)
Parity, median (IQR)	3 (1-4)	3 (2-5)
Child's Age in months, median (IQR)	14 (10-19)	14 (9-18)
Rural	68,347 (67)	112,748 (69)
Mother's Education		
None	24,683 (24)	76,654 (47)
Primary	39,955 (39)	50,130 (31)
Secondary	30,611 (30)	32,922 (20)
Higher	7,295 (7)	4,643 (3)
Wealth Quintile		
Poorest	27,965 (27)	40,059 (24)
Poorer	23,960 (23)	36,180 (22)
Middle	20,193 (20)	33,380 (20)
Richer	16,472 (16)	29,651 (18)
Richest	13,964 (14)	24,909 (15)
GDP Per Capita, median (IQR)	3,153 (2092.48-8857.86)	2,135 (1442.76-4170.73)
PEPFAR Funding ($5) Per Capita, median (IQR)	0.01 (0-0.78)	0.00 (0-0.29)
Health Expenditure Per Capita, median (IQR)	61 (42.2-1102)	37 (24.89-782)
Worldwide Governance Indicators (percentile), median (IQR)		
Control of Corruption	32 (23-52)	22 (13-35)
Political Stability and Absence of Violence	34 (21-44)	22 (6-41)
Voice and Accountability	47 (31-54)	33 (25-44)
Government Effectiveness	37 (28-42)	21 (14-35)
Regulatory Quality	44 (31-50)	27 (20-39)
Rule of Law	35 (26-47)	22 (12-37)
Region (column %)		
Asia	26,148 (25)	9,610 (6)
Latin America/Caribbean	20,037 (20)	8,864 (5)
North Africa	0 (0)	1,673 (1)
Sub-Saharan Africa	56,369 (55)	144,207 (88)

Supplementary Table 10. Heterogeneity analyses by coverage level and transfer amount. Subgroup analyses by cash transfer coverage level and transfer amount (above or below the median). Effect estimates are absolute changes in the outcome with 95% confidence intervals. Estimates were generated using two-stage difference and differences models with country and year (of birth) fixed effects, country-level covariates (GDP per capita, PEPFAR funding budgeted, total health expenditures, and three Worldwide Governance Indicators: control of corruption, political stability and absence of violence, and voice and accountability), and individual-level covariates (mother's age, child's age [post-natal outcomes], rural or urban setting, and birth order). Standard errors were clustered at the country level.

Outcome	Absolute Change with Cash Transfers (95% CI)
Early antenatal care	
High cov / high transfer	10.6% (5.3 to 15.9)
High cov / low transfer	5.0% (3.0 to 6.9)
Low cov / high transfer	-2.1% (-5.5 to 1.4)
Low cov / low transfer	-2.7% (-4.3 to -1.1)
Facility delivery	
High cov / high transfer	11.5% (4.1 to 18.9)
High cov / low transfer	9.7% (4.0 to 15.5)
Low cov / high transfer	-0.4% (-4.1 to 3.3)
Low cov / low transfer	-1.1% (-4.7 to 2.5)
Skilled birth attendant	
High cov / high transfer	17.6% (14.0 to 21.2)
High cov / low transfer	0.5% (-2.8 to 3.9)
Low cov / high transfer	-11.2% (-25 to 2.6)
Low cov / low transfer	6.9% (1.6 to 12.2)
Desired pregnancy	
High cov / high transfer	3.6% (1.4 to 5.8)
High cov / low transfer	-0.3% (-2.1 to 1.5)
Low cov / high transfer	0.5% (-1.3 to 2.2)
Low cov / low transfer	2.2% (0.5 to 3.9)
Intended pregnancy	
High cov / high transfer	-0.7% (-3.7 to 2.4)
High cov / low transfer	-2.8% (-6.5 to 0.8)
Low cov / high transfer	-1.6% (-7.7 to 4.5)
Low cov / low transfer	4.4% (0.4 to 8.5)
Age at first birth	
High cov / high transfer	0.2 months (-4.2 to 4.7)
High cov / low transfer	3.6 months (-0.8 to 8.0)
Low cov / high transfer	-0.3 months (-4.3 to 3.6)
Low cov / low transfer	3.2 months (0.0 to 6.3)
Unmet need for contraception	
High cov / high transfer	-3.0 (-7.3 to 1.3)
High cov / low transfer	-20.6 (-27.7 to -13.5)
Low cov / high transfer	8.5% (4.4 to 12.6)
Low cov / low transfer	-8.1% (-16.7 to 0.6)

Subjective small birth size	
High cov / high transfer	0.1% (-1.0 to 1.1)
High cov / low transfer	-1.2% (-2.9 to 0.5)
Low cov / high transfer	1.0% (-1.5 to 3.5)
Low cov / low transfer	3.0% (1.9 to 4.1)
Ever breastfeed	
High cov / high transfer	-0.8% (-3.3 to 1.7)
High cov / low transfer	-0.5% (-1.2 to 0.1)
Low cov / high transfer	1.2% (-1.0 to 3.3)
Low cov / low transfer	-0.5% (-1.7 to 0.8)
Interdelivery Interval	
High cov / high transfer	2.4 months (1.8 to 3.0)
High cov / low transfer	3.6 months (2.5 to 4.6)
Low cov / high transfer	-0.1 months (-1.2 to 0.9)
Low cov / low transfer	1.8 months (0.8 to 2.8)
Male twin birth	
High cov / high transfer	-0.01% (-0.05 to 0.03)
High cov / low transfer	0.28% (0.21 to 0.35)
Low cov / high transfer	-0.08% (-0.17 to 0.01)
Low cov / low transfer	0.00% (-0.08 to 0.07)
Measles vaccination	
High cov / high transfer	3.1% (-1.5 to 7.8)
High cov / low transfer	12.0% (3.5 to 20.4)
Low cov / high transfer	-6.2% (-14.7 to 2.3)
Low cov / low transfer	-0.5% (-4.0 to 3.1)
Minimal acceptable diet	
High cov / high transfer	-0.03% (-1.4 to 1.4)
High cov / low transfer	20.8% (17.9 to 23.7)
Low cov / high transfer	3.8% (1.4 to 6.1)
Low cov / low transfer	-1.6% (-2.7 to 0.5)
Diarrhea in last 2 weeks	
High cov / high transfer	-2.7% (-5.5 to 0.1)
High cov / low transfer	-18.1% (-23.1 to -13.0)
Low cov / high transfer	-2.5% (-6.5 to 1.6)
Low cov / low transfer	0.1% (-3.5 to 3.7)
Underweight	
High cov / high transfer	-2.1% (-3.5 to -0.7)
High cov / low transfer	-5.0% (-8.1 to -1.9)
Low cov / high transfer	-2.4% (-4.5 to -0.4)
Low cov / low transfer	0.2% (-1.3 to 1.8)
Wasting	
High cov / high transfer	-1.8% (-4.7 to 1.1)
High cov / low transfer	-9.4% (-13.3 to -5.5)
Low cov / high transfer	0.0% (-2.7 to 2.7)
Low cov / low transfer	1.6% (-1.8 to 5.0)
Stunting	
High cov / high transfer	-4.6% (-6.6 to -2.6)
High cov / low transfer	17.8% (13.8 to 21.8)
Low cov / high transfer	-4.8% (-7.9 to -1.7)

Low cov / low transfer	2.5% (-1.0 to 6.1)

Supplementary Table 11. Heterogeneity analyses by cash transfer conditionality (unconditional, conditional, mixed). Effect estimates are absolute changes in the outcome with 95% confidence intervals. Estimates were generated using two-stage difference and differences models with country and year (of birth) fixed effects, country-level covariates (GDP per capita, PEPFAR funding budgeted, total health expenditures, and three Worldwide Governance Indicators: control of corruption, political stability and absence of violence, and voice and accountability), and individual-level covariates (mother's age, child's age [post-natal outcomes], rural or urban setting, and birth order). Standard errors were clustered at the country level.

Outcome	Absolute Change with Cash Transfers (95% CI)
Early antenatal care	
Unconditional	5.0% (3.5 to 6.6)
Conditional	5.1% (0.1 to 10.1)
Mixed	4.0% (1.3 to 6.7)
Facility delivery	
Unconditional	6.6% (2.0 to 11.1)
Conditional	7.0% (0.9 to 13.2)
Mixed	14.6% (9.0 to 20.2)
Skilled birth attendant	
Unconditional	15.9% (12.0 to 19.8)
Conditional	4.5% (-1.0 to 10.0)
Mixed	-10.9% (-21.7 to -0.2)
Desired pregnancy	
Unconditional	3.1% (1.1 to 5.2)
Conditional	1.3% (-0.5 to 3.2)
Mixed	-1.6% (-2.1 to -1.1)
Intended pregnancy	
Unconditional	-1.3% (-3.9 to 1.3)
Conditional	0.8% (-3.2 to 4.7)
Mixed	-3.4% (-6.1 to -0.7)
Age at first birth	
Unconditional	-2.0 months (-4.0 to 0.1)
Conditional	3.7 months (1.1 to 6.4)
Mixed	5.0 months (1.2 to 8.8)
Unmet need for contraception	
Unconditional	-2.7% (-7.1 to 1.7)
Conditional	-13.9% (-19.2 to -8.5)
Mixed	-14.3% (-26.5 to -2.1)
Subjective small birth size	
Unconditional	0.8% (0.1 to 1.5)
Conditional	0.1% (-1.6 to 1.8)
Mixed	0.0% (-2.1 to 2.1)
Ever breastfeed	
Unconditional	-2.9% (-3.9 to 2.0)
Conditional	1.5% (0.2 to 2.7)
Mixed	-2.0% (-4.1 to 0.0)

Interdelivery Interval	
Unconditional	1.7 months (1.2 to 2.3)
Conditional	2.9 months (1.9 to 4.0)
Mixed	3.6 months (2.7 to 4.5)
Measles vaccination	
Unconditional	1.6% (-3.7 to 7.0)
Conditional	6.9% (1.8 to 12.0)
Mixed	7.0% (-9.3 to 23.4)
Male twin birth	
Unconditional	-0.09% (-0.12 to -0.06)
Conditional	0.19% (0.12 to 0.25)
Mixed	0.14% (0.08 to 0.20)
Minimum acceptable diet	
Unconditional	1.2% (-1.9 to 4.3)
Conditional	13.2% (11.6 to 14.7)
Mixed	-1.5% (-3.1 to 0.1)
Diarrhea in last 2 weeks	
Unconditional	-5.2% (-8.2 to -2.3)
Conditional	-4.5% (-6.8 to -2.1)
Mixed	5.4% (0.1 to 10.6)
Underweight	
Unconditional	1.4% (0.4 to 2.5)
Conditional	-4.8% (-6.4 to -3.2)
Mixed	-5.3% (-7.1 to -3.6)
Wasting	
Unconditional	5.0% (3.6 to 6.4)
Conditional	-9.0% (-10.6 to -7.5)
Mixed	-0.8% (-1.8 to 0.3)
Stunting	
Unconditional	-2.4% (-4.4 to -0.4)
Conditional	1.4% (-1.1 to 3.8)
Mixed	-10.3% (-13.0 to -7.7)

Supplementary Table 12. Heterogeneity analyses by region. Effect estimates are absolute changes in the outcome with 95% confidence intervals. Estimates were generated using two-stage difference and differences models with country and year (of birth) fixed effects, country-level covariates (GDP per capita, PEPFAR funding budgeted, total health expenditures, and three Worldwide Governance Indicators: control of corruption, political stability and absence of violence, and voice and accountability), and individual-level covariates (mother's age, child's age [post-natal outcomes], rural or urban setting, and birth order). Standard errors were clustered at the country level.

Outcome	**Absolute Change with Cash Transfers (95% CI)**
Early antenatal care	
Sub-Saharan Africa	1.9% (-0.8 to 4.5)
Outside Sub-Saharan Africa	11.5% (6.0 to 17.1)
Facility delivery	
Sub-Saharan Africa	4.2% (0.3 to 8.0)
Outside Sub-Saharan Africa	14.4% (1.6 to 27.2)
Skilled birth attendant	
Sub-Saharan Africa	10.0% (4.9 to 15.1)
Outside Sub-Saharan Africa	19.6% (6.8 to 32.5)
Desired pregnancy	
Sub-Saharan Africa	2.5% (1.0 to 4.0)
Outside Sub-Saharan Africa	1.9% (0.2 to 3.7)
Intended pregnancy	
Sub-Saharan Africa	0.5% (-3.1 to 4.0)
Outside Sub-Saharan Africa	0.3% (-2.8 to 3.4)
Age at first birth	
Sub-Saharan Africa	-0.2 months (-3.5 to 3.1)
Outside Sub-Saharan Africa	2.0 months (-0.7 to 4.7)
Unmet need for contraception	
Sub-Saharan Africa	-3.9% (-8.5 to 0.7)
Outside Sub-Saharan Africa	-6.5% (-8.6 to -4.5)
Subjective small birth size	
Sub-Saharan Africa	1.6% (0.5 to 2.7)
Outside Sub-Saharan Africa	0.0% (-1.9 to 1.8)
Ever breastfeed	
Sub-Saharan Africa	-1.6% (-2.8 to -0.3)
Outside Sub-Saharan Africa	26.7% (14.6 to 38.8)
Interdelivery Interval	
Sub-Saharan Africa	0.8 months (-1.4 to 1.5)
Outside Sub-Saharan Africa	1.4 months (-2.9 to 5.6)
Measles Vaccination	
Sub-Saharan Africa	1.4% (-3.3 to 6.1)
Outside Sub-Saharan Africa	36.2% (12.7 to 59.7)
Male twin birth	
Sub-Saharan Africa	0.14% (0.09 to 0.20)
Outside Sub-Saharan Africa	-0.05% (-0.20 to 0.11)

Minimum acceptable diet	
Sub-Saharan Africa	1.6% (0.1 to 3.0)
Outside Sub-Saharan Africa	12.9% (7.0 to 18.8)
Diarrhea in last 2 weeks	
Sub-Saharan Africa	-0.9% (-3.5 to 1.7)
Outside Sub-Saharan Africa	-7.3% (-20.0 to 4.9)
Underweight	
Sub-Saharan Africa	-1.2% (-2.2 to -0.2)
Outside Sub-Saharan Africa	14.1% (8.7 to 19.6)
Wasting	
Sub-Saharan Africa	0.7% (-0.8 to 2.2)
Outside Sub-Saharan Africa	8.7% (3.6 to 13.9)
Stunting	
Sub-Saharan Africa	-2.2% (-5.0 to 0.7)
Outside Sub-Saharan Africa	13.4% (8.8 to 18.2)

Supplementary Table 13. Heterogeneity analyses by child age. Effect estimates are absolute changes in the outcome with 95% confidence intervals. Estimates were generated using two-stage difference and differences models with country and year (of birth) fixed effects, country-level covariates (GDP per capita, PEPFAR funding budgeted, total health expenditures, and three Worldwide Governance Indicators: control of corruption, political stability and absence of violence, and voice and accountability), and individual-level covariates (mother's age, child's age, rural or urban setting, and birth order). Standard errors were clustered at the country level.

Outcome	Absolute Change with Cash Transfers (95% CI)
Measles vaccination	
<2 years	4.3% (-0.7 to 9.3)
2-5 years	1.0% (-2.0 to 4.0)
Diarrhea in last 2 weeks	
<2 years	-6.4% (-12.1 to -0.8)
2-5 years	-1.0% (-7.7 to 5.7)
Underweight	
<2 years	-3.5% (-5.4 to -1.6)
2-5 years	5.7% (2.8 to 8.5)
Wasting	
<2 years	-3.7% (-7.1 to -0.2)
2-5 years	4.6% (2.4 to 6.9)
Stunting	
<2 years	3.3% (-1.2 to 7.8)
2-5 years	2.3% (-2.1 to 6.7)

Supplementary Table 14. Heterogeneity analyses by schooling attainment. Effect estimates are absolute changes in the outcome with 95% confidence intervals. Estimates were generated using two-stage difference and differences models with country and year (of birth) fixed effects, country-level covariates (GDP per capita, PEPFAR funding budgeted, total health expenditures, and three Worldwide Governance Indicators: control of corruption, political stability and absence of violence, and voice and accountability), and individual-level covariates (mother's age, child's age [post-natal outcomes], rural or urban setting, and birth order). Standard errors were clustered at the country level.

Outcome	**Absolute Change with Cash Transfers (95% CI)**
Early antenatal care	
None	1.6% (-2.1 to 5.2)
Primary	6.4% (3.6 to 9.3)
Secondary	3.2% (-0.6 to 6.9)
Higher	4.1% (3.0 to 5.2)
Facility delivery	
None	6.0% (1.1 to 10.8)
Primary	8.9% (4.6 to 13.2)
Secondary	6.1% (2.4 to 9.8)
Higher	3.8% (1.0 to 6.6)
Skilled birth attendant	
None	10.2% (6.2 to 14.2)
Primary	13.4% (8.0 to 18.8)
Secondary	2.5% (-1.0 to 6.0)
Higher	-0.1% (-2.3 to 2.1)
Desired pregnancy	
None	1.4% (0.4 to 2.4)
Primary	2.0% (0.7 to 3.3)
Secondary	0.0% (-2.7 to 2.7)
Higher	1.0% (-0.5 to 2.4)
Intended pregnancy	
None	2.3% (-1.2 to 5.9)
Primary	-0.1% (-2.5 to 2.3)
Secondary	-1.0 (-3.7 to 1.6)
Higher	0.0% (-1.9 to 2.0)
Age at first birth	
None	5.7 months (2.0 to 9.4)
Primary	3.5 months (-0.2 to 7.2)
Secondary	0.2 months (-1.8 to 2.2)
Higher	-5.9 months (-11.0 to -0.9)
Unmet need for contraception	
None	-7.6% (-16 to 1.4)
Primary	-7.5% (-12.6 to -2.2)
Secondary	-9.1% (-11.8 to -6.4)
Higher	-5.7% (-8.4 to -2.9)

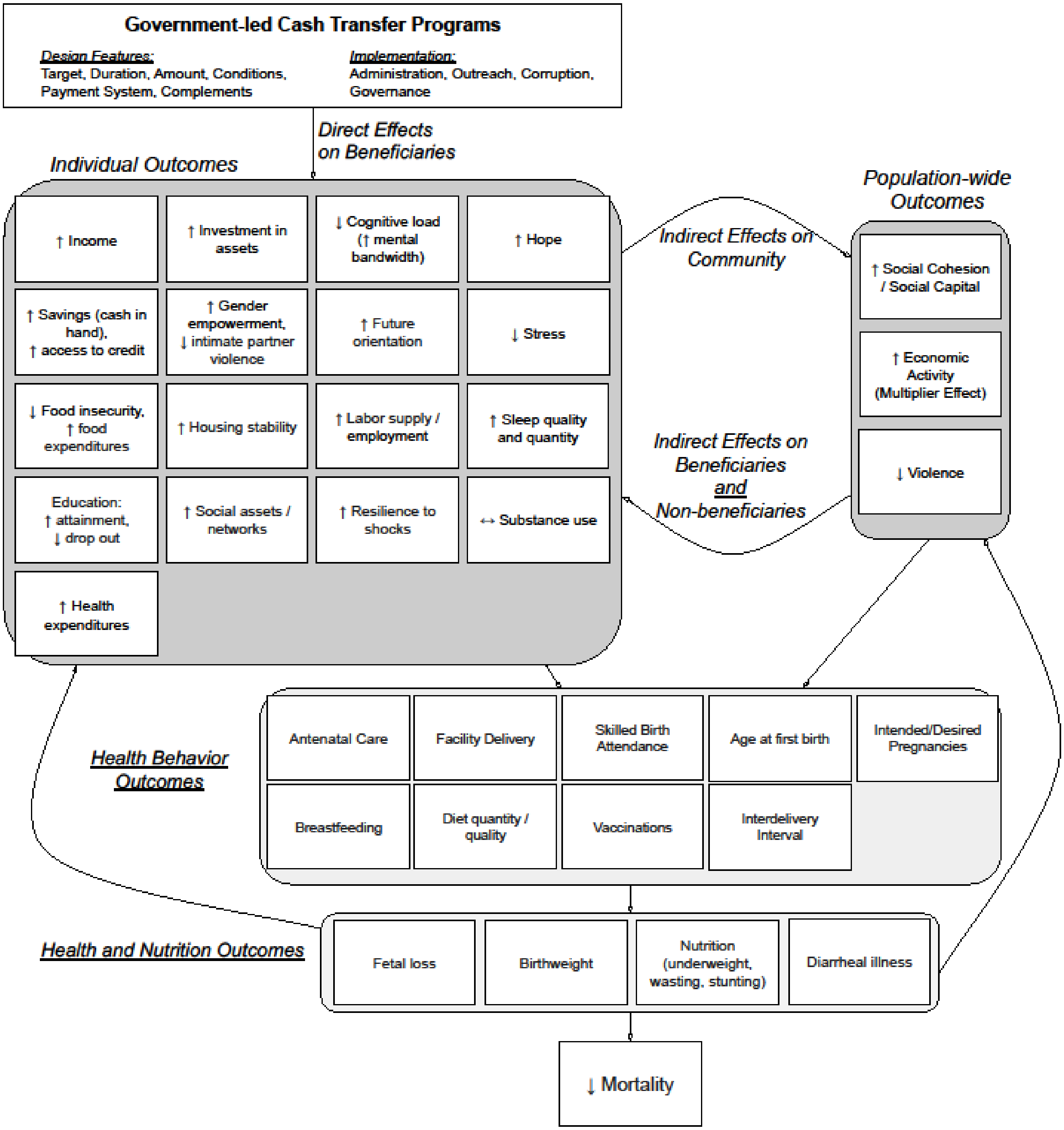
Subjective small birth size	
None	2.5% (0.9 to 4.1)
Primary	-0.4% (-1.4 to 0.5)
Secondary	-1.0% (-2.3 to 0.3)
Higher	-0.6% (01.4 to 0.2)
Ever breastfeed	
None	-0.5% (-1.9 to 0.9)
Primary	-0.9% (-2.2 to 0.5)
Secondary	-0.6% (-2.5 to 1.2)
Higher	-10.5% (-14.1 to -6.9)
Interdelivery Interval	
None	1.8 months (0.2 to 3.3)
Primary	3.4 months (2.2 to 4.5)
Secondary	1.3 months (0.0 to 2.6)
Higher	2.6 months (-0.3 to 5.6)
Measles Vaccination	
None	0.2% (-4.2 to 4.6)
Primary	4.3% (0.0 to 8.8)
Secondary	8.9% (2.2 to 15.6)
Higher	8.7% (1.9 to 15.4)
Male twin birth	
None	0.09% (-0.02 to 0.20)
Primary	0.32% (0.25 to 0.39)
Secondary	0.10% (-0.01 to 0.20)
Higher	0.71% (0.49 to 0.92)
Minimal acceptable diet	
None	1.5% (0.5 to 2.5)
Primary	2.6% (0.9 to 4.3)
Secondary	11.6% (8.4 to 14.8)
Higher	18.0% (9.7 to 26.3)
Diarrhea in last 2 weeks	
None	-1.8% (-4.8 to 1.1)
Primary	-6.7% (-12.1 to -1.3)
Secondary	-9.2% (-15.9 to -2.6)
Higher	6.6% (-0.2 to 13.4)
Underweight	
None	-1.0% (-2.5 to 0.5)
Primary	-0.2% (-1.5 to 1.1)
Secondary	-4.1% (-6.8 to -1.3)
Higher	-8.7% (-16.2 to -1.3)
Wasting	
None	1.4% (-0.3 to 3.2)
Primary	-2.0% (-4.1 to 0.2)
Secondary	-7.6% (-10.9 to -4.3)
Higher	-11.9% (-18.8 to -4.9)
Stunting	
None	0.3% (-1.9 to 2.6)
Primary	1.1% (-2.5 to 4.7)

Secondary	13.1% (5.6 to 20.6)
Higher	14.7% (9.1 to 20.4)

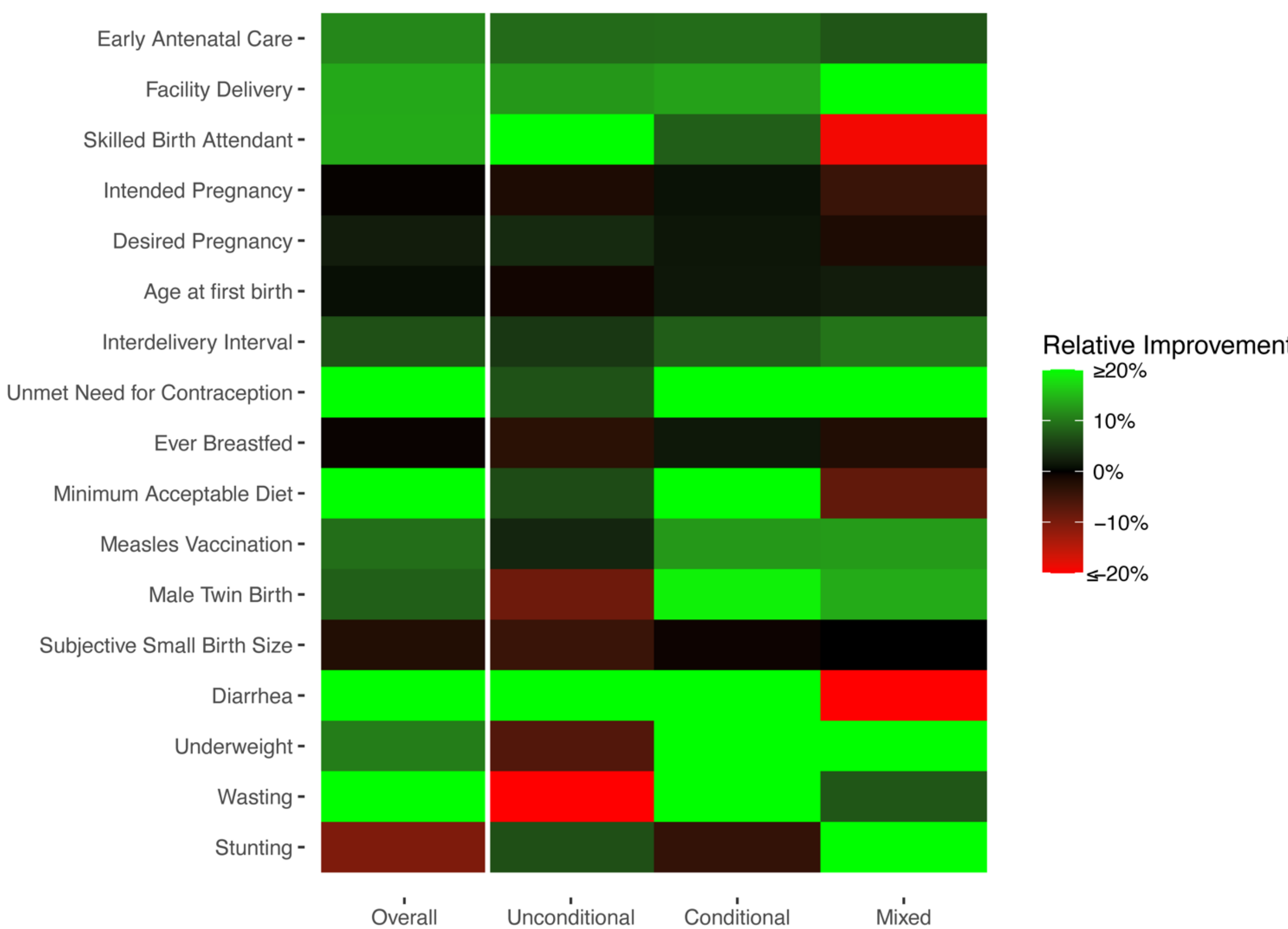
Supplementary Table 15. Exploratory analyses estimating the association between outcomes associated with cash transfer programs and mortality among children less than 5 years of age. We replicated the approach used in our prior analysis estimating the effects of cash transfer programs on mortality, except we substituted downstream outcomes associated with cash transfer programs for the cash transfer exposure.[26] We used modified Poisson models with the unit of observation being the person-year, death being the outcome, and outcomes associated with cash transfer programs as exposures. We include country and year fixed effects, and also control for child's sex, child's age, mother's age (except for the mother's age exposure), rural or urban setting, birth order, GDP per capita, PEPFAR funding, and three World Development Indicators (corruption, stability, and voice and accountability).

Exposure	**Adjusted Risk Ratio (ARR) for death**	**95% confidence interval**
Early antenatal Care	1.00	0.95 to 1.05
Facility Delivery	0.89	0.84 to 0.93
Skilled Birth Attendant	0.86	0.82 to 0.91
Interdelivery interval (per month increase)	0.987	0.985 to 0.989
Desired pregnancy	0.88	0.81 to 0.96

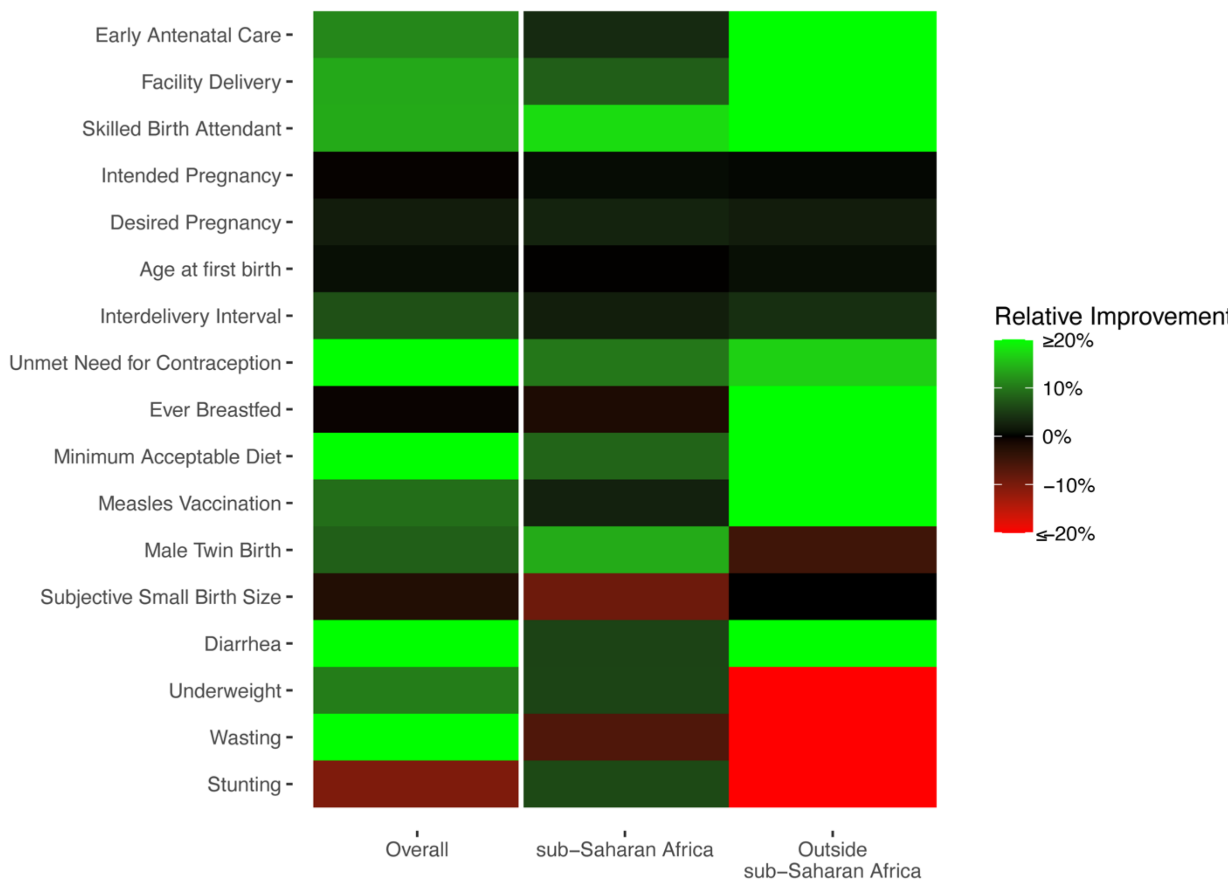
Supplementary Figure 1. Conceptual model illustrating hypothesized pathways between governmental cash transfer programs and population-wide changes in health and nutrition outcomes among women and young children.



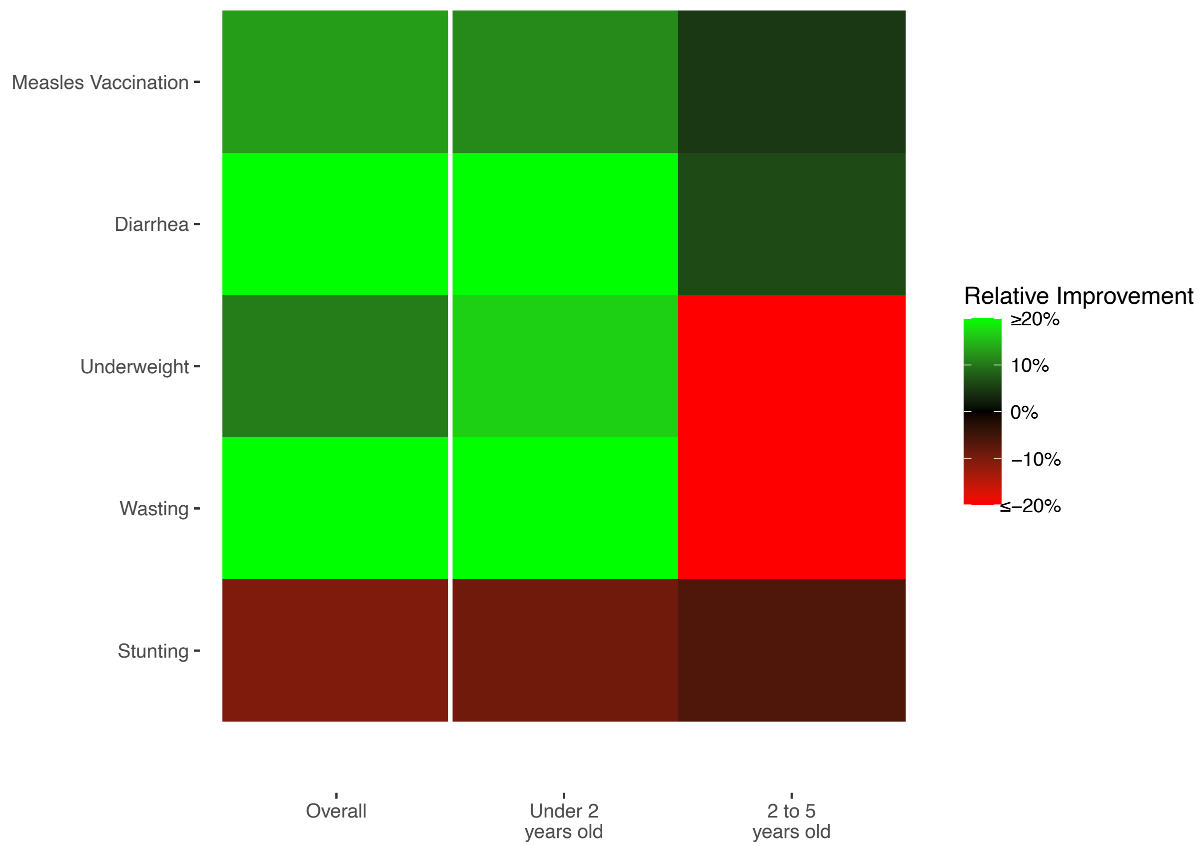
Supplementary Figure 2. Heat map showing heterogeneity analyses by cash transfer program conditionality. Subgroup analyses by cash transfer conditionality (unconditional, conditional, mixed) showing improvement in the primary outcome relative to the mean among comparison observations based on fully adjusted effect estimates generated using two-stage difference and differences models with country and year fixed effects, country-level covariates (GDP per capita, PEPFAR funding budgeted, total health expenditures, and three Worldwide Governance Indicators: control of corruption, political stability and absence of violence, and voice and accountability), and individual-level covariates (mother's age, child's age [post-natal outcomes], rural or urban setting, and birth order).



Supplementary Figure 3. Heat map showing heterogeneity analyses by region. Subgroup analyses by region showing improvement in the primary outcome relative to the mean among comparison observations based on fully adjusted effect estimates generated using two-stage difference and differences models with country and year fixed effects, country-level covariates (GDP per capita, PEPFAR funding budgeted, total health expenditures, and three Worldwide Governance Indicators: control of corruption, political stability and absence of violence, and voice and accountability), and individual-level covariates (mother's age, child's age [post-natal outcomes], rural or urban setting, and birth order).



Supplementary Figure 4. Heat map showing heterogeneity analyses by child age. Subgroup analyses by child age showing improvement in the primary outcome relative to the mean among comparison observations based on fully adjusted effect estimates generated using two-stage difference and differences models with country and year fixed effects, country-level covariates (GDP per capita, PEPFAR funding budgeted, total health expenditures, and three Worldwide Governance Indicators: control of corruption, political stability and absence of violence, and voice and accountability), and individual-level covariates (mother's age, child's age, rural or urban setting, and birth order).



Supplementary Figure 5. Heat map showing heterogeneity analyses by maternal schooling attainment. Subgroup analyses by maternal schooling attainment showing improvement in the primary outcome relative to the mean among comparison observations based on fully adjusted effect estimates generated using two-stage difference and differences models with country and year fixed effects, country-level covariates (GDP per capita, PEPFAR funding budgeted, total health expenditures, and three Worldwide Governance Indicators: control of corruption, political stability and absence of violence, and voice and accountability), and individual-level covariates (mother's age, child's age [post-natal outcomes], rural or urban setting, and birth order).