

Exploring the region-level relationship between non-governmental organizations  
and maternal and child health in Tanzania

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A thesis

submitted in partial fulfillment of the  
requirements for the degree of

Master of Public Health

University of Washington

2013

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Program Authorized to Offer Degree:

Epidemiology – Public Health

University of Washington

**Abstract**

Exploring the region-level relationship between non-governmental organizations  
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**Objective:** To explore the region-level relationship between Tanzanian non-governmental organizations (NGOs) and four maternal and child health (MCH) outcomes – stunting, child vaccination, antenatal care (ANC) visits, and health facility delivery – at five time periods during the past twenty years.

**Methods:** Associations between five region-level NGO covariates and MCH outcomes were modeled using cross-sectional and retrospective cohort designs. NGO, health, and additional covariates were derived from a 2010 NGO survey conducted by the Foundation for Civil Society, Demographic and Health Surveys (DHS), and government reports and published sources, respectively.

**Findings:** Cross-sectionally, regional NGO concentration was positively associated with multiple MCH outcomes in 2010, with each increase of 1 NGO per 100,000 capita associated with a 3-6% increased likelihood of full child vaccination, attending  $\geq 4$  ANC visits, or health facility delivery. Following regions over time, NGO concentration in 2010 and 2000 were associated with change in MCH outcomes

between DHS surveys, with each unit increase associated with a 3-10% reduction and 5% increase in the prevalence of stunting and attending  $\geq 4$  ANC visits, respectively.

**Conclusions:** Both cross-sectionally on an individual-level and following regions over time, regional concentration of NGOs was consistently and statistically significantly associated with improved MCH outcomes in Tanzania, with similar but less consistent findings for NGO funding and staff concentration. Population-level analysis shows great promise in assessing long-term health impacts of NGOs. A greater understanding of robust indicators of population-level NGO influence may guide development of best practices for monitoring and evaluation of NGOs.

## Introduction

There has been a major shift over the past two decades with non-governmental organizations (NGOs) receiving an increasing share of development assistance for health (DAH) channeled to sub-Saharan Africa compared to governments, with the amount of DAH to NGOs increasing 60-fold between 1995 and 2006 and DAH to governments increasing only 4-fold during the same time period. (1, 2) In response to this dramatic transition and the recent slowdown in growth of DAH (3, 4), development partners have called for evaluation of the NGO sector's long-term impacts on population-level health. (5-8) In practice, most NGO impact evaluations are specific to project objectives rather than long-term population-level outcomes, lacking in rigorous statistical analysis, and rarely report negative outcomes. (9, 10) Accordingly, there is a paucity of evidence to support whether the NGO model has led to improved population-level health outcomes in sub-Saharan Africa. (5-7, 11)

Tanzania is a prime example of a nation where the NGO sector has experienced dramatic growth in number and funding over the past two decades. In 1994, an estimated 729 NGOs were working in Tanzania (12), but by 2010 this number had increased more than 5-fold. (13, 14) Annual growth of DAH to Tanzania remained relatively stable from 1990 to 2003 increasing on average 9% per year; however, funding spiked by 76% between 2003 and 2004 and continued to rise through 2008. (1) This dramatic scale up in resources channeled to Tanzania in 2003 is documented in the literature and estimated to have been measurable in the Tanzanian NGO sector by 2006. (15)

Unfortunately, this massive increase in DAH targeted to the NGO sector has not necessarily been equitably distributed across Tanzania. Regional variation in the number of NGOs per capita has persisted over time, with Tanzania's wealthier regions having a higher concentration. (12, 16) There is also substantial regional variation in health. According to the 2010 Demographic and Health Survey (DHS), under-5 mortality ranged from 32.9 deaths per 1,000 live births in Kilimanjaro region to 153.3 in

Mara region. (17) Such regional variation exists for many other health indicators measured by DHS and can be observed across all DHS surveys beginning in 1992. (18-20)

In the current national Health Sector Strategic Plan, the Tanzania Ministry of Health and Social Welfare (MOHSW) calls for geographical equity in health across regions, highlighting the need for strengthened monitoring and evaluation of NGO projects, as funding and human resources for such activities are insufficient in most regions. (21) Despite the surge in NGOs and NGO funding over the past ten years, to the best of our knowledge, there has not yet been an evaluation of the population-level relationship between NGOs and health in Tanzania. Until recently, the only available region-level indicator for assessing NGO influence in Tanzania was the number of NGOs per capita. The Foundation for Civil Society (FCS), a Tanzanian NGO that provides funding and capacity building to other Tanzanian NGOs, conducted a national survey in 2010 which collected detailed data on all enumerated NGOs, allowing a novel examination of the region-level relationship between NGOs and health in Tanzania. (13) A greater understanding of this relationship may support funders, governments, and NGOs to identify best practices for monitoring and evaluating the NGO sector's long-term impacts on population-level health.

In this paper, we utilized data from the 2010 FCS survey and sequential DHS surveys to explore the region-level relationship between Tanzanian NGOs and four maternal and child health (MCH) outcomes – stunting, child vaccination, antenatal care (ANC) visits, and health facility delivery – at five time periods during the past twenty years.

## **Methods**

We first developed a theoretical framework (Figure 1) to guide our analysis based on the observed spike in DAH to Tanzania, the etiological time period for such funding to affect the NGO sector and health, and data availability. We relied heavily on data from the FCS survey and four DHS surveys

(1991, 1996, 2004, 2010). We supplemented this with Tanzania-specific region-level covariate data from a range of government reports and published sources. Finally, we assessed the influence of key assumptions through conducting three sensitivity analyses.

### *Study design and setting*

We conducted three primary analyses to explore the relationship between NGOs and health on an individual-level at one point in time, and also on a region-level as change over time. We used a multilevel cross-sectional study design to assess the relationship between region-level NGO covariates and the likelihood of individual health outcomes in 2010. We used a retrospective cohort ecological study design to examine the relationship between the same region-level NGO covariates and the region-level change in the prevalence of health outcomes between 2004 and 2010, and similarly between 1996 and 2004. We included 19 regions of Tanzania (Figure 2) in our analysis, excluding Zanzibar, Dar es Salaam, and Lindi (Appendix 1). Additionally, for the 1996-2004 cohort analysis we combined Arusha and Manyara regions, as the latter was not separated from Arusha until 2003.

### *Data sources*

All data sources were acquired online or through correspondence with Tanzanian NGOs and government ministries. The majority of NGO data come from a survey of 3,713 NGOs surveyed by FCS between 2010 and 2011 (Appendix 2). (13) Using data from the Tanzania NGO Registrar (14), we estimated that the FCS survey captured approximately 88% of Tanzanian NGOs. The FCS survey data and questionnaire were translated from Swahili to English by the first author. As some NGOs may have been captured more than once, the dataset was de-duplicated using Link Plus v.2 (Centers for Disease Control and Prevention, Atlanta, GA). To ensure international NGOs were captured, the de-duplicated NGO sample was matched to a list of President's Emergency Plan for AIDS Relief Tanzania 2010 prime partners (Appendix 3). (22) All health outcome data were abstracted from the 1996, 2004, and 2010 Tanzania DHS surveys, which interviewed a total of 27,327 households with a weighted mean response

rate of 98%. (17-19) DHS surveys are designed to produce region-level estimates for most MCH outcomes.

#### *Analytic covariates*

All covariates used in the primary analyses are listed in Table 1. All NGO covariates used in the 2010 cross-sectional and 2004-2010 cohort analyses were abstracted from FCS survey data. We selected five NGO covariates from a list of 65 using *a priori* selection criteria (Appendix 4). NGO concentration in 2000 was abstracted from the reports of two Tanzania NGOs (16, 23) based on the 2000 Tanzania Vice President's Office NGO Directory. We selected four health outcomes from a list of 34 DHS indicators using *a priori* selection criteria (Appendix 4). DHS sampling weights were used to calculate the regional cross-sectional prevalence of health outcomes for the cohort analyses. The decision to assess additional covariates was made *a priori* and based on the existence of data suggesting an association with NGOs and health outcomes, causal model diagrams, and collinearity among covariates (Appendix 4). All per capita covariates were constructed using regional population projections from the Tanzania 2002 and 1988 censuses (24, 25), with the projection year being matched to the closest year covariate data were collected.

#### *Data analysis*

NGO, health and additional covariate datasets were merged matching on region for all analyses. For the 2010 cross-sectional analysis, clustered log-binomial regression was used to estimate the prevalence ratio (PR) for all individual-level binary outcomes associated with a change of 1 unit in a given region-level covariate, per recommendations for cross-sectional analyses reported in the literature. (26, 27) For cohort analyses, linear regression was used to estimate the mean percent change in the regional prevalence of a given outcome from baseline to endline associated with a change of 1 unit in a given covariate. Models were fit using an *a priori* data analysis plan (Appendix 5). Two-tailed p-values of

0.05 or less were considered to indicate significance in all statistical tests. All statistical analyses were performed using Stata v.11 (Stata Corp, College Station, TX).

### *Sensitivity analysis and minor aims*

We conducted three sensitivity analyses. NGO funding was collected categorically to reduce the risk of social desirability bias and non-response. Total NGO funding per capita was calculated by using both the minimum and median of each category to determine the influence of this decision.

We included NGOs from all sectors as there is ample evidence for non-health sectors affecting health outcomes through impacting social determinants of health. (28) To determine the importance of sector, we re-ran the analyses with a subset of NGOs restricted to those working in the health sector (Appendix 6).

FCS conducted two national NGO surveys – one in 2009 and another in 2010; however, we obtained only the latter’s dataset. Some NGOs surveyed in the first survey may not have been captured in the second due to survey fatigue. To address this limitation, we assessed the impact of adjusting NGO funding, NGO staff, and NGO concentration to account for NGOs that were captured in the first survey but not the second (Appendix 6).

Finally, two minor aims were developed to serve as a comparison to the 2010 cross-sectional analysis. We conducted a cross-sectional analysis for 1996 and 2004, using as the sole NGO covariate NGO concentration in 2000 and 1994, respectively.

## **Results**

The final NGO sample consisted of 2,566 NGOs for the 2010 cross-sectional analysis and 2004-2010 cohort analysis, and 1,194 NGOs for the 1996-2004 cohort analysis (Figure 2). Regional NGO concentration shifted between 2000 and 2010, though the western and southeastern regions appear to consistently have relatively low and high NGO concentration, respectively (Figure 2). The 2010 cross-

sectional analysis included 4,973 children to assess stunting, 5,385 children to assess vaccination, 3,798 women to assess ANC visits, and 3,762 women to assess health facility delivery.

The results of the three primary analyses are given in Table 2. Cross-sectionally, concentration of NGO staff per 1,000 capita, NGO funding per 10 capita and NGOs per 100,000 capita in 2010 were positively associated with vaccination, with each unit increase associated with a 14% (PR 1.14, 95% CI 1.04, 1.26), 6% (PR 1.06, 95% CI 1.02, 1.09), and 3% (PR 1.03, 95% CI 1.01, 1.06) increased likelihood of a child being fully vaccinated, respectively. Conversely, NGO concentration in 2010 was negatively associated with region-level change in vaccination from 2004 to 2010, with each unit increase associated with a 4% decrease (95% CI -7.7%, -0.8%) in the prevalence of child vaccination. Concentration of NGO staff and NGOs in 2010 as well as NGOs in 2000 were negatively associated with change in stunting during the intersurvey interval, with each unit increase associated with a 21% (95% CI -35.7%, -6.7%), 3% (95% CI -4.6%, -0.4%), and 10% (95% CI -15.3%, -4.3%) decrease in the prevalence of stunting, respectively.

Cross-sectionally, NGO concentration and funding in 2010 were positively associated with both ANC attendance and health facility delivery, with each unit increase associated with a 5% (PR 1.05, 95% CI 1.02, 1.08) and 6% (PR 1.06, 1.01, 1.11) increased likelihood of a woman attending  $\geq 4$  ANC visits, and a 6% (PR 1.06, 95% CI 1.03, 1.09) and 9% (PR 1.09, 95% CI 1.07, 1.12) increased likelihood of health facility delivery, respectively. Following regions over time, NGO staff concentration in 2010 and NGO concentration in 2000 were positively associated with change in ANC attendance during the intersurvey interval, with each unit increase associated with a 16% (95% CI -0.1%, 32.0%) and 5% increase (95% CI 2.3%, 6.7%) in the prevalence of attending  $\geq 4$  ANC visits, respectively.

The results of the sensitivity analysis are provided in Table 3. The 2010 cross-sectional analysis was robust to all three sensitivity analyses with miniscule changes in adjusted effect measures. The 2004-2010 cohort analysis was moderately sensitive to use of a median-based NGO funding covariate,

which slightly attenuated effect measures toward the null. Additionally, restricting to a health sector NGO subset led to inconsistent changes in effect measures with the greatest impact on models of health facility delivery. The results of the two minor aims are provided in the Appendix (Appendix 7). The 2004 cross-sectional analysis generated results consistent with the 2010 analysis; however, the 1996 analysis suggested a null association between NGO concentration and MCH.

## **Discussion**

Both cross-sectionally on an individual-level and following regions over time, regional concentration of NGOs was generally associated with improved maternal and child health in Tanzania. Less consistent was the association between NGO funding and MCH. Specifically, each regional unit increase of NGOs and NGO funding in 2010 was associated with a 3-9% increased likelihood of an individual being fully vaccinated, attending  $\geq 4$  ANC visits, or delivering in a health facility in 2010. Viewing the 2010 Tanzanian NGO sector as a marker of NGO activity over the prior five years, the same increase in NGO concentration was associated with a 3-4% reduction in the prevalence of stunting and vaccination. Over the same time period concentration of NGO staff was also associated with MCH, with each unit increase associated with a 21% reduction and 16% increase in the prevalence of stunting and attending  $\geq 4$  ANC visits, respectively. Neither the degree of NGO establishment nor staff education was consistently associated with MCH. Where confounding was identified, government health spending was most commonly implicated, with adjustment attenuating effect measures toward the null suggesting that regions with greater NGO influence also had higher government health spending per capita. The findings were robust to the sensitivity analysis and remained most sensitive to use of a median-based NGO funding covariate.

The findings suggest that NGOs may impact the likelihood of future but not concurrent stunting, consistent with the fact that stunting reflects malnutrition and chronic illness over long periods of time

and is resistant to recent, short-term changes in dietary intake due to factors such as drought or acute illness. (17) In contrast, child vaccination, ANC and health facility delivery are health service-related outcomes and thus might be expected to more rapidly respond to NGO influence as observed in the 2010 cross-sectional analysis. Additionally, NGOs have been recognized as playing an important role in increasing access to routine child immunization (29) and improving the equity of antenatal and childbirth services in many low- and middle-income countries. (30) However, the inverse relationship between NGOs and change in vaccination coverage found in the 2004-2010 cohort analysis was unexpected. One possible explanation is that in 2010 NGOs were more concentrated in regions with higher vaccination coverage in 2004, which experienced smaller improvements in coverage from 2004 to 2010, with both linear trends reaching statistical significance. Interestingly, this relationship between NGO concentration and baseline prevalence was not observed for any additional MCH outcomes and time periods.

To the best of our knowledge, this is the first population-level analysis of the relationship between NGOs and their long-term impact on health in sub-Saharan Africa. Whereas most available evaluations of NGO impact are tailored to achievement of project objectives, we have used publically available data and rigorous statistical methods to assess the impact of the Tanzanian NGO sector on MCH outcomes at five time periods during the past twenty years. Furthermore, we collaborated with Tanzanian government agencies and development partners to prioritize aims, identify data and frame the analysis. Lastly, we have provided evidence to support the use of regional NGO and NGO staff concentration as meaningful measures of NGO influence.

However, these findings must be interpreted in the context of some limitations. A district-level ecological design would likely yield greater variation in NGO influence and a reduced risk of cross-level bias; however, a single NGO's sphere of influence would likely spread across districts, hindering cross-district comparisons. In addition, the FCS survey collected self-reported data raising the possibility of

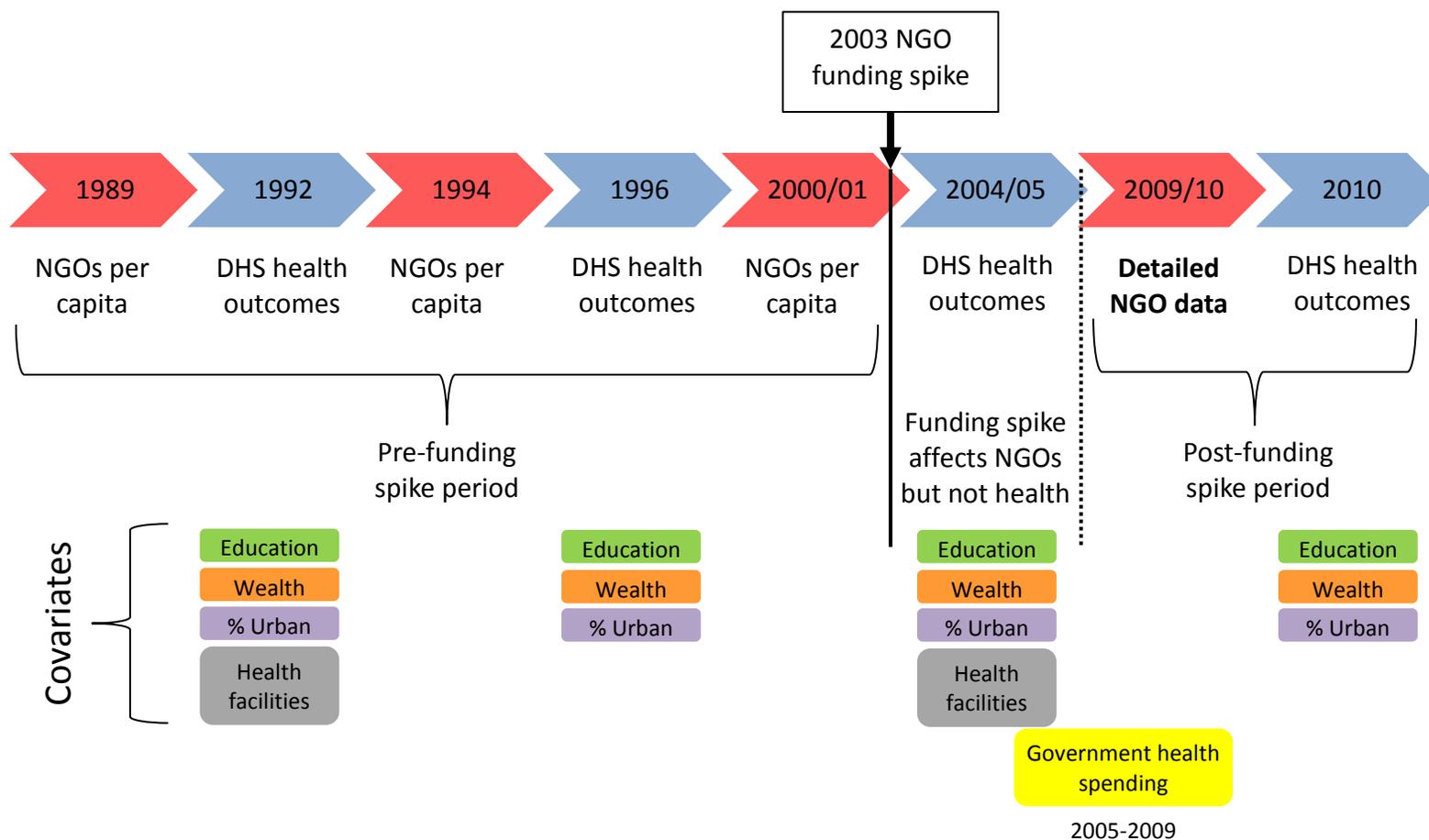
misclassification of NGOs when grouped into categories. However, such misclassification would likely be non-differential across covariate categories and regions, conservatively attenuating true associations toward the null. As with any observational study, residual confounding may persist despite efforts to assess all potential confounders. To address this, we mounted a search to identify all relevant NGO and covariate data sources in Tanzania. Finally, the 2010 Tanzanian NGO sector may not well represent NGO activity over the prior five years, in which case the 2004-2010 cohort analysis would have utilized NGO data from a mismatched etiological time period. However, a comparison of the number of annual NGO registrations between the FCS survey and the Tanzania NGO Registrar revealed similar trends, suggesting that most NGOs that registered in 2005 were still actively working in 2010. To further address this limitation, we plan to conduct a 2010-2015 cohort analysis when 2015 Tanzania DHS data are available.

The majority of research on the NGO sector focuses on elucidating determinants of individual NGO project success (10, 31), classifies household NGO involvement as a yes/no variable (32), or aims to identify household-level barriers to utilizing NGO services (33). Through objective evaluation of individual NGO projects and beneficiaries in India, Heard et al. found that staff qualification and age of establishment were not predictive of project success (31), consistent with our finding that these indicators were not consistently associated with MCH outcomes. In contrast, Bechange observed that staff competence and NGO networking were determinants of project success in Uganda, though these findings were self-reported by NGO staff (10). Our results suggest a consistent relationship between MCH and regional NGO concentration, which has no equivalent on an individual NGO-level.

The NGO sector has become the predominant channel of development assistance for health in Tanzania, and elsewhere in sub-Saharan Africa and low-and middle-income countries. Where substantial health disparities exist across subnational regions, population-level analysis of the relationship between NGOs and health shows great promise in supporting funders, governments and

NGOs to evaluate long-term impacts of the NGO model. A greater understanding of robust indicators of population-level NGO influence may guide development of best practices for monitoring and evaluation of NGOs. With the slowdown in growth of development assistance for health and the imminent deadline of the Millennium Development Goals, it is essential for development partners to assess the efficiency and effectiveness of the NGO sector in low-and middle-income countries.

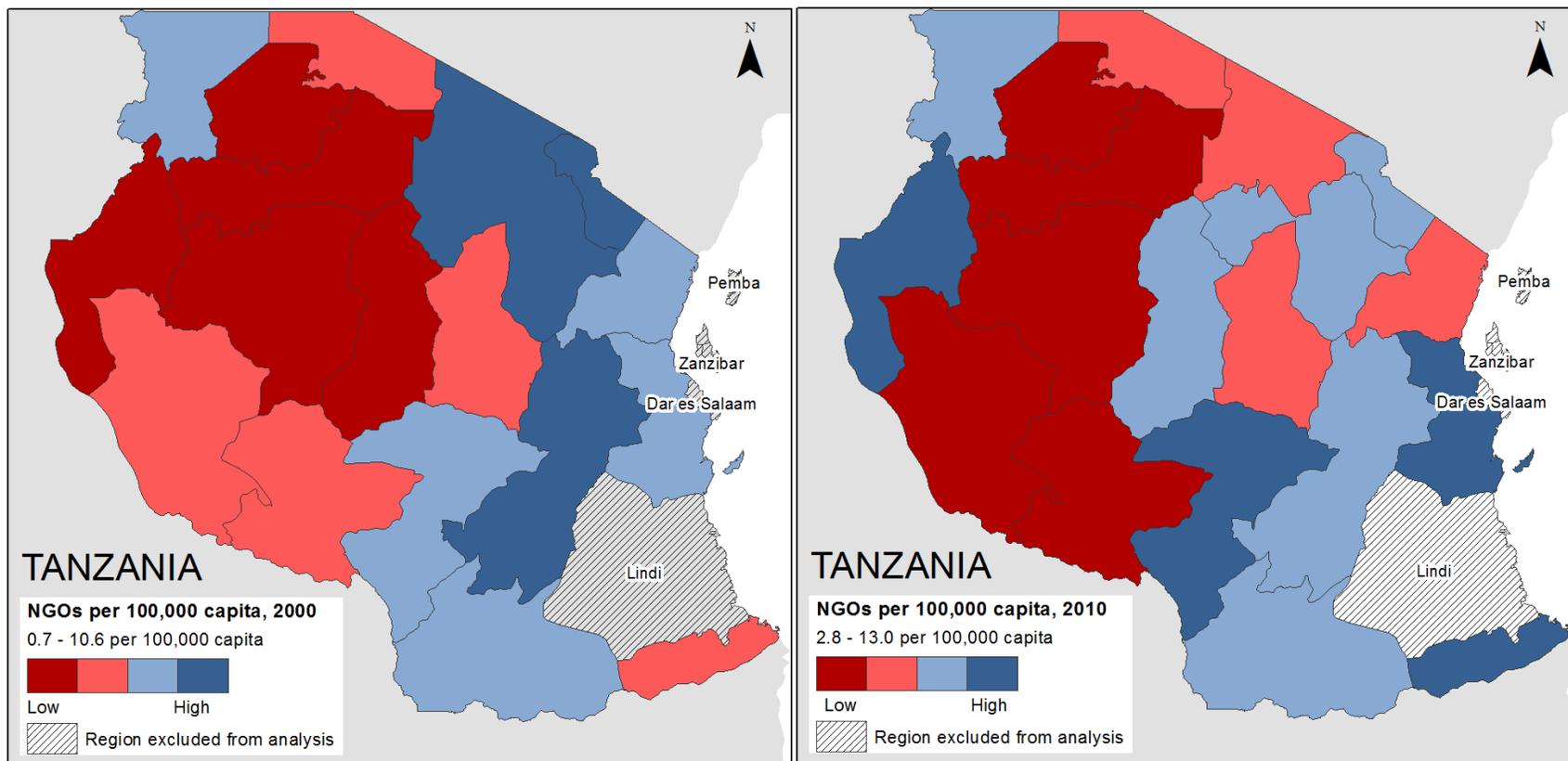
**Figure 1.** Theoretical framework for the three primary analyses assessing the region-level relationship between NGOs and MCH in Tanzania.



Colored shapes represent Tanzanian data sources identified by the authors: red, NGO covariate data; blue, DHS health outcome data; green, mean years of education among females; orange, percentage of households with  $\geq$ middle class wealth; purple, percentage of households that are urban; grey, number of health facilities per region; yellow, annual government health spending per region from 2005-2009. The data source marked "Detailed NGO data" refers to the 2010 FCS survey data.

NGO, non-governmental organization; MCH, maternal and child health; DHS, Demographic and Health Survey.

**Figure 2.** Number of NGOs per 100,000 capita working in Tanzania in 2000 and 2010, by region.



Color categories represent quartiles, range provided in legend. NGO, non-governmental organization.

Shape file provided by Bjorn Sandvik of thematicmapping.org, [http://thematicmapping.org/downloads/world\\_borders.php](http://thematicmapping.org/downloads/world_borders.php)

**Table 1.** Distribution of regional NGO covariates, health outcomes and additional covariates used in the three primary analyses assessing the region-level relationship between NGOs and MCH in 19 regions of Tanzania.

	Mean	Range	Standard Deviation	Source
<b>NGO COVARIATES</b>				
Number of NGO staff per 1,000 capita in 2010 <sup>A</sup>	1.4	0.5, 3.1	0.8	(13)
NGO funding per 10 capita in 2010 (2010 US\$) <sup>B</sup>	3.2	0.6, 8.1	2.0	(13)
Percentage of NGOs with “well-educated” staff in 2010 <sup>C</sup>	33.7%	15.6%, 51.1%	11.6%	(13)
Percentage of NGOs that are “well-established” in 2010 <sup>D</sup>	21.6%	15.2%, 30.2%	4.0%	(13)
Number of NGOs per 100,000 capita in 2010	7.4	2.8, 13.0	3.1	(13)
Number of NGOs per 100,000 capita in 2000	4.2	0.7, 10.6	2.6	(16, 23)
<b>HEALTH OUTCOMES</b>				
Child stunted <sup>E</sup>				
Prevalence in 2010	42.5%	25.3%, 55.5%	8.2%	(17)
Percent change in prevalence from 2004-2010	-7.7%	-31.6%, 33.0%	17.3%	(17, 18)
Percent change in prevalence from 1996-2004	-5.1%	-30.5%, 51.6%	20.6%	(18, 19)
Child fully vaccinated <sup>F</sup>				
Prevalence in 2010	53.8%	31.1%, 64.6%	9.0%	(17)
Percent change in prevalence from 2004-2010	16.2%	-14.0%, 63.0%	19.7%	(17, 18)
Percent change in prevalence from 1996-2004	-2.1%	-52.9%, 29.8%	20.4%	(18, 19)
Woman attended ≥4 antenatal care visits <sup>G</sup>				
Prevalence in 2010	41.6%	23.8%, 65.2%	10.6%	(17)
Percent change in prevalence from 2004-2010	-29.3%	-59.8%, -2.1%	14.6%	(17, 18)
Percent change in prevalence from 1996-2004	-10.9%	-40.8%, 18.7%	15.1%	(18, 19)
Woman delivered in a health facility attended by a health professional <sup>G</sup>				
Prevalence in 2010	53.6%	30.6%, 88.6%	16.9%	(17)
Percent change in prevalence from 2004-2010	16.6%	-17.3%, 70.3%	24.5%	(17, 18)
Percent change in prevalence from 1996-2004	2.5%	-29.4%, 55.7%	23.8%	(18, 19)
<b>ADDITIONAL COVARIATES</b>				
Number of health facilities per 100,000 capita in 2004	16.0	8.3, 26.6	4.0	(34)
Number of health facilities per 100,000 capita in 1992	8.5	3.9, 13.7	3.0	(20)

Mean government health spending per capita from 2005-2009 (2009 TSh)	6,059	4,438, 9,201	1,311	(35)
Percentage of households that were urban in 2004	19.6%	6.0%, 40.5%	8.0%	(18)
Percentage of households that were urban in 1996	16.7%	3.4%, 28.9%	7.5%	(19)
Percentage of households with $\geq$ middle class wealth in 2004	55.8%	26.5%, 94.0%	16.4%	(18)
Percentage of households with $\geq$ middle class wealth in 1996	58.1%	44.0%, 87.0%	12.0%	(19)
Median years of education completed by women in 1996	0.9	0.0, 3.7	1.2	(19)
Number of NGOs per 100,000 capita in 1994	1.4	0.2, 5.4	1.3	(12)

<sup>A</sup>NGO staff included local, expatriate and volunteer staff.

<sup>B</sup>NGO funding included income from membership fees and contributions, government and private sector grants, and other sources.

<sup>C</sup>Defined as NGO with mean staff education  $>11$  years, which is equal to the length of secondary school education in Tanzania.

<sup>D</sup>NGO classified as “well-established” if it had  $\geq 26$  members, belonged to a regional or district NGO network, and was involved in a development policy debate or project planning with either the central government, regional government, or local government in the past year.

<sup>E</sup>Stunting is defined as a child aged 0-5 years having height-for-age less than two standard deviations from the World Health Organization (WHO) reference median.

<sup>F</sup>Full child vaccination is defined as having a health card documenting vaccination with one BCG dose, three DPT doses, three polio doses, and one measles dose, in accordance with Tanzania’s schedule for routine childhood immunization.

<sup>G</sup>Maternal health outcome variables reflect WHO recommendations for pregnant women.

NGO, non-governmental organization; MCH, maternal and child health; TSh, Tanzania Shilling.

**Table 2.** Results of the three primary analyses assessing the region-level relationship between NGOs and MCH in 19 regions of Tanzania.

**A)** Results of the 2010 individual-level cross-sectional analysis.

Region-level increase in 2010	Child stunted	Child fully vaccinated			Woman attended ≥4 ANC visits	Woman had health facility delivery		
	Prevalence ratio (95% CI)   p-value							
1 NGO per 100,000 capita	1.01 (0.97, 1.04)	0.74	1.03 (1.01, 1.06)	0.02	1.05 (1.02, 1.08)	<0.001	1.06 (1.03, 1.09)	<0.001
1 USD of NGO funding per 10 capita	0.99 (0.93, 1.05)	0.72	1.06 (1.02, 1.09)	0.003	1.06 (1.01, 1.11)	0.03	1.09 (1.07, 1.12)	<0.001
1 NGO staff per 1,000 capita	0.96 (0.84, 1.11)	0.66	1.14 (1.04, 1.26)	0.01	1.06 (0.90, 1.23) <sup>A</sup>	0.49	1.12 (0.91, 1.39) <sup>A</sup>	0.29
10% increase in NGOs that are “well-established”	1.00 (0.80, 1.26)	0.98	1.13 (0.89, 1.43)	0.32	1.15 (1.03, 1.28) <sup>A</sup>	0.01	1.07 (0.83, 1.38) <sup>A</sup>	0.59
10% increase in NGOs with “well-educated” staff	0.94 (0.87, 1.01)	0.08	1.00 (0.91, 1.08)	0.91	1.00 (0.92, 1.10)	0.98	1.02 (0.94, 1.12)	0.61

**B) Results of the 2004-2010 region-level cohort analysis.**

Region-level increase from 2004 to 2010	Prevalence of child stunting		Prevalence of full vaccination		Prevalence of ≥4 ANC visits		Prevalence of health facility delivery	
	Mean percent change (95% CI)   p-value							
1 NGO per 100,000 capita	-2.5% (-4.6, -0.4) <sup>BC</sup>	0.02	-4.2% (-7.7, -0.8) <sup>A</sup>	0.02	+2.7% (-0.3, 5.7) <sup>B</sup>	0.07	+3.3% (-2.9, 9.4) <sup>A</sup>	0.28
1 USD of NGO funding per 10 capita	-3.5% (-7.8, 0.8) <sup>ADE</sup>	0.10	-2.7% (-7.5, 2.0) <sup>AD</sup>	0.24	+1.6% (-2.7, 5.8) <sup>BD</sup>	0.44	+0.8% (-6.1, 7.6) <sup>ABDE</sup>	0.82
1 NGO staff per 1,000 capita	-21.2% (-35.7, -6.7) <sup>ABC</sup>	0.01	-14.6% (-34.3, 5.0) <sup>AD</sup>	0.13	+15.9% (-0.1, 32.0) <sup>ABD</sup>	0.05	+9.5% (-21.4, 40.5) <sup>ACD</sup>	0.52
10% increase in NGOs that are “well-established”	+5.3% (-17.9, 28.4) <sup>ABCDE</sup>	0.63	-23.4% (-44.4, -2.5) <sup>A</sup>	0.03	+9.8% (-5.0, 24.5) <sup>D</sup>	0.18	+6.6% (-13.9, 27.1) <sup>A</sup>	0.51
10% increase in NGOs with “well-educated” staff	+0.4% (-7.2, 7.9) <sup>ACDE</sup>	0.92	+6.7% (-1.5, 14.9) <sup>D</sup>	0.10	-3.4% (-9.5, 2.7) <sup>D</sup>	0.26	-5.7% (-17.3, 5.9) <sup>AE</sup>	0.31

**C) Results of the 1996-2004 region-level cohort analysis.**

Region-level increase from 1996 to 2004	Prevalence of child stunting		Prevalence of full vaccination		Prevalence of ≥4 ANC visits		Prevalence of health facility delivery	
	Mean percent change (95% CI)   p-value							
1 NGO per 100,000 capita	-9.8% (-15.3, -4.3) <sup>F</sup>	0.002	+7.3% (-1.5, 16.0) <sup>FGHI</sup>	0.10	+4.5% (2.3, 6.7) <sup>G</sup>	0.001	+5.5% (-7.8, 18.9) <sup>FGHJ</sup>	0.39

<sup>A</sup>Adjusted for mean government health spending per capita from 2005-2009.

<sup>B</sup>Adjusted for number of health facilities per 100,000 capita in 2004.

<sup>C</sup>Adjusted for percentage of households with ≥middle class wealth in 2004.

<sup>D</sup>Adjusted for number of NGOs per 100,000 capita in 2000.

<sup>E</sup>Adjusted for percentage of households that were urban in 2004.

<sup>F</sup>Adjusted for number of NGOs per 100,000 capita in 1994.

<sup>G</sup>Adjusted for percentage of households with  $\geq$ middle class wealth in 1996.

<sup>H</sup>Adjusted for percentage of households that were urban in 1996.

<sup>I</sup>Adjusted for median years of education completed by women in 1996.

<sup>J</sup>Adjusted for number of health facilities per 100,000 capita in 1992.

NGO, non-governmental organization; MCH, maternal and child health; 95% CI, 95% confidence interval; ANC, antenatal care.

**Table 3.** Results of the three sensitivity analyses for the 2010 cross-sectional and 2004-2010 cohort analyses.

Sensitivity analysis	2010 individual-level cross-sectional analysis	2004-2010 region-level cohort analysis
	Mean absolute percent change from primary analysis estimate (range)	
Using a median-based NGO funding covariate	3% (1-5%)	42% (23-66%)
Restricting NGO sample to health sector subset	3% (0-18%)	40% (1-207%)
Adjusting NGO covariates to account for missing NGOs	1% (0-4%)	27% (1-83%)

NGO, non-governmental organization.

## **Acknowledgements**

E.K. had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. E.K, S.H., S.G., and J.H. contributed to study concept and design. E.K. acquired all data. E.K., S.H., and J.H. contributed to statistical analysis and interpretation of data. E.K. drafted and wrote the manuscript. All authors contributed to critical revision of the article for accuracy, consistency, and ease of interpretation.

Data collection, data analysis, data interpretation, and writing of the manuscript were not supported by any funding sources. All authors declare conflict of interest. The authors would like to extend a special acknowledgement to key Tanzanian stakeholders who provided data and guidance during the study, including Neema Yobu, John Ulanga and Bernard Kindoli of FCS, Marcel Katemba, Director of the Tanzania NGOs Coordination Division, Ngunga Tepani, Executive Director of the Tanzania Association of NGOs, Rose Aiko of Twaweza, Albina Chuwa and Mwanaidi Mahiza of the Tanzania National Bureau of Statistics, and Anne Lema of Hakikazi Catalyst. Asanteni sana kwa msaada wenu! The authors would also like to thank MEASURE, ICF International, Siri Lange, Ilse Frederickx, and Tiina Kontinen for their assistance in tracking down every last available data source.

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## **Appendix**

**Appendix 1.** Exclusion criteria for Tanzanian regions included in the analysis of the relationship between NGOs and MCH outcomes in Tanzania.

We included 19 regions of Tanzania in our analysis, excluding Zanzibar, Dar es Salaam, and Lindi using the following criteria:

- 1) Zanzibar and other islands were handled differently across sequential DHS surveys.
- 2) Dar es Salaam had an abnormally large number of well-funded, well-educated NGOs in 2010, leading to abnormally large values for most NGO variables.
- 3) Dar es Salaam had the highest proportion of NGOs working at the national level or above in 2010, suggesting a dissimilar relationship between NGOs and health compared to other regions.
- 4) Lindi had an abnormally large number of NGOs in 2010 compared to 2009, and FCS staff were unable to provide a rationale for the sharp increase (230%) between years.

**Appendix 2.** Survey methodology for the 2010 FCS national survey of Tanzanian NGOs.

The FCS survey was designed to enumerate all NGOs actively working in Tanzania between 2010 and 2011, identifying NGOs through use of regional and district NGO network directories and research assistants who traveled to each district to locate remote or unlisted NGOs. Questionnaires were distributed through FCS branch offices, the FCS website, email, postal mail and research assistants, and were returned to the FCS central office through hand delivery, the website, email, postal mail, and regional and district NGO networks.

**Appendix 3.** Assessment of whether large international NGOs were captured by the FCS survey.

To ensure international NGOs were captured by the FCS survey, the de-duplicated FCS NGO sample was matched to a list of President's Emergency Plan for AIDS Relief Tanzania (PEPFAR) 2010

prime partners. After excluding government health facilities, Ministries, churches and mosques from the list of 2010 PEPFAR prime partners, 133 of 215 (62%) PEPFAR prime partners were matched to the FCS survey data and 34 of the 82 (41%) unmatched prime partners were international NGOs.

**Appendix 4.** *A priori* selection criteria for key NGO covariates, health outcomes and additional covariates used in the analysis of the relationship between NGOs and MCH outcomes in Tanzania.

We selected five NGO variables *a priori* from a list of 65 variables (Appendix Table 1) constructed from FCS data through considering reliability (e.g. social desirability bias, discrete number vs. ordered categorical), amount of missing data, regional variation, collinearity, existence of data suggesting a relationship with health outcomes, and the ease with which a variable could be measured. NGO staff included local, expatriate and volunteer staff. NGO funding included income from membership fees and contributions, government and private sector grants, and other sources. An NGO is classified as having “well-educated” staff if the average staff member had >11 years of education, the length of secondary school education in Tanzania. Based on descriptive analysis of FCS survey data and a 2004 FCS report on Tanzanian NGOs (36), an NGO was considered to be “well-established” if it had >=26 members, belonged to a regional or district NGO network, *and* was involved in a development policy debate or project planning with *either* the central government, regional government, or local government in the past year.

We selected four MCH outcomes *a priori* from a list of 34 abstracted from the 2010 Tanzania DHS survey (Appendix Table 2) through considering reliability (e.g. health card vs. self-report), inclusion and consistency across DHS surveys, relevance to Tanzania’s Health Sector Strategic Plan, existence of data suggesting a relationship with NGOs, international and/or national recommendations for each health outcome, sample size of individuals with the outcome, overall prevalence, regional variation, and collinearity. Stunting is defined as a child aged 0-5 years having height-for-age less than two standard

deviations from the World Health Organization (WHO) reference median. Full child vaccination is defined as having a health card documenting vaccination with one BCG dose, three DPT doses, three polio doses, and one measles dose, in accordance with Tanzania's schedule for routine childhood immunization. (37) We excluded a fourth dose of polio vaccine from our analysis due to low coverage and the WHO considering it an optional dose. (38) Additionally, vaccines against hepatitis B and *Haemophilus influenzae* type b were excluded to allow comparison with past surveys as these were not introduced in Tanzania until 2002 and 2009, respectively. (39) Maternal health outcome variables reflect WHO recommendations for pregnant women (40).

Additional covariates assessed in the 2010 cross-sectional analysis included household wealth, NGO concentration in 2000, rural residence, and government health spending. The relationship between wealth, rural residence and health care access and health outcomes in Tanzania is well documented (41, 42), as is a similar relationship between wealth, rural residence and access to NGOs (12, 16). These same covariates were assessed in the 2004-2010 cohort analysis in addition to health facility concentration in 2004, which is excluded from the cross-sectional analysis due to high correlation with government health spending. Female education was excluded from both the cross-sectional and 2004-2010 cohort analysis as it was highly correlated with household wealth, with the latter being a composite variable and thus capturing more information. Additional covariates assessed in the 1996-2004 cohort analysis included similar household education, wealth and urban residence variables, health facility concentration in 1992, and NGO concentration in 1994. Additional covariates assessed in the 2004 cross-sectional analysis were the same as those included in the 1996-2004 cohort analysis. Additional covariates assessed in the 1996 cross-sectional analysis included NGO concentration in 1989 (43), health facility concentration in 1992, household wealth in 1996, and urban residence and female education in 1991 (20).

**Appendix Table 1.** Distribution of 65 regional NGO covariates abstracted from the 2010 FCS survey of 2,566 NGOs across 19 Tanzanian regions.

<b>Region-level NGO Covariate<sup>A</sup></b>	<b>Mean</b>	<b>Range</b>	<b>Standard Deviation</b>	<b>Percentage of NGOs with Missing Data</b>
Number of NGO staff per 10,000 capita	14.4	4.9, 31.1	7.6	8.7
Total NGO funding per capita (2010 US\$), using minimum of categories	0.3	0.1, 0.8	0.2	15.3
NGOs where mean years of education per staff >11 years (%)	33.7	15.6, 51.1	11.6	9.0
NGOs that are “well-established” (%)	21.6	15.2, 30.2	4.0	0.1
Number of NGOs per 10,000 capita	0.7	0.3, 1.3	0.3	0.0
NGOs with rural headquarters (%)	27.6	10.5, 52.4	11.9	0.0
Organizations registered as an NGO (%)	51.8	26.8, 80	15.8	3.5
Organizations registered as a CBO (%)	32.5	9.3, 59.3	15.2	3.5
Ratio of female to male NGO staff	1.1	0.7, 2.1	0.3	8.7
Ratio of female to male NGO volunteers	1.2	0.7, 1.7	0.2	8.7
Ratio of female to male NGO staff and volunteers	1.1	0.7, 1.6	0.2	8.7
NGOs with mean staff education ≥ Form 4 education (%)	0.6	0.4, 0.7	0.1	9.0
NGOs with mean staff education ≥ Form 6 education (%)	0.3	0.1, 0.4	0.1	9.0
NGOs with mean staff education ≥ college education (%)	0.1	0.0, 0.1	0.0	9.0
NGOs with mean staff education ≥ graduate education (%)	0.0	0.0, 0.1	0.0	9.0
Mean years of education per NGO staff	10.0	8.6, 10.9	0.7	9.0
Mean age of NGO staff (years)	42.3	37, 46.4	2.2	11.9
Mean year of NGO registration	2003	2001, 2005	1	18.6
Median year of NGO registration	2006	2004, 2007	0.8	18.6
Mean number of members per NGO, using minimum of categories	67.1	13.6, 120.6	29.8	14.9
Mean number of members per NGO, using median of categories	102.6	24.7, 176.1	41.1	14.9
NGOs belonging to a district or regional NGO network (%)	0.8	0.7, 0.9	0.1	0.1
Total NGO funding per capita (2010 US\$), using median of categories	0.9	0.4, 2	0.5	15.3
Total NGO expenditures per capita (2010 US\$), using median of categories	1.6	0.5, 3.9	0.9	21.2
Total NGO expenditures per capita (2010 US\$), using minimum of categories	0.7	0.1, 2	0.5	21.2
NGOs reporting sustainable funding (%)	0.7	0.6, 1	0.1	1.3
NGOs working at village level (%)	32.0	5.6, 57.8	13.1	2.3
NGOs working at district level (%)	35.0	11.3, 59.1	11.3	2.3
NGOs working at regional level (%)	18.2	6.2, 27.9	5.6	2.3

NGOs working at national level (%)	14.8	0.7, 25.6	7.4	2.3
NGOs working at or above region level (%)	40.8	17.1, 59.3	11.7	2.3
NGOs working at or above district level (%)	75.4	45, 95.6	13.1	2.3
NGOs in the health sector (%)	71.0	52.1, 86.5	7.5	6.0
NGOs in the agriculture/environment sector (%)	61.4	33.3, 76.8	8.8	6.0
NGOs in the education sector (%)	62.8	46.5, 77.5	8.0	6.0
NGOs with an independent board of directors (%)	59.8	31, 92	15.7	1.4
NGOs inspected by an external auditor (%)	47.8	31.1, 73.1	10.2	7.1
NGOs with rules/regulations for money (%)	87.0	79.7, 93	3.5	0.0
NGOs with an office (%)	30.1	10.7, 56.4	10.4	0.0
NGOs with internet service (%)	43.7	20.2, 61.3	11.3	0.0
Mean number of computers per NGO	0.9	0.2, 2.2	0.4	0.0
Mean number of cars per NGO	0.3	0, 1	0.2	0.0
NGOs with satisfying relationship with the central government (%)	64.9	46.7, 79.5	8.9	0.6
NGOs with satisfying relationship with the local government (%)	75.2	62.7, 87.3	8.1	0.6
NGOs with satisfying relationship with the private sector (%)	44.5	24.4, 64	11.6	0.6
NGOs with satisfying relationship with the public (%)	57.9	37.2, 76.7	11.8	0.6
NGOs with satisfying relationship with development partners (%)	57.9	39.5, 78.7	12.4	0.6
NGOs with satisfying relationship with the media (%)	49.5	22.1, 67.5	12.1	0.6
NGOs rating lack of funding as 1 of top 3 challenges (%)	93.2	84.5, 98.4	3.5	5.0
NGOs rating lack of human resources as 1 of top 3 challenges (%)	17.6	5.6, 54.1	10.4	5.0
NGOs rating limited availability of information as 1 of top 3 challenges (%)	36.7	20.7, 56.8	10.6	5.0
NGOs rating lack of leadership skills as 1 of top 3 challenges (%)	23.7	13.8, 39.2	7.7	5.0
NGOs rating lack of resources as 1 of 3 top challenges (%)	78.6	69.3, 93.2	5.7	5.0
NGOs rating limited participation by members as 1 of top 3 challenges (%)	16.7	6.8, 26.2	4.9	5.0
NGOS rating donor dependence as 1 of top 3 challenges (%)	48.1	33.8, 63.4	9.2	5.0
NGOs involved in central government development policy debate in past year (%)	52.4	26.7, 71.4	10.1	1.6
NGOs that saw expected results from participation in government debate (%)	47.8	25.3, 64.3	9.4	1.6
NGOs that debated policy with regional government representative in past year (%)	23.9	9.3, 38	6.7	0.1
NGOs that involved local government in planning/budgeting in past year (%)	41.8	17.3, 60.2	9.9	3.0
NGOs involved in central, regional OR local government debate/planning in past year (%)	66.3	40, 83.4	10.0	0.0
NGOs reporting that village/ward in operational area convenes community meetings (%)	69.5	6.5, 89.8	21.2	0.1
NGOs reporting having met with Ministry leaders (%)	27.1	8.7, 45.5	10.1	0.0
NGOs with wealth indicator 1 - external auditing & ≥1 computer (%)	23.4	11.9, 38.9	9.1	7.1

NGOs with wealth indicator 2 – indicator 1 & internet service (%)	16.8	8.1, 29.6	7.1	7.1
NGOs with wealth indicator 3 – indicator 2 & board of directors (%)	14.0	4.6, 24.1	6.2	8.1

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<sup>A</sup> (%) after covariate description signifies that the value provided is the percentage of NGOs with a given indicator.

NGO, non-governmental organization; CBO, community-based organization.

**Appendix Table 2.** List of 34 MCH outcomes abstracted from the 2010 Tanzania DHS survey.

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**MCH Outcome**

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Woman received  $\geq 2$  tetanus toxoid doses during last pregnancy  
Woman had  $\geq 4$  ANC visits during last pregnancy  
Woman saw health professional for ANC during last pregnancy  
Woman had  $\geq 4$  ANC visits and saw health professional for ANC during last pregnancy  
Woman received  $\geq 2$  doses of IPT for malaria during last pregnancy  
Woman received delivery assistance from health professional during last pregnancy  
Woman delivered at health facility during last pregnancy  
Woman delivered at health facility assisted by health professional during last pregnancy  
Woman didn't deliver at health facility during last pregnancy due to limited access  
Woman reported not delivering at health facility and limited access during last pregnancy  
Woman has heard of ORS  
Woman has used ORS  
Woman has moderate or severe anemia  
Woman has a bednet for sleeping  
Woman slept under bednet last night  
Woman has tested for HIV  
Woman knows where to test for HIV  
Woman reports distance to health care barrier to accessing care  
Child was born with low birth weight ( $< 2500\text{g}$ )  
Child was born with low birth weight ( $< 2500\text{g}$ ), documented on health card  
Child received all childhood vaccines, documented on health card  
Child received all childhood vaccines and hepatitis B vaccine, documented on health card  
Child had diarrhea in last 2 weeks and sought treatment at medical facility  
Child had diarrhea in last 2 weeks and sought or received treatment  
Child had diarrhea in last 2 weeks and was treated with ORS, RHS, or zinc  
Child had diarrhea in last 2 weeks and was treated with ORS, RHS, zinc, antibiotics, or IVF  
Child had ARI in last 2 weeks and sought treatment at medical facility  
Child had fever/cough in last 2 weeks and received antimalarial treatment  
Child is stunted (height-for-age  $< -2$  SD), CDC  
Child has growth faltering (weight-for-age  $< 2$  SD), CDC  
Child is stunted (height-for-age  $< -2$  SD), WHO

Child has growth faltering (weight-for-age < 2 SD), WHO

Child has moderate or severe anemia

Child slept under a treated bednet last night

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MCH, maternal and child health; DHS, Demographic and Health Survey; IPT, intermittent preventive therapy; ORS, oral rehydration solution; RHS, recommended home solution; IVF, intravenous fluids; ARI, acute respiratory illness; CDC, Centers for Disease Control and Prevention; WHO; World Health Organization.

**Appendix 5.** *A priori* data analysis plan for assessing the relationship between NGOs and MCH outcomes in 19 regions of Tanzania.

Models were fit using a six-step *a priori* data analysis plan: (i) run univariate regression models to estimate crude effect measures for each NGO covariate-health outcome combination, ii) conduct first round of diagnostics to assess goodness-of-fit and influential points, iii) test for effect modification by household rural residence, using author opinion to judge the difference between stratum-specific effect measures (2010 cross-sectional analysis only), iv) test for confounding one covariate at a time, using change of effect measure by  $\geq 10\%$  of the crude estimate to identify confounding, v) add identified confounders to each model and run multivariate regression models to estimate final adjusted effect measures for each NGO covariate-health outcome combination, and vi) conduct second round of diagnostics to assess goodness-of-fit and influential points. For the 2010 cross-sectional analysis, model goodness-of-fit was assessed through conducting the link test for proper model specification, plotting deviance residuals against the linear predicted values, constructing a Q-Q plot of the deviance residuals to assess normality, and influential regions were identified by plotting Cook's distance against region. For the two cohort analyses, model goodness-of-fit was assessed through plotting studentized residuals against fitted values to assess for linearity and heteroscedasticity, constructing a Q-Q plot of the studentized residuals to assess normality, and influential regions were identified by plotting delta-betas against region.

**Appendix 6.** Detailed explanation of health sector and missing NGOs sensitivity analyses.

To determine the importance of NGO target sector, we re-ran the analyses with a subset of NGOs restricted to those working in the health sector. An NGO was classified as working in the health sector if it reported its sector as "drugs and alcohol", "health" and/or "HIV/AIDS", regardless of any other sectors reported.

FCS conducted two national NGO surveys – one in 2009 and another in 2010; however, we obtained only the latter’s dataset. Some NGOs surveyed in the first survey may not have been captured in the second due to survey fatigue. To address this limitation, we assessed the impact of adjusting NGO funding, NGO staff, and NGO concentration to account for NGOs that were captured in the first survey but not the second. The number of missing NGOs per region was estimated by subtracting the number surveyed in the 2009 survey from that surveyed in 2010. If this number was  $>0$ , it was multiplied by the mean value of each NGO-level variable for all NGOs captured in the 2010 survey, which was then used to estimate adjusted region-level NGO variables.

**Appendix 7.** Results of the minor aims assessing the region-level relationship between NGOs and MCH in 19 regions of Tanzania.

	<b>Child stunted</b>	<b>Child fully vaccinated</b>			<b>Woman attended ≥4 ANC visits</b>	<b>Woman had health facility delivery</b>		
<b>Region-level increase</b>	Prevalence ratio (95% CI)   p-value							
1 NGO per 100,000 capita in 2000 <sup>A</sup>	0.99 (0.96, 1.02)	0.33	1.03 (1.00, 1.06)	0.05	1.04 (1.01, 1.06)	0.001	1.04 (1.00, 1.07)	0.05
1 NGO per 100,000 capita in 1994 <sup>B</sup>	0.98 (0.94, 1.03)	0.40	0.97 (0.91, 1.04)	0.37	0.97 (0.93, 1.01)	0.13	1.02 (0.95, 1.09)	0.57

<sup>A</sup>This cross-sectional analysis explored the relationship between NGOs per capita in 2000 and health outcomes in 2004.

<sup>B</sup>This cross-sectional analysis explored the relationship between NGOs per capita in 1994 and health outcomes in 1996.

NGO, non-governmental organization; MCH, maternal and child health; 95% CI, 95% confidence interval; ANC, antenatal care.