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Association between maternal income status and infant mortality in Tanzania: Findings from the 2015-2016 Demographic Health Survey

By

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By

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An abstract of
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2016

Abstract

Association between maternal income status and infant mortality in Tanzania: Findings from the 2015-2016 Demographic Health Survey

By Rachelle Jones

BACKGROUND: The 2015-2016 Tanzania Demographic and Health Survey and Malaria Indicator Survey (TDHS-MIS) found infant mortality rates to be higher among wealthier women living in Tanzania compared to less wealthy women. This was a surprising finding, considering the survey found that wealthy women aged 15-49 are more likely to engage in behaviors that protect against infant mortality (e.g., antenatal care, education, family planning). We performed a secondary analysis To assess potential effect modifiers on the association between maternal wealth and infant mortality women age 15-49 who had live births in Tanzania.
METHODS: To evaluate the association between maternal wealth and infant mortality for the current study, we analyzed the survey responses of mothers aged 15-49 using the Birth Recode dataset from the 2015-2016 Tanzania Demographic and Health Survey and Malaria Indicator Survey. Using logistic regression, we estimated odd ratios and 95% confidence intervals to examine interactions between wealth index and covariates, maternal age, maternal education, birth index, birth order, delivery location, and assistance with delivery.
RESULTS: The unadjusted odds ratios for household wealth were 43% (95% C.I. 1.05-1.94), 16% (95% C.I. 0.89-1.53), 37% (95% C.I. 1.01-1.85), and 75% (95% C.I. 1.19-2.59) more likely to not survive infancy (poorest, poorer, richer, and richest, respectively) than the odds of not surviving infancy if born to mothers in the middle wealth quintile. When not adjusting for other variables, there does appear to be significant evidence that the highest wealth quintile, richest, is significantly more likely to have infants not survive infancy than the middle wealth quintile.
CONCLUSION: As expected, wealth index is associated with infant mortality for children born to women age 15-49 years in Tanzania, but no significant effect modifiers were identified. Maternal age, maternal education, and birth interval were found to have a significant association with infant mortality.

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Contents

CHAPTER I: Introduction

Global Infant mortality

Infant mortality is defined as the risk of dying within one year after birth. Infant mortality rate is one of the indicators of the socioeconomic status of a country and the quality of life of the population. (UNICEF, WHO, World Bank, UN-DESA Population Division, 2018) Globally, there has been a significant focus on the reduction of infant and child mortality for the past three decades. Governments and public health organizations have campaigned worldwide on child survival through promoting initiatives such as the Millennium Development Goal 4 (MDG 4), Sustainable Development Goal 3.2 (SDG 3.2), United Nations Commission for Accountability for Women's and Children's Health, UNICEF work on child intervention, and the Health for All by the Year 2000 campaign. (Wang, H et al, 2014, Global Burden of Disease Collaborative Network, 2016).

MDG 4 aimed to reduce under 5 child mortality by two thirds between 1990 and 2015. There was a decline in under 5 mortality rate (U5MR) in all MDG regions. The MDG target of two thirds reduction was met by 2013 in Eastern Asia, Latin America and Caribbean, and Northern Africa. These regions, along with Southeastern Asia and Western Asia, achieved a U5MR of <30 under-five deaths per 1000 live births by 2013. Southern Asia and Sub-Saharan Africa account for a third and almost half, respectively, of the 6.3 million under 5 deaths that occurred in 2013. Globally, the infant mortality rate decreased between 1990 and 2013 from 63 to 34 infant deaths per 1000 live births. In Sub-Saharan African and Southern Asia, infant mortality rate (IMR) continued to be high at 61 and 43 infant deaths per 1,000 live births respectively, in 2013. (Gaffey, M. F., Das, J. K., & Bhutta, Z. A., 2015).

The Sustainable Development Goal 3, which replaced the MDGs, introduced new targets to reach by 2030 that focused on child survival: 1) reduce under-5 mortality to less than 25 deaths per 1,000 live births 2) reduce neonatal mortality to fewer than 12 deaths per 1,000 live births 3) ending preventable deaths of newborns and children under 5 years of age. (Global Burden of Disease Collaborative Network, 2016)

The Global Strategy for Women's, Children's, and Adolescent's Health 2016-2030 also focuses on the need to end preventable child deaths. Most of the 5.3 million deaths among children under 5 that occurred in 2017 were due to preventable or treatable causes, like infectious diseases or injuries. That breaks down to 15,000 child deaths a day that could have possibly been prevented in 2017. Prevention of infectious diseases through access to simple health interventions, like vaccines and medical treatments, and providing children with the proper nutrition and clean water and sanitation could have prevented many of these deaths. (UNICEF et al, 2018). Preventing two thirds the under five years of age death globally through readily available interventions, such as vaccines or basic nutrition seems to be a challenge poorer regions, like Sub-Saharan Africa. (Armstrong Schellenberg, J. R et al 2008). There have been evidence where treatment interventions have shown a significant impact on reducing the child mortality. With the HIV epidemic in the 1990s in sub-Saharan Africa, there was an increase in child mortality. With the introduction and scale-up of ways to prevent mother-to-child transmission of HIV and antiretroviral therapy there has been a decline in child mortality in the region since 2000. (Wang, H et al, 2014)

From 1990 to 2017, the annual infant mortality has decreased from 8.8 million to 4.1 million deaths per year. Even with this progress, there is still a potential of 56 million children under 5 years of age dying in the next 6 years, of which 28 million are newborns, if more progress is not made by 2030. Sub-Saharan Africa still has the highest under-5 mortality with an average U5MR of 76 deaths per 1,000 live births (1 out of 13 children die before their fifth birthday). Based on data provided in the United Nations Inter-agency Group for Child Mortality Estimation (UN IGME) Child Mortality Report 2018, in 2017, the U5MR rate across countries ranged from 2 to 127 deaths per 1,000 live births. Sub-Saharan Africa was the only region with countries above 100 deaths per 1,000 live births during this time. If mortality trends continue to progress similar to current trends, then it is estimated that between 2018 and 2030 there will be 56 million deaths among children under, with greater than fifty percent occurring in Sub-Saharan Africa. (UNICEF et al, 2018)

Problem statement

Infant mortality rate is one of the indicators of the socioeconomic status of a country and the quality of life of the population. Higher wealth tends to be associated with lower infant mortality; however, this is not the case women age 15-49 who have live births in Tanzania. We plan to evaluate the impact of whether a delivery method, number of antenatal care visits, maternal age, maternal education, birth order, birth interval, place of delivery and assistance with delivery to assess potential conditions that influenced the increased infant mortality in Tanzania among wealthy women age 15-49 years of age. The 2015-2016 Tanzania Demographic and

Health Survey and Malaria Indicator Survey (TDHS-MIS) found infant mortality rates to be higher among wealthier women living in Tanzania compared to less wealthy women. This was a surprising finding, considering the survey found that wealthy women aged 15-49 are more likely to engage in behaviors that protect against infant mortality (e.g., antenatal care, education, family planning).

Specific Aim

Assess potential influencers contributing to higher infant mortality rate for children born to mothers from wealthier households.

Purpose statement

We performed a secondary analysis on the 2015-2016 TDHS-MIS data to evaluate infant mortality. To assess potential effect modifiers (including maternal age, maternal education, health, birth order, birth interval, delivery method, antenatal care visits, place of delivery, and assistance with delivery) on the association between maternal wealth and infant mortality women age 15-49 who had live births in Tanzania.

CHAPTER II: Review of Literature

Infant Mortality in Tanzania

Infant mortality is a key indicator in Tanzania of the overall health of a community and helps to identify infants with a high risk of death. Like other developing countries, Tanzania's child mortality rate is high (43 deaths per 1,000 live births) (MOHCDGEC Tanzania Mainland, MOH Zanzibar et al, 2016). It is estimated that 1 out of every 7 children born in Tanzania do not live to see their fifth birthday. Malaria, acute respiratory infection, diarrhea and malnutrition are the most common causes of death among children. (Armstrong Schellenberg, J. R et al, 2002)

In similarity to other developing countries, there is no complete data on vital registration and routine health information. Trends on mortality are estimates from cross-sectional household surveys. National data on child mortality disguises the variations at the local level. Armstrong Schellenberg et al, noted that in 1999, infant mortality ranged from 41 to 129 deaths per live births for Arusha Region and Lindi Region, respectively (Armstrong Schellenberg, J. R et al, 2008)

Over the past 15 years, infant mortality rate has decreased from 99 deaths per 1,000 live births to 43 deaths per 1,000 live births in Tanzania. Tanzania has implemented government policies and programs that focus on increased health services to reduce neonatal, infant and child mortality. As a result, Tanzania has seen a continuous decline in early childhood mortality. Post the MDG close in 2015, Tanzania, along with 19 other countries, was identified as a country on track to reducing their U5MR by two-thirds from the 1990 levels (Afnan-Holmes, H. et al, 2015).

While there has been a continuous decline in infant mortality, the 2015-2016 Tanzania Demographic and Health Survey (TDHS) found that since the last series there has been an increase in neonatal and infant mortality rate among the women age 15-49 in the highest wealth index. The aim of this project is to understand factors that contribute to the unexpected relationship of infant mortality and wealth (MOHCDGEC Tanzania Mainland, MOH Zanzibar et al, 2016).

Factors Associated with Infant Mortality in Tanzania

Tanzania is one of the poorest countries in the world (Armstrong Schellenberg, J. R et al, 2008). Over the past two decades, the population in Tanzania has doubled, requiring health and social services to increase at the same rate to maintain convers (Afnan-Holmes, H. et al, 2015).

Factors that increase the risk of death for infants include short birth intervals, higher birth order, mother's age at birth, low birth weight, mother's education, household income, father's occupation, access to clean drinking water and sanitation and survival of oldest sibling (Hailemariam, A., & Tesfaye, M., 1997). According to the 2015-2016 THDS data, in Tanzania, children have a higher risk of death if born to mothers under 20 years and between 40-49 years, if they were born shortly after preceding sibling and if they are reported to be small or very small. Between the Mainland and Zanzibar, children born on the mainland had a higher risk of mortality. Across the Mainland, infant mortality ranged from as low as 38 deaths per 1,000 live births, up to 70 deaths per 1,000 live births. Unexpected patterns observed were higher infant mortality: 1) in urban areas than rural areas (report attributes this solely to high neonatal mortality rates in urban areas), 2) among children born to mothers with incomplete primary education than children born to mothers with no education (66 and 43 deaths per 1,000 live births, respectively) and, as mentioned earlier, 3) among children born to mothers in households in the highest wealth quintiles. These patterns are unusual because urban areas and those with higher wealth usually have access to better health services, improved living conditions and a better education, which are associated with improved health outcomes, included lower risk of infant and child mortality (MOHCDGEC Tanzania Mainland, MOH Zanzibar et al, 2016).

Schellenberg and colleagues (2008) found children who lived further from health facilities had lower vaccine coverage, increased anaemia, fewer mosquito nets, poorer-care seeking, and higher infant mortality than children who lived closer to a health facility (Armstrong Schellenberg, J. R et al, 2008). In rural populations, one out of three infant deaths occurred at a health facility (Armstrong Schellenberg, J. R et al, 2002). This disparity is seen even with the "broad reach" of Tanzania's health system to villages and its frequent use for child illness (Armstrong Schellenberg, J. R et al, 2008).

Studies have shown that other than household income and rural-urban divide, maternal education level and changes in technology have long-term associations with child mortality. Research has studied the association between health systems and child mortality, helping to understand why health systems at the same income or health expenditure can achieve different child mortality outcomes. With some having "faster rates of decrease or lower levels of child mortality" (Wang, H et al, 2014) than others at the same level. Understanding the global connective impact of the interconnection of maternal education, income per person, technology change and child mortality could provide insight on future recommendations to decrease child mortality (Wang, H et al, 2014).

Household Wealth in Tanzania and Infant Mortality

Tanzania Mainland and Zanzibar make up the United Republic of Tanzania, making it the largest country in East Africa. With a population of 50.1 million, 95% live on the Tanzania Mainland. Wealthier populations mostly live in the urban areas, 88% of which are in the two highest wealth quintiles. Eighty percent of Zanzibar's population is in the two highest wealth quintiles. While 79% of the rural population in Tanzania are in the three lowest quintiles (MOHCDGEC Tanzania Mainland, MOH Zanzibar et al, 2016).

Research has found that infants born to mothers of higher wealth generally have a lower mortality rate due to increased access to health care services. The 2015-2016 Tanzania Demographic and Health Survey and Malaria Indicator Survey (TDHS-MIS) found that infant mortality rates were actually higher for children born to women between the ages of 15-49 in the highest wealth quintile compared those born to women in the four lower wealth quintiles (MOHCDGEC Tanzania Mainland, MOH Zanzibar et al, 2016).

Determinants such as access to health services, clean water and sanitation, and adequate nutrition are all indicators to the well-being of infants and children. According to UN IGME, "three quarters of children and adolescents aged 0-14 are dying from communicable, perinatal, and nutritional conditions" (UNICEF et al, 2018). Disparities between rural and urban living and household wealth add to the "inequitable child mortality outcome within countries" (UNICEF et al, 2018), putting those children in rural areas and poorer households at a disproportionally higher potential of an early death. Children under 5 living in rural communities are 1.5 times more likely to die before reaching 5 years of age than those living in urban communities. Those of poorer households have two times U5MR than the wealthiest household (UNICEF et al, 2018).

In summary, many studies have examined the impact of wealth on infant mortality. Unlike many other studies, this study will assess if wealthy mothers had access to trained staff at health facilities and during delivery and other potential determinants that may be affecting infant mortality among their wealth quintile. Accurate reporting on live birth data is a potential problem with retrospective data. Under reporting of live births and infants that died, the dates and ages at the time of death is a major concern. As noted in Mturi et al findings, under reporting from by rural women is possible (Mturi, A. J., & Curtis, S. L., 1995). As previously noted, Tanzania has implemented many programs and policies to address child mortality. Increasing access to care and maternal and child health services available at health facilities. Not much research has gone into understanding the impact this has had on the population. Mturi et al. stated that the increased focus on rural health had negatively impacted services in the urban health system. Contributing higher mortality rate in urban areas than rural areas to the neglect of their health system and inadequate staff. This paper aims at understanding if the wealth mortality advantage that has been the findings of earlier studies is eliminated by neglect to the health facilities and inadequately trained staff that assist with deliveries among the wealthiest in Tanzania (Mturi, A. J., & Curtis, S. L. 1995).

CHAPTER III: Methodology

Data Source and Study Population

The 2015-2016 TDHS-MIS is a cross-sectional survey that was implemented collaboratively by the National Bureau of Statistics, the Office of Chief Government Statistician, Zanzibar, the Tanzanian Mainland Ministry of Health, Community Development, Gender, Elderly, and Children and the Ministry of Health, Zanzibar. The aim of the survey is to provide current estimates on demographic and health indicators to provide data-driven decision making for policy makers and program mangers involved with implementing and measuring outcomes of programs and defining strategies to improve health across the country. Men and women age 15-49 across the 30 regions on the Tanzania Mainland and Zanzibar were included in the survey if they were regular residents or visitors in the household on the night before the survey. For the 2015-2016 TDHS-MIS, 13,376 households were surveyed. (MOHCDGEC Tanzania Mainland, MOH Zanzibar et al, 2016)

The 2015-2016 DHS is comprised of four questionnaires, Household, Women's, Men's and Biomarker Questionnaires. To evaluate the association between maternal wealth and infant mortality for the current study, we analyzed the survey responses of mothers aged 15-49 using the Birth Recode dataset. The Birth Recode dataset includes the birth history for all children born within the last 5 years to women who responded to the survey. Only women who responded to having a child within 5 years prior to the survey were included in the analysis.

Outcome Variable

The outcome variable was whether the infant was living or not living. Infants (age 1 month to less than 12 months) were identified through filtering age at death and current age of child in months. Alive infants were identified using current age of child between 1 and 12 months and child alive response was yes. To identify children who had died as infants at the time of the survey, we used the age at death variable where age was between 30 days and 12 months.

Primary Exposure Variable

Our main exposure variable was wealth index. Wealth, in the TDHS-MIS data set, was measured as a categorical variable divided into five quintiles. The quintiles were determined based on a score given to a household that is calculated using number and kinds of consumer goods owned, housing characteristics, and ranking each person in the household. For the purpose of analysis, we examined the quintiles as: 1) Poorest, 2) Poorer, 3) Medium, 4) Richer and 5) Richest.

Covariates

Covariates related to the mother's demographics were examined and categorized based on WHO recommendations or guidelines and similar research. Maternal age (in years) was grouped into 3 categories: 15-24, 25-34, 35-49 (WHO, 2018 and Fall. C.H et al, 2015). Maternal education level was grouped as "No education to Primary" and "Secondary to Higher" (UNICEF & WHO, 2017).

Covariates associated with the birth and pregnancy were also examined and categorized based on WHO recommendations or guidelines and similar research. Birth order was grouped into four categories: "First", "Second", "Third", and "Forth or higher" (Hong, R., & Ruiz-Beltran, M. 2008). Preceding birth interval or birth index: "Less than 24 months", "24-36 months", "37-48 months", and "Greater than 49 months" (WHO, 2005). Delivery by caesarean was a yes or no response. Place of delivery was classified into three categories: "Home", “Private/Religious/Voluntary/Other: Referral/ Spec. Hospital, District Hospital, General Hospital, Health Center, Dispensary, Clinic” and “Government: National/Zonal referral/ Spec. Hospital, Regional Referral Hospital, Regional Hospital District Hospital, Health Center, Dispensary, Clinic”. Assistance with the delivery: “Doctor/AMO/Clinical officer/Assist. Clinical Officer/Nurse/Assist. Nurse/Midwife” and “Traditional Birth Attendants (TBA)/Relative Friend/No One/ Other”. Number of antenatal care visits was also examined and grouped as “”Less than 8 visits” and “8 or more visits” (WHO, 2016a and WHO, 2016b).

Statistical Analysis

The TDHS-MIS birth recode dataset was used for analysis. The data was cleaned to include records of interest. Infant records were included if 1) current age greater than or equal to 1 month or less than or equal to 12 months or 2) age at death greater than or equal to 30 days or less than or equal to 12 months. SAS version 9.4 software was used to perform statistical analysis. All variables were categorical and reported as frequency and percentage. Bivariate analysis (Rao Scott Chi-square) test for association to between infant mortality and independent variables showed no significant association with infant mortality and place of delivery, assistance with delivery, birth order, and delivery by caesarean. Crude and adjusted odds ratios were calculated using logistic regression. Stratification, clustering, and weight parameters were used. The level of significance for probability value (p-value) was set at <0.05. Variables with a p-value of less than 0.05 are considered significant.

CHAPTER IV: Results

Descriptive analysis of birth records

Records for mothers surveyed that gave birth between 2010 and 2015, in Tanzania, who either had a child that died at infancy or were infants at the time of the interview were used. 3,312 infant records were identified. Among the infants identified, 1,318 (40%) died at infancy and 1,994 (60%) were still living. 25% of births were by mothers in the poorest wealth quintile, 22% among poorer mothers, 20% among middle mothers, 19% among richer mothers, and 14% among the richest mothers. Mothers with no education or a primary education were responsible for 88% of the infants born and mothers with a secondary or higher education made up 12% of the births. 99% of mothers had less than 8 antenatal visits during pregnancy and 1% had 8 or more antennal visits. Most of the infants born were the forth born or more in their family (38%). First borns were 27%, second born 19%, and third born 16% of births. 35% of children were born 24 to 36 months after a previous birth, 26% were born less than 24 months after a previous birth, 22% were born more than 49 months after a previous birth, and 17% were born between 37 to 48 months after a previous birth. Only 7% of births were by caesarean, 93% were normal births. Most births occurred either in a government health facility (52%) or at the mother’s home (30%), while only 18% of births were in a private or religious health facility. 63% of births were assisted by a medical professional (Doctor/AMO/Clinical officer/Assist. Clinical Officer/Nurse/Assist. Nurse/Midwife) and 27% were assisted by a Traditional Birth Attendant (TBA), relative or friend, no one, or other.

Covariates among Living Infants

For wealth index, 509 living infants were born to mothers in the poorest quintile (26%), poorer (21%), richer (20%), middle (18%), richest (15%). Mothers between 15 to 24 years and 25 to 34 years had the most births, 42% and 41%, respectively. Mothers age 35 to 49 years were responsible for 17% of the births. 83% of living infants were born to mothers with no education or only a primary education and 17% were born to mothers with secondary or higher education. Only 1% of mothers attended 8 or more antenatal visits, 99% attended fewer than 8 visits. Birth order distribution: first (26%), second (18%), third (16%), and forth or higher (40%). Living infants were mostly born 24 to 36 months following a preceding birth (35%), 49 months or more (28%), less than 24 months (19%), and 37 to 48 months (18%). Most of the living infants were born through normal delivery methods (93%), caesareans were only 7%. Place of delivery reflected the summary of sample data, government health facilities were the location of birth for 52% of the living infants, 30% were born at home, and 18% were born at a private, religious, or voluntary health facility. A medical professional assisted with 65% of the births and 35% were assistant by a TBA, relative or friend, no one, or other.

Covariates among Deceased Infants

Most of the infants that did not survive infancy were born to mothers in the poorest (23%), poorer (24%), and middle (23%) wealth quintiles. Richer and richest quintiles gave birth to 18% and 11%, respectively, of the deceased infants. Mothers' age 35-49 years has the highest percentage of deceased infants 71%, age 25-34 years 23%, and 15-2 years 6%. 96% of mothers who had an infant that died during the period of the survey had no education or only a primary education and 4% had secondary or higher education. Only 1 mother completed 8 or more antenatal visits, almost 99.9% completed few than 8 visits. Birth order was similar to living infants, first (28%), second (20%), third (16%), and forth or higher (36%). Unlike living infants, preceding birth intervals were highest for deceased infants born less than 24 months (37%) and 24-36 months (34%) following a previous birth. Preceding birth intervals of 37-48 months and more than 49 months were 16% and 13%. Due to missing values, frequency for delivery method, place of delivery, and assisted with delivery were low for deceased infants. Of the 1,318 deceased infant records, 147 were delivered through normal delivery methods and 17 were through caesarean. 88 births occurred in a government health facility, 44 at home, and 38 at a private, religious, voluntary, or other type of health facility. Medical professionals assisted with 107 births and 57 were assisted by a TBA, relative or friend, no one, or other.

Association between household health and infant mortality

Household wealth had a p-value of 0.0148, suggesting there is significant difference between wealth categories and infant mortality. Maternal age ($p < 0.0001$), maternal education ($p < 0.0001$), antenatal care visits ($p = 0.0006$), and birth interval ($p < 0.0001$) also appear to have significant difference between categories and infant mortality. There appears to be no significant evidence that infant mortality is different across categories for birth order (p=0.3096), delivery method (p=0.1347), place of delivery (p=0.4323), and assistance with delivery (p=0.895) (Table 1). The unadjusted association of the covariates appears to be significant for household wealth, maternal age, maternal education, antenatal care visits, and birth interval since the confidence intervals do not include the null value of 1. For household wealth, poorer category had OR of 1.16 and 95% confidence interval of 0.89-1.53 (Table 2). The association between infant mortality and household wealth when controlling for maternal age, maternal education, birth interval, place of delivery, and assistance with delivery independently was not significant (Table 3).

CHAPTER V: Discussion

The 2015-2016 TDHS-MIS found that women living in the richest households had the highest infant mortality rates. Our study assessed the potential influencers that could be attributing the high infant mortality rates among wealthy households in Tanzania. While our study is not the first to look into determinants of infant mortality, it is one of the first, besides the analysis conducted by DHS analyst, to study the unexpected relationship of wealthiest households in Tanzania and infant mortality. We found no significant evidence that infants born to mothers of the wealthiest quintile were more likely to die then infants born to mothers of the other wealth quintiles when adjusting for maternal age, maternal education, and birth index.

Our findings show, like many other studies, that maternal age and birth interval (birth spacing) play an important role in infant mortality (Hailemariam, A., & Tesfaye, M., 1997). The odds of not surviving infancy for infants born to mothers age 35-49 years were 97% (95% C.I. 0.02-0.04) less likely than those born to mothers age 15-24 years. The odds of not surviving infancy for infants born to mothers age 25-34 years were 79% (95% C.I. 2.81-7.94) less likely than those born to mothers age 15-24 years. The odds of infants born between 24-36 months after a previous birth not surviving infancy were 6.40 (95% C.I. 4.25-9.64) times the odds of infants born less than 24 months after a previous birth. For infants born between 37-48 months or ≥49 months after a previous birth, the odds of not surviving infancy were 2.20 (95% C.I. 1.60-3.01) and 3.43 (95% C.I. 2.33-5.03), respectively, times the odds of infants born less than 24 months after a previous birth. All odds ratios for maternal age and birth interval were significant.

Previous studies show that wealth, age, and education are significantly associated with the use of antenatal care. Antenatal cares visits are important for maternal health and health outcomes of the child (Arthur, E., 2012). The population distribution for antenatal care visits were not evenly distributed. Thirty-eight percent of the records had missing data for the number of antenatal care visits. Of the records with responses, more than 90% of the infants that did not survive infancy were born to mothers that attended one or fewer antenatal care visits. Only one infant that did not survive infancy was born to a mother that received the WHO recommended number of visits, which is 8 or more (WHO, 2016b)

After gaining independence, Tanzania put forth the Arusha Declaration of 1967 that declared people should have access to free health care services and health care facilities should be in close proximity of the people. Beginning in 1983, the Tanzanian Ministry of Health implemented a 5-year development plan which expands on initiatives outlined in 1967 and adapts to the Primary Health Care strategies outlined by the World Health Organization (WHO) in the Declaration of Alma-Ata of 1978 (Karungula, J., 1992). One of the key objectives of the development plan focused on reducing infant mortality rate to 50 deaths per 1,000 live births by 2000, which achieved by 2010 according data collected in the 2010 Tanzania Demographic and Health Survey and has continued to decrease over the years (MOHCDGEC Tanzania Mainland, MOH Zanzibar et al, 2016 and Karungula, J., 1992).

Local government reform is continuously being addressed in Tanzania, as well reform to the health sector. To increase autonomy among local councils and provide them control of their budgets and plans, the Ministry of Health and development partners combine funding resources.

These pool of funds is then distributed to districts and some to local councils to implement independent plans. It is estimated that health spending is $11.34 per capita, nationally. Almost all of health spending is contributed by households (Armstrong Schellenberg, J. R et al, 2008). In 2015, donor funding to support child health and HIV/AIDS tripled. Analysis done with the Lives Saved Tool, used by Haviye Afrnan-Holmes and others in 2015, suggested that increases in coverage of “high-impact interventions at lower levels of the health system (e.g., the community and dispensary levels)” contributed to 39% of the child mortality reduction between 1990 and 2014 (Afnan-Holmes, H. et al, 2015).

Tanzania’s ongoing stable political stability, which has continued for the past several decades (Afnan-Holmes, H. et al, 2015). Some key actions taken by the Tanzanian government that contributed to the improvement of maternal and child health include: increased access to health services by increasing number of health facilities, improve quality and access to serves through increased trained maternal and child health aids, implementation of programs that focus on disease prevention. Programs implemented by the Tanzanian government included Maternal and Child Health, Nutritional, Control of Communicable Disease, The Essential Drug and Health Education programs (Karungula, J., 1992). Tanzania has the fifth fastest reduction in U5MR among the 20 Countdown to 2015 countries as a result of ongoing government policies and programs (Afnan-Holmes, H. et al, 2015).

One strength of this study was the reliability of the data provided through the TDHS. The administrators of the survey put in parameters to check data quality both in the field and during data entry. The 2015-2016 THDS-MIS also had a 97% response rate. Both support accurate survey estimates for infant mortality.

Although the data is reliable, there were limitation due to data being dependent on the mother's ability to recall births accurately. Age at death and date of birth could affect the calculations of infant mortality if inaccurate, which can result in an overestimation or under estimate of infant mortality. There is also a chance of mother selectively omitting children that did not survive infancy, causing and underestimation of infant mortality in Tanzania (MOHCDGEC Tanzania Mainland, MOH Zanzibar et al, 2016).

Forty percent of infants not surviving infancy of the 3,312 live births seems to be pretty high for the region. A study conducted by Berhe Weldearegawi and colleagues in neighboring country, Ethiopia, showed that 96% of infants born in the country that live longer than 30 days, live to see their first birthday (Weldearegawi, B. et al, 2015). Due to high missing data, analysis of the effect of number of antenatal care visits, place of delivery, and assistance with delivery has on the association between wealth index and infant mortality were not performed. Further exploration, through more complexed modeling, of determinants that are contributing to the unexpected high mortality rates among households with the highest wealth index should be conducted. In 2014, a study done by Andrew Tatem and colleagues from the University of Southampton, stated that only 50% of births in Tanzania do not occur in a facility.

In conclusion, wealth index is associated with infant mortality for children born to women age 15-49 years in Tanzania, but no significant effect modifiers were identified. Maternal age, maternal education, and birth interval were found to have a significant association with infant mortality. While the Tanzania Ministry of Health and Social Welfare have placed emphasis on strengthening the number of trained health personnel within the country, a lot of focus has been on the rural areas. (Tatem, A. et al., 2014). Further research on if these programs are neglecting children born in urban areas and/or wealthier households would be useful in helping the Ministry of Health understand where they can improve their programs to ensure better health outcomes for all children.

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Appendix

Table 1. Characteristics of mothers aged 15-49 in Tanzania between 2010-2015 who had an infant that survived infancy or not (n=3312)

Characteristic	Living(n=1994)		Not Living(n=1318)			
	n=	%	n=	%	X^2 (d.f.)*	*p-value*
Household wealth					12.3710 (4)	*0.0148*
Poorest	509	*25.53%*	305	*23.11%*		
Poorer	425	*21.33%*	312	*23.66%*		
Middle	362	*18.16%*	309	*23.43%*		
Richer	389	*19.52%*	243	*18.43%*		
Richest	308	*15.46%*	150	*11.38%*		
Maternal Age					671.6393 (2)	*<.0001*
15-24	829	*41.57%*	75	*5.66%*		
25-34	824	*41.34%*	302	*22.92%*		
35-49	341	*17.09%*	941	*71.43%*		
Maternal education					55.3927 (1)	*<.0001*
No education - Primary	1660	*83.22%*	1261	*95.64%*		
Secondary - Higher	334	*16.79%*	57	*4.35%*		
Antenatal care visits					11.8442 (1)	*0.0006*
< 8 Visit	1973	*99.12%*	1317	*99.92%*		
≥ 8 Visits	17	*0.88%*	1	*0.08%*		
Birth order					3.5874 (3)	*0.3096*
First	527	*26.42%*	371	*28.15%*		
Second	365	*18.30%*	266	*20.22%*		
Third	315	*15.78%*	209	*15.88%*		
Forth or higher	788	*39.51%*	471	*35.76%*		
Birth interval					75.2976 (3)	*<.0001*
<24 months	272	*18.54%*	348	*37.13%*		
24-36 months	513	*34.95%*	322	*34.39%*		
37-48 months	270	*18.40%*	148	*15.81%*		
≥49 months	412	*28.10%*	119	*12.67%*		
Delivery method					2.2373 (1)	*0.1347*
Normal	1862	*93.35%*	147	*89.42%*		
Caesarean section	133	*6.65%*	17	*10.58%*		
Place of delivery					1.6772 (2)	*0.4323*
Home	595	*29.86%*	44	*26.74%*		
Private/Religious/Voluntary/Other: Referral/ Spec. Hospital, District Hospital, General Hospital, Health Center, Dispensary, Clinic	360	*18.03%*	38	*22.90%*		
Government: National/Zonal referral/ Spec. Hospital, Regional Referral Hospital, Regional Hospital District Hospital, Health Center, Dispensary, Clinic	1039	*52.11%*	83	*50.36%*		
Assisted with delivery					0.0173 (1)	*0.8952*
Assistance: Doctor/AMO/Clinical officer/Assist. Clinical Officer/Nurse/Assist. Nurse/Midwife	1287	*64.55%*	107	*65.18%*		
Assistance: Traditional Birth Attendants (TBA)/Relative Friend/No One/ Other	707	*35.45%*	57	*34.82%*		

* Chi-square test, d.f. = degrees of freedom

‡‡ Chi-square test excludes missing data

Table 2. Unadjusted associations of characteristics of infants born in Tanzania during the period of the Tanzania DHS 2015-2016 survey

Characteristic	Crude Odds Ratio	95% C.I.†
Household wealth		
Poorest	1.43	(1.05 -1.94)
Poorer	1.16	(0.89 - 1.53)
Middle (reference)	1	---
Richer	1.37	(1.01 - 1.85)
Richest	1.75	(1.19 - 2.59)
Maternal Age		
15-24 (reference)	1	---
25-34	0.25	(0.17 -0.35)
35-49	0.03	(0.02 - 0.05)
Maternal education		
No education - Primary	0.23	(0.15 - 0.35)
Secondary - Higher (reference)	1	---
Antenatal care visits		
< 8 Visit	0.10	(0.02 - 0.50)
≥ 8 Visits (reference)	1	---
Birth order		
First (reference)	1	---
Second	0.97	(0.77 - 1.20)
Third	1.06	(0.83 - 1.35)
Fourth or higher	1.18	(0.92 - 1.50)
Birth interval		
<24 months (reference)	1	---
24-36 months	2.04	(1.57 - 2.65)
37-48 months	2.33	(1.68 - 3.23)
≥49 months	4.44	(3.02 - 6.52)
Delivery method		
Normal (reference)	1	---
Caesarean section	1.66	(0.85 - 3.26)
Place of delivery		
Home	1.08	(0.68 - 1.69)
Private/Religious/Voluntary/Other: Referal/ Spec. Hospital, District Hospital, General Hospital, Health Center, Dispensary, Clinic	0.76	(0.46 - 1.27)
Government: National/Zonal referral/ Spec. Hospital, Regional Referral Hospital, Regional Hospital District Hospital, Health Center, Dispensary, Clinic (reference)	1	---
Assisted with delivery		
Assistance: Doctor/AMO/Clinical officer/Assist. Clinical Officer/Nurse/Assist. Nurse/Midwife	1	---
Assistance: Traditional Birth Attendants (TBA)/Relative Friend/No One/ Other	1.03	(0.68 - 1.56)

† C.I. Confidence interval

Table 3. Association of household wealth with infant mortality, adjusted for other birth characteristics of mothers who had an baby during the Tanzania DHS 2015-2016 Survey

Adjusted For *	Household wealth	Odds Ratio	95% C.I.†
Unadjusted (crude)	Poorest	1.43	(1.05 -1.94)
	Poorer	1.16	(0.89 - 1.53)
	Middle (reference)	1	---
	Richer	1.37	(1.01 - 1.85)
	Richest	1.75	(1.19 - 2.59)
Maternal Age	Poorest	1.34	(0.94 - 1.92)
	Poorer	0.99	(0.72 - 1.35)
	Middle (reference)	1	---
	Richer	1.20	(0.87 - 1.66)
	Richest	1.26	(0.83 - 1.91)
Maternal education	Poorest	1.52	(1.12 - 2.08)
	Poorer	1.24	(0.94 - 1.62)
	Middle (reference)	1	---
	Richer	1.23	(0.91 - 1.68)
	Richest	1.08	(0.73 - 1.60)
Antenatal care visits	Poorest	1.45	(1.06 - 1.97)
	Poorer	1.18	(0.90 - 1.54)
	Middle (reference)	1	---
	Richer	1.4	(1.01 - 1.85)
	Richest	1.73	(1.17 - 2.56)
Birth order	Poorest	1.42	(1.04 - 1.94)
	Poorer	1.17	(0.89 - 1.54)
	Middle (reference)	1	---
	Richer	1.41	(1.04 - 1.91)
	Richest	1.87	(1.26 - 2.78)
Birth interval	Poorest	1.89	(1.32 - 2.70)
	Poorer	1.33	(0.97 - 1.82)
	Middle (reference)	1	---
	Richer	1.37	(0.93 - 2.03)
	Richest	1.64	(0.97 - 2.79)
Delivery method	Poorest	1.85	(0.96 - 3.56)
	Poorer	1.10	(0.59 - 2.05)
	Middle (reference)	1	---
	Richer	1.33	(0.68 - 2.61)
	Richest	1.20	(0.56 - 2.57)
Place of delivery	Poorest	1.87	(0.97 - 3.62)
	Poorer	1.10	(0.58 - 2.08)
	Middle (reference)	1	---
	Richer	1.33	(0.67 - 2.64)
	Richest	1.13	(0.54 - 2.35)
Assisted with delivery	Poorest	1.91	(0.99 - 3.70)
	Poorer	1.13	(0.60 - 2.13)
	Middle (reference)	1	---
	Richer	1.32	(0.65 - 2.69)
	Richest	1.10	(0.52 - 2.35)

* For categories of adjustment variables, see Table 2

† C.I. Confidence interval

Table 4. Unadjusted and adjusted odds ratios of characteristics of mothers of infants that died during the Tanzania DHS 2015-2016 Survey

		Logistic regression analysis						
		Crude				Adjusted*		
	Characteristic	Odds Ratio	95% C.I.†	p-value‡		Odds Ratio	95% C.I.†	p-value‡
Household wealth				*0.0387*				*0.0124*
WEALTH1	Poorest	1.43	(1.05 -1.94)			1.86	(1.24 - 2.80)	
WEALTH2	Poorer	1.16	(0.89 - 1.53)			*1.11*	(0.79 - 1.56)	
	Middle (reference)	1	---			*1*	---	
WEALTH3	Richer	1.37	(1.01 - 1.85)			*1.23*	*(0.80 - 1.89)*	
WEALTH4	Richest	1.75	(1.19 - 2.59)			*0.82*	*(0.45 - 1.51)*	
CRUDE MODEL: logit $(P(D=1 \mid WEALTH)) = b_0 + b_1*WEALTH1 + b_2*WEALTH2 + b_3*WEALTH3 + b_4*WEALTH4$								
ADJUSTED MODEL: logit $(P(D=1 \mid WEALTH, AGE, EDUC, BINT)) = b_0 + (b_1*WEALTH1 + b_2*WEALTH2 + b_3*WEALTH3 + b_4*WEALTH4) + b_5*AGE1 + b_6*AGE2 + b_7*EDUC + (b_8*BINT1 + b_9*BINT2 + b_{10}*BINT3)$								
Maternal Age				*<.0001*				*<.0001*
	15-24 (reference)	1	---			*1*	---	
AGE1	25-34	0.25	(0.17 -0.35)			*0.21*	*(0.13 - 0.36)*	
AGE2	35-49	0.03	(0.02 - 0.05)			*0.03*	*(0.02 - 0.04)*	
CRUDE MODEL: logit $(P(D=1 \mid AGE1, AGE2)) = b_0 + b_1*AGE1 + b_2*AGE2$								
ADJUSTED MODEL: logit $(P(D=1 \mid WEALTH, AGE, EDUC, BINT)) = b_0 + (b_1*WEALTH1 + b_2*WEALTH2 + b_3*WEALTH3 + b_4*WEALTH4) + b_5*AGE1 + b_6*AGE2 + b_7*EDUC + (b_8*BINT1 + b_9*BINT2 + b_{10}*BINT3)$								
Maternal education				*<.0001*				*0.0006*
EDUC	No education - Primary	0.23	(0.15 - 0.35)			0.34	*(0.18 - 0.62)*	
	Secondary - Higher (reference)	1	---			1	---	
CRUDE MODEL: logit $(P(D=1 \mid EDUC)) = b_0 + b_1*EDUC$								
ADJUSTED MODEL: logit $(P(D=1 \mid WEALTH, AGE, EDUC, BINT)) = b_0 + (b_1*WEALTH1 + b_2*WEALTH2 + b_3*WEALTH3 + b_4*WEALTH4) + b_5*AGE1 + b_6*AGE2 + b_7*EDUC + (b_8*BINT1 + b_9*BINT2 + b_{10}*BINT3)$								
Birth interval				*<.0001*				*<.0001*
	<24 months (reference)	1	---			1	---	
BINT1	24-36 months	2.04	(1.57 - 2.65)			2.20	(1.60 - 3.01)	
BINT2	37-48 months	2.33	(1.68 - 3.23)			3.43	(2.33 - 5.03)	
BINT3	≥49 months	4.44	(3.02 - 6.52)			6.4	(4.25 - 9.64)	
CRUDE MODEL: logit $(P(D=1 \mid BINT)) = b_0 + b_1*BINT1 + b_2*BINT2 + b_3*BINT3$								
ADJUSTED MODEL: logit $(P(D=1 \mid WEALTH, AGE, EDUC, BINT)) = b_0 + (b_1*WEALTH1 + b_2*WEALTH2 + b_3*WEALTH3 + b_4*WEALTH4) + b_5*AGE1 + b_6*AGE2 + b_7*EDUC + (b_8*BINT1 + b_9*BINT2 + b_{10}*BINT3)$								

* Adjusted simultaneously for all other factors

† C.I. Confidence interval

‡ Wald Chi-square Test

Table 5. Adjusted* odds ratios for household wealth and infant mortality with various effect modifiers, among 15-49 year old mothers interviewed during the period of the Tanzania DHS 2015-2016 survey

Interaction with	Poorest		Poorer		Richer		Richest	
	Odds Ratio	95% C.I.†	Odds Ratio	95% C.I.†	Odds Ratio	95% C.I.†	Odds Ratio	95% C.I.†
No Interaction	*1.86*	*(1.24 - 2.80)*	*1.11*	*(0.79 - 1.56)*	*1.23*	*(0.80 - 1.89)*	*0.82*	*(0.45 - 1.51)*
ADJUSTED MODEL: logit (P(D=1 |								
Maternal Age								
15-24 (reference)	*1.18*	(0.33 - 4.19)	0.49	(0.14 - 1.64)	3.47	(0.39 - 30.61)	0.59	(0.01 - 5.80)
25-34	*2.38*	(1.38 - 4.11)	1.28	(0.80 - 2.07)	1.19	(0.64 - 2.21)	0.85	(0.38 - 1.90)
35-49	*1.30*	(0.70 - 2.44)	1.04	(0.58 - 1.86)	1.21	(0.62 - 2.38)	0.77	(0.31 - 1.92)
ADJUSTED MODEL: logit (P(D=1 | WEALTH, AGE, EDUC,BINT)) = b0 + (b_1*WEALTH1 + b_2*WEALTH2 + b_3*WEALTH3 + b_4*WEALTH4) + b_5*AGE1+ b_6*AGE2 + b_7*EDUC + (b_8*BINT1 + b_9*BINT2 + b_{10}*BINT3) +(b_{11}*WEALTH*AGE)								
Maternal education								
No education - Primary	*10.01*	(1.04 - 96.26)	2.97	0.45 - 19.52)	0.50	(0.15 - 1.75)	0.62	(0.17 - 2.29)
Secondary - Higher (reference)	*1.87*	(1.24 - 2.82)	*1.11*	(0.79 - 1.57)	1.28	(0.82 - 1.99)	0.80	(0.42 - 1.53)
ADJUSTED MODEL: logit (P(D=1 | WEALTH, AGE, EDUC,BINT)) = b0 + (b_1*WEALTH1 + b_2*WEALTH2 + b_3*WEALTH3 + b_4*WEALTH4) + b_5*AGE1+ b_6*AGE2 + b_7*EDUC + (b_8*BINT1 + b_9*BINT2 + b_{10}*BINT3) +(b_{11}*WEALTH*EDUC)								
Birth interval								
<24 months (reference)	*0.96*	(0.50 - 1.84)	0.76	(0.37 - 1.56)	*1.58*	(0.72 - 3.46)	1.47	(0.59 - 3.68)
24-36 months	*3.94*	(2.15 - 7.21)	1.59	(0.87 - 2.92)	0.93	(0.48 - 1.77)	1.66	(0.66 - 4.17)
37-48 months	*1.50*	(0.61 - 3.66)	1.16	(0.51 - 2.66)	1.18	(0.52 - 2.71)	0.45	(0.20 - 1.01)
≥49 months	*1.51*	(0.57 - 4.01)	0.93	(0.44 - 1.98)	1.40	(0.60 - 3.28)	0.43	(0.15 - 1.23)
ADJUSTED MODEL: logit (P(D=1 | WEALTH, AGE, EDUC,BINT)) = b0 + (b_1*WEALTH1 + b_2*WEALTH2 + b_3*WEALTH3 + b_4*WEALTH4) + b_5*AGE1+ b_6*AGE2 + b_7*EDUC + (b_8*BINT1 + b_9*BINT2 + b_{10}*BINT3) +(b_{11}*WEALTH*BINT)								

* Models include maternal age, maternal education, birth interval, and wealth

† C.I. Confidence interval