Secondary Education and its Effects on Child Health: Empirical Evidence from Sub-Saharan Africa.

Mwoya Byaro[†] and Daniel Mpeta[§]

Abstract
Sub-Saharan Africa (SSA) experience higher under-five mortality compared to other regions. This study examines the effect of lagged parent's secondary education on child health outcome in sub-Saharan Africa countries. It applies the System GMM (Generalized Method of Moments) estimator for 17 years period from 2000 to 2016 using a panel data of 33 selected countries. The findings show strong evidence that lagged parent's secondary education; income (GDP per capita) and measles immunization have significant effects on improvements of child health in sub-Saharan Africa. Increasing an access to secondary education in the region has achieved better child health status over the period 2000-2016. Lagged parent's education skills acquired in leaving secondary school are the most important channels that affect child health. The findings suggest expanding and strengthening secondary education in sub-Saharan Africa to meet a Sustainable Development Goal target (SDG) in reducing under-five mortality by the year 2030.

Keywords: Education, child health, sub-Saharan Africa
JEL Classification Codes: I20, I12

[†] Corresponding Author, IRDP, P.O BOX 11957, Mwanza, Tanzania, Email: mwoyabyaro2018@gmail.com
[§] IRDP, P.O BOX 11957, Mwanza, Tanzania

1. Introduction

Education is one of the strongest determinants of health and human capital (Commission for Social determinants for Health, 2008). It is strongly related to health, wellbeing and other socioeconomic, cultural and political factors (Montez and Friedman, 2015). Evidence has shown that the association between education and health are strengthening over time in high income countries, and the more educated live longer lives with less ill-health in both rich and poor countries (Viner et al., 2017). Education and health has some causal effects, and it improves health through different mechanisms for example; knowledge acquisition and literacy, promotion of more healthy behaviors, avoidance of early marriage and health risks such as smoking and drug abuse (Juke et al., 2008; Baker et al., 2011; Behrman, 2015). It is believed that, the mechanisms by which education influences health operate strongly during secondary schooling than primary schooling (i.e. Viner et al., 2017). In secondary education there is dynamic brain development, cognitive and social interaction (Patton et al., 2016). For instance, in a natural experiment in Zimbabwe, secondary schooling led to delayed sexual debut, delayed fertility and reduced child mortality (Grepin and Bharadwaj, 2015). Overall, it is also believed that parents who had at least primary education have a higher rate of under-five mortality than parents who had at least secondary education (Adebowale et al., 2020).

This study focuses on sub-Sahara African (SSA) countries because the region still lags behind from education compared to other regions of the world (See, Deaton and Tortora, 2015; Appleton et al., 1996). Education is also given priority to the sustainable development goal 4 (SDG4), of which sub-Sahara African countries commit to lead the implementation of its agenda in 2030. sub-Saharan Africa has made considerable improvement in secondary school enrollment rate of 11% in 1970 to 32% and 22% for lower and upper secondary, respectively in 2018 (UNICEF Data, 2019). On the other hand, under-five and infant mortality rate in sub-Saharan Africa are highest compared to other regions in the world (Adebowale *et al*., 2020; Hug *et al*., 2017). Therefore, the higher infant and under-five mortality rate in sub-Saharan Africa remains a threat to national development across countries in the region and underscore the need to come up with measures to reduce the trend (Adebowale et al., 2020). The Sustainable Development Goals (SDGs) emphasize the urgent need to reduce under-five mortality to at least as low as 25 per 1000 live births by the year 2030 (UNICEF Data, 2019). Thus, it is doubtful if this target would be met by some countries in sub-Saharan Africa with the current sustained trend in under-five mortality rate of 76 per 1000 live births (UN-IGME-Child-Mortality, 2018). It is unclear whether expanding access to secondary education in SSA has contributed to the gains of child health in the regions. Further, the associations between health and education may change with the level of economic development in developing countries (see, Snopkowski *et al*., 2016). In SSA, most infant and under-five mortality is caused by malnutrition, malaria, anaemia, pneumonia, diarrhea, HIV/AIDS, sepsis, tetanus, measles and meningitis (Sanyang, 2019; Lugangira and Kalokola, 2017). In regard to child mortality, parent's education could have an impact on understanding the transmission of some infectious diseases.

Against this background, the study examines the effect of secondary education attainment (i.e. parent knowledge acquired in secondary) on child health in a sample of 33 selected sub-Saharan Africa countries using a panel system generalized method of moment's (GMM) estimator over the year 2000-2016. Nevertheless, the major weakness of the evidence to date is that, much of the assessment of the effects of education on child health outcomes are measured in terms of maternal education and using demographic health surveys (e.g. Gunes, 2015; Bado and Susuman, 2016; Abuya *et al*., 2012; Desai and Alva, 1998). Likewise, very few studies are focused on the potential impact that secondary educational attainment has on child health outcomes at the macro level (See, Viner et al., 2017). In fact, the relationship between health and education may operate at the micro, meso and

macro levels (Suhrche and de Paz Nieves, 2011). Furthermore, the existing empirical evidence on the effect of secondary education on child health outcomes in sub-Saharan Africa countries relies on single countries (e.g., Anyamele *et al*., 2017; Byaro and Musonda, 2016; Abuya *et al*., 2012). Given this overview, our study contributes to the body of literatures on the number of ways. First, we implement the dynamic panel data (GMM) which control endogeneity in the model. Secondly, we consider macro level data that involves the gross enrollment ratio of both male and female (i.e. parent's knowledge acquisition in secondary) as a proxy for secondary education in examining its effect on under-five mortality in sub-Saharan Africa.

The remainder of this study is organized as follows. Section 2 reviews the literature on the linkage between education and child health. Section 3 present the methodology, while section 4 reports empirical results. Section 5 discusses the results and, finally section 6 concludes.

2. Literature Review: Linkage between education and child health

Education operates as a proxy for the socioeconomic status of the family and geographic area of the residence (Desai and Alva, 1998). A society having at least a good secondary education can generate income; equip with knowledge and skills necessary for the workforce, stimulating economic growth, transforming health, self-reliance and linked to lowering under-five mortality in many countries (Adebowale et al., 2020; Bado and Susuman, 2016; Bain et al., 2013; Frost et al., 2005). This implies that, expanding access to secondary schools may be greatly accelerating the declines in child mortality in the developing countries.

Conversely, increases in education levels may lead to better economic opportunities (Grepin and Bharadwaj, 2015). It is also argued that socioeconomic factors and the modern attitudes about health care are the most important pathways linking maternal education and child nutritional status (Dasgupta et al., 2021; Frost et al., 2005; Imdad et al., 2011). In contrast, parental low socioeconomic status in childhood seems to be related to poorer future adult health (Smith et al., 1998). For instance, Grossman (2000) described child's current health depends on health inputs like medical care, food, housing as well as previous health levels. These health inputs explain the way parental socioeconomic status affect child health. It is also known that, budget constraints are critical in poorer families, preventing them from buying more or better material health inputs such as better quality medical care and food. When cigarette, alcohol, and more prenatal care are controlled for highly educated mothers, maternal schooling has little additional association with child health, suggesting that parental education may affect child health largely through the use of health inputs (Curie and Goodman, 2020).

Case *et al* (2005) found that children's health was significantly affected by the socioeconomic status of their family. Further, Currie et al (2004) concluded that around 60% of the variation in children health was explained by unobserved family characteristics (i.e. lack of investment in health or education). It is also believed that, children of lower socioeconomic status families are likely to have lower health status at birth (Curie and Goodman, 2020). However, this does not imply that low socioeconomic status (i.e. income, education) causes poor child health. It means there might be a third factor; for example, poor parental health that cause both poverty and poor child health (Curie and Goodman, 2020). In turn, proximate determinants of poor child health outcomes are infectious diseases and under-nutrition, which are linked to socioeconomic status.

Low educational attainment in parents is linked with child risk factors that family members share or due to effects of maternal or paternal education on the offspring (Torvik *et al*., 2020). These imply the roles that both maternal and paternal education may play equally in improving child health

(Breierova and Duflo, 2004). Moreover, the pattern of under-five mortality has been observed in children of parents where husbands were more educated than their partners (Adebowale et al., 2020). Furthermore, both paternal and maternal education appears to have had no impact on child mortality, though father's education reduces the likelihood of child stunting (Ali and Elsayed, 2018). These imply that, the low level of parental education has little effect on literacy and the use of antenatal care that may improve child health.

On the other hand, better health status in childhood is correlated with educational outcomes. Yet, a casual relationship between maternal education and child health is far from established (Desai and Alva, 1998; Glewwe, 1999). In turn, Grepin and Bharadwaj (2015) found little causal evidence of the impact of maternal education on child health outcomes in settings with high fertility and high child mortality. This is also supported by Glewwe (1999) who found no evidence that health knowledge is directly taught in schools and the mother's health knowledge acquired outside the classroom appears to be an important skill for raising child health. Formal education obtained by mothers in classrooms transmits health knowledge to future mothers. Furthermore, literacy and numeracy skills acquired in school enhance their ability to recognize illness and seek treatment for their children (Glewwe, 1999).

In light of the above fact, the links between secondary education and child health have not been tested with macro-level data for a wide range of countries and existing literature are mixed. This paper helps to fill the void that currently exists in the literature. It uses a system Generalized Methods of Moments (GMM) estimator to explain the dynamic nature of education and health (See, Grossman, 2015), solving endogeneity of schooling/education and health variables (i.e. omitted variables and reverse causality) by adopting the lags of instrumented variables. Further, the paper uses secondary school enrollment ratio as a proxy for lagged parent's education and under-five mortality as a proxy for child health outcome in sub-Saharan Africa.

3. Methodology: Data, Variable Selection and Estimation Method

Sub-Saharan Africa is a sub-region in Africa that comprises of 46 countries out of 54 countries. The study used pooled cross section and annual time series data from 2000 to 2016 for 33 selected countries in sub-Saharan Africa. These countries are selected due to their availability of data. The data used in the empirical analysis was extracted from the World Bank Development Indicators (2018) database. We used under-five mortality as an indicator of child health. Under-five mortality is measured as the death of a child younger than 5 years old per 1000 live births. The indicator is widely used to measure child development.

Gross secondary school enrollment ratio is used as a proxy for lagged parent education attainment for both female and male (i.e. when leaving in secondary schools). The minimum secondary school students leaving ages in sub-Saharan Africa are at 15 and 16. This means, the existing parents (mothers and fathers) leaves secondary school at ages 15 and 16. Total health expenditures (public and private), measles immunization coverage (% of children 12-23 months), income (real GDP per capita) and Vitamin A supplements coverage (% of children 6-59 months) was controlled for in the regression model. Real GDP per capita is measured in terms of percentage GDP and used for the demand for health services and other economic factors. Overall, the predictor variables included total health expenditures, secondary school enrollment ratio for sexes, measles immunization coverage, Vitamin A supplement, and income (Real GDP per capita). The outcome variable was under-five mortality as a measure of child health.

3.1 Model and Estimation Method

The system Generalized Methods of Moments (GMM) is an extension of instrumental variable estimation to control endogenous variables like education and health. It was developed by Arellano and Bover (1995), Blundell and Bover (1998) using two equations both in level and difference forms. In this paper, the system GMM applies a number of instruments to combine the regression in levels and first differences to overcome the common causes of endogeneity (i.e. omitted variable bias, measurement error and simultaneity or reverse causality) on estimating the effect of secondary education on child health status in sub-Saharan Africa (SSA).

The endogeneity of variables in equation (1) (i.e. education, GDP and health expenditures) occurs when the causality run in both directions to the dependent variable (under-five mortality) and vice versa. It means education, GDP and health expenditures may be correlated with the error term($\varepsilon_{i,t}$). This is known as simultaneous bias or reverse causality. It can be eliminated by using the fixed effects instrumental variables or two-stages least squares estimator (Woodridge, 2005). However, both fixed effects and two-stages least squares estimators rely on the external instruments identified by the user which may be weak and biased.

To predict the effects of secondary education on child health outcomes (i.e. under-five mortality), we controlled for total health expenditures (public and private), measles immunization coverage, Vitamin A supplements and income (GDP per capita). The estimating equation in level form is specified as follows: -

$$health_{i,t} = \alpha_0 + x_1 health_{i,t-1} + x_2 educ_{i,t} + x_3 GDP_{i,t} + x_4 Thex_{i,t} + x_5 Vaccine_{i,t} + x_6 VitA_{i,t} + \gamma_t + \mu_i + \varepsilon_{i,t} \quad (1)$$

Where:

health_{it}	=	Under-five mortality
Educ	=	Secondary school gross enrolment ratio for sexes as a proxy for education
GDP	=	Gross domestic product or Income per capita
Thex	=	Total health expenditure (public and private)
Vaccine	=	Measles vaccination coverage
VitA	=	Vitamin A supplements
x	=	Estimated coefficients
α_0	=	intercept
$\varepsilon_{i,t}$	=	Error term
γ_t	=	Time specific effects
i	=	1.....N (Countries),
t	=	$t = 1$.....T (time)
μ_i	=	Country specific fixed effects constant in time

In equation (1), the country specific effects (μ_i) reflect time invariant characteristics of each country that may correlate with explanatory variables. This is called unobserved heterogeneity bias. The unobserved heterogeneity and its omitted variable bias can be eliminated through first differencing expressed as follows**: -**

$$\Delta health_{i,t} = \Delta\alpha_0 + x_1 \Delta health_{i,t-1} + x_2 \Delta educ_{i,t} + x_3 \Delta GDP_{i,t} + x_4 \Delta Thex_{i,t} + x_5 \Delta Vaccine_{i,t} + x_6 \Delta VitA_{i,t} + \Delta\mu_i + \Delta\gamma_t + \Delta\varepsilon_{i,t} \quad (2)$$

Since μ_i is controlled and constant in time, then $\Delta\alpha_0 = \Delta\mu_i = 0$

According to Arellano and Bond (1991), first-differences remove the unobserved heterogeneity and its omitted variable bias through Generalized Methods of Moments (GMM in difference) estimator. In this estimator, the endogenous explanatory variables in differences ($\Delta health_{i,t-1}$), are instrumented by their lagged value. Then, Equation 2 is re-written as follows: -

$$\Delta health_{i,t} = x_1 \Delta health_{i,t-1} + x_2 \Delta educ_{i,t} + x_3 \Delta GDP_{i,t} + x_4 \Delta Thex_{i,t} + x_5 \Delta Vaccine_{i,t} + x_6 \Delta VitA_{i,t} \quad (3)$$

Blundell and Bond (1998) combined the instruments in differences (i.e. equation 3) and the instruments in level (i.e. equation 1) as follows: -

$$\left.\begin{aligned} health_{i,t} &= \alpha_0 + x_1 health_{i,t-1} + x_2 educ_{i,t} + x_3 GDP_{i,t} + x_4 Thex_{i,t} + x_5 Vaccine_{i,t} + x_6 VitA_{i,t} + \mu_i + \gamma_t + \varepsilon_{i,t} \\ \Delta health_{i,t} &= x_1 \Delta health_{i,t-1} + x_2 \Delta educ_{i,t} + x_3 \Delta GDP_{i,t} + x_4 \Delta Thex_{i,t} + x_5 \Delta Vaccine_{i,t} + x_6 \Delta VitA_{i,t} + \Delta\varepsilon_{i,t} \end{aligned}\right\} \quad (4)$$

In equation (4), the variables in differences are instrumented through their values in level, and variables in level are instrumented through their values in differences by using number of lags (Blundell and Bond, 1998). The validity of the instruments used in the two-step system GMM estimator are checked through Hansen- Tests when the p-value is higher than 10% and absence of second-order serial correlation of the error term (AR2). In general, the two step GMM estimator eliminates unobservable heterogeneity and omitted variable bias through differencing. Before data analysis, all variables were transformed into natural logarithm to help interpretation in terms of elasticity.

4. Empirical Results

Descriptive statistics in Table 1 show the average secondary school gross enrollment ratio to be approximately 38 %. This implies that almost 62% of the secondary school-age was not enrolled in secondary school. Total health care expenditure as percentage of GDP in sub-Saharan Africa was estimated at 5.78%. The average rate of under-five mortality has been estimated to be 105 deaths per 1000 live births respectively. The GDP per capita in the regions were estimated at US dollars 2035. The mean for measles immunization and vitamin A supplements coverage for children were 72.7% and 70% respectively.

Table 1: Summary of Descriptive Statistics

Variables	Mean	Std deviation	Minimum	Maximum
Secondary school gross enrollment ratio, sexes (%)	37.76	19.71	6.11	102.75
Under-five mortality rate (per 1000 live births)	105.05	39.10	38.5	233.10
Total health expenditure per GDP (%)	5.78	2.43	0.84	19.73
Measles Vaccination (% of children, 6-59 months)	72.71	16.54	21	99
Vitamin A supplement (% of children, 12-23months)	70.35	0.75	1	99
GDP per capita (at constant US $ 2010)	2035.45	3217.96	194.87	20512.94

Source: Authors estimation (2021).

Grossman (2006, 2015) pointed out that, the causal relationship between education and child health is affected by the problem of endogeneity (i.e. third omitted variables) such as genetics and family endowments. In this paper, all other kinds of endogeneity between secondary education and child health are addressed by using the system GMM estimator.

The results from the system GMM estimator (Table 2) show that a 1 percentage increases in secondary education level leads to reduction of under-five mortality by 5%. This implies that an expansion and access to secondary schools education improves child health ($\rho < 0.05$). A 1 percentage increase in the real GDP per capita reduces under-five mortality by 1% ($\rho < 0.1$). This implies that income is significantly in improving child health in the region. Similarly, a 1 percentage increase in measles vaccination coverage in children age (6-59months) decreases under-five mortality by 8% ($\rho < 0.05$). This implies that measles vaccination coverage reduces preventable deaths among children in sub-Saharan Africa. The results also revealed that vitamin A supplements among children (6-59 months) and total health expenditures contribute to reduction of under-five mortality in sub-Saharan Africa. Furthermore, both Hansen Test and serial correlation Test (AR2) are used to ensure the validity of the estimates. For instance, the Hansen-test value ($\rho > 0.10$) shows that the instruments used in the two-step system GMM estimators are valid. Meanwhile, the result indicates absence of second-order serial correlation test (AR (2), since the ρ value > 0.10). Moreover, the *collapse* option suggested by Roodman (2009) and emphasized by Byaro (2021) was applied to ensure that the number of instruments is smaller than the number of groups.

Table 2: System-GMM estimates for Under-Five Mortality

Variables	Coefficient	P -value
Under-five mortality (-1)	1.01 (0.021)	0.000***
Measles vaccination	- 0.08 (0.033)	0.02**
Secondary education	- 0.05 (0.021)	0.01**
GDP per capita	- 0.01(0.009)	0.09*
Vitamin A supplement	- 0.01(0.005)	0.96
Total health expenditure	- 0.02 (0.016)	0.37
Constant	- 0.09 (0.21)	0.64
Number of observation (N)	217	
Number of instruments	17	
Number of Groups	29	
Hansen Test ρ value	0.17	
AR(2) ρ value	0.75	

Source: Authors estimation (2021)

Note: *** $\rho < 0.01$, ** $\rho < 0.05$, * $\rho < 0.10$; Robust standard errors in paranthesis; dependent variables = under-five mortality rate (per 1000 live births). All variables are expressed in natural logarithm

5. Discussion

The objective of this study was to assess the impact of secondary education on child health outcome (under-five mortality) in a sample of 33 sub-Saharan African countries (SSA). The findings from this study show that secondary school education has a significant and negative impact on under-five mortality in SSA. Lagged parents secondary education (i.e. skills acquired leaving in secondary school) is the most important channels that may affect child health. A few studies that explored the pathways for the effects of parental education on child health include (Le and Nguyen, 2020; Aslam and Kingdon, 2012; Breierova and Duflo, 2004).

Aslam and Kingdon (2012) found that maternal schooling improves child health in Pakistan. They pointed out the mechanisms that parental education can impact on child health. These include higher household income, exposure to media, literacy, health knowledge, maternal empowerment at home

and labor market participation. Further, they found that fathers and mothers education are positively associated with the immunization decision and longer term child health outcomes respectively. Similarly, Le and Nguyen (2020) highlighted the mechanisms that influence parental education to child health. They found that fertility behaviour (i.e. Age at birth), husband education, mothers health care utilization (i.e. pre-natal visits, delivery at health facility), access to information (i.e. watches television, reads newspapers), health knowledge (i.e. contraceptive use) and labor market outcome (i.e. earnings). Likewise, Viner *et al.* (2017) suggested that each additional year of secondary education has been attributed to mortality reduction in low income countries. In turn, Chewe and Hangoma (2020) showed that an increase in educational attainment in sub-Saharan Africa is associated with reductions in child health outcomes. Breierova and Duflo (2004) found that an increase in the average number of years of education in the household reduces child mortality. The result implied that having a secondary education can increase the uptake of preventative care and take advantage of the child's health care provision. This is also true that people with secondary education have the potential to change health beliefs and behaviors if are well designed and delivered appropriate about their health, child health and illness. Therefore, an increase of education levels may provide an access to skilled work with higher earnings which are essential for improving child health such as affordable medical care, access to clean water, nutritious food and better housing (See, Case et al., 2012).

Target 4.1 of the SDGs (Sustainable Development Goals) requires all young people to complete secondary education by 2030. If this target will be achieved in sub-Saharan Africa, investment in secondary education will bring major child health benefits. Meeting the SDG target of universal secondary education will be a key mechanism for achieving the health targets in SDG3. Education does not work on health in separation from other factors. Income is an additional factor that relate with education as influences on health. The findings showed that per capita income (GDP) significantly improves child health outcome in sub-Saharan Africa. This means, income influences health in a positive way and an important determinant of child survival (Byaro et al, 2017; O'Hare et al., 2013; Nishiyama, 2011; Filmer & Pritchett, 1999). Higher income on a macro level links with an increase of overall standard of living through access of nutrition, access of health care and improved housing which improves child health. Further, the findings show that measles vaccination among children aged (6-59 months) contributed to the reduction in under-five mortality in SSA. The study also found an evidence of total health care expenditures and vitamin A supplements to reduce under-five mortality in SSA despite of their insignificant effect. Moreover, health expenditure findings are consistent with (Ankilo et al., 2019; Arawomo et al., 2018; Kato et al., 2018; Arthur and Oaikhenan, 2017; Anyanwu and Erhijakpor, 2009) who argued that increasing in health care expenditure improve child health outcomes.

Generally, expanding and accessing of secondary school education in urban and rural areas will be critical towards improving child health outcomes and accelerating progress towards health-related Sustainable Development Goals (SDGs) in sub-Saharan Africa. The findings from this study support previous study undertaken at the micro level (Arcaya and Saiz, 2020; Viner *et al*., 2017; Grepin and Bharadwaj, 2015; Glewwe, 1999) that showed education attainment matters for health outcomes. This suggests that secondary school enrollment rates as a proxy for lagged parental education has a significant impact on reducing under-five mortality in SSA.

6. Conclusion

This study examines the effect of lagged parent's secondary education on child health outcomes in selected 33 sub-Saharan Africa countries from 2000 to 2016. A two-step Generalized Methods of Moments (GMM) estimator was used to overcome the problems of endogeneity (i.e. reverse

causality, third omitted variables) between lagged parents secondary education and child health. The findings from the study showed that secondary education attainment is significant in reducing under-five mortality in sub-Saharan Africa. It further reveals that, measles immunization and income per capita had significant effects in reducing under-five mortality in the region. The findings suggest expanding and strengthening an access to secondary education by adding more classrooms in both rural and urban areas to increase gross enrollment ratio to meet the Sustainable Development Goals (SDGs) of reducing under-five mortality in sub-Saharan Africa. African government should abolish fees in public secondary schools to increase current enrollment rates of future parents (mothers and fathers). Further, it should establish effective partnerships (private and public) to coordinate and deliver secondary education programs in the region. Thus, financing secondary education strategies are critical in the regional development agenda and in ensuring the success of SDGs 4 (ensure inclusive and equitable quality education and promote lifelong learning opportunities for all) that in turn influence SDGs 3 (ensure healthy lives and promote well being for all at all ages).

References

Abuya, B. A., Onsomu, E. O., Kimani, J. K., & Moore, D. (2011). Influence of maternal education on child immunization and stunting in Kenya. *Maternal and child health journal*, *15*(8), 1389-1399.

Adebowale, A. S., Fagbamigbe, A. F., Morakinyo, O., Obembe, T., Afolabi, R. F., & Palamuleni, M. E. (2020). Parental educational homogamy and under-five mortality in sub-Saharan Africa: Clarifying the association's intricacy. *Scientific African*, *7*, e00255.

Ali, F. R. M., & Elsayed, M. A. (2018). The effect of parental education on child health: Quasi-experimental evidence from a reduction in the length of primary schooling in Egypt. *Health economics*, *27*(4), 649-662.

Anyamele, O. D., Ukawuilulu, J. O., & Akanegbu, B. N. (2017). The role of wealth and mother's education in infant and child mortality in 26 sub-Saharan African countries: Evidence from pooled Demographic and Health Survey (DHS) data 2003–2011 and African Development Indicators (ADI), 2012. *Social Indicators Research*, *130*(3), 1125-1146.

Anyanwu, J. C., & Erhijakpor, A. E. (2009). Health expenditures and health outcomes in Africa. *African Development Review*, *21*(2), 400-433.

Appleton, S., Hoddinott, J., & Mackinnon, J. (1996). Education and health in Sub-Saharan Africa. *Journal of International Development*, *8*(3), 307-339

Arawomo, O., Oyebamiji, Y. D., & Adegboye, A. A. (2018). Dynamics of economic growth, energy consumption and health outcomes in selected sub-Sahara African countries. *African Journal of Economic Review*, *6*(2), 92-114.

Arcaya, M. C., & Saiz, A. (2020). Does Education Really Not Matter for Health?. *Social Science & Medicine*, 113094.

Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The review of economic studies*, *58*(2), 277-297.

Arthur, E., & Oaikhenan, H. E. (2017). The effects of health expenditure on health outcomes in Sub-Saharan Africa (SSA). *African Development Review*, *29*(3), 524-536.

Aslam, M., & Kingdon, G. G. (2012). Parental education and child health—understanding the pathways of impact in Pakistan. *World Development*, *40*(10), 2014-2032.

Bado, A. R., & Susuman, A. S. (2016). Women's education and health inequalities in under-five mortality in selected sub-Saharan African countries, 1990–2015. *PloS one*, *11*(7).

Bain, L. E., Awah, P. K., Geraldine, N., Kindong, N. P., Siga, Y., Bernard, N., & Tanjeko, A. T. (2013). Malnutrition in Sub–Saharan Africa: burden, causes and prospects. *Pan African Medical Journal*, *15*(1).

Baker, D. P., Leon, J., Smith Greenaway, E. G., Collins, J., & Movit, M. (2011). The education effect on population health: a reassessment. *Population and development review*, *37*(2), 307-332.

Behrman, J. A. (2015). The effect of increased primary schooling on adult women's HIV status in Malawi and Uganda: Universal Primary Education as a natural experiment. *Social science & medicine*, 127, 108-115.

Breierova, L., & Duflo, E. (2004). *The impact of education on fertility and child mortality: Do fathers really matter less than mothers?* (No. w10513). National bureau of economic research.

Byaro, M. (2021). Commentary on "Drivers of health in sub-Saharan Africa". A dynamic Panel Analysis. *Health Policy OPEN*, 100034.

Byaro, M., & Musonda, P. (2016). Determinants of Infant and under five mortality Differentials in Tanzanian Zones: Evidence from Panel Data Analysis. *Journal of Economics and Sustainable Developments*, *7*(18), 113-123.

Byaro, M., & Musonda, P. (2017). Per capita income and public health expenditure: what makes good child health outcomes in Tanzania? a comparison of Frequentist and Bayesian approach (1995-2013). *International Journal of Health*, *5*(1), 74-81.

Cameron, A. C., & Trivedi, P. K. (2005). *Microeconometrics: methods and applications*. Cambridge university press.

Case, A., Fertig, A., & Paxson, C. (2005). The lasting impact of childhood health and circumstance. *Journal of health economics*, *24*(2), 365-389.

Case, A., Lubotsky, D., & Paxson, C. (2002). Economic status and health in childhood: The origins of the gradient. *American Economic Review*, *92*(5), 1308-1334.

Chewe, M., & Hangoma, P. (2020). Drivers of Health in sub-Saharan Africa: A Dynamic Panel Analysis. *Health Policy OPEN*, *1*, 100013.

Commission on Social Determinants of Health. (2008). Closing the gap in a generation: health equity through action on the social determinants of health: final report of the commission on social determinants of health.

Currie, A., Shields, M. A., & Price, S. W. (2004). Is the child health/family income gradient universal? Evidence from England.

Currie, J., & Goodman, J. (2020). Parental socioeconomic status, child health, and human capital. In *The Economics of Education* (pp. 239-248). Academic Press.

Dasgupta, S., Mustafa, G., Paul, T., & Wheeler, D. (2021). The socioeconomics of fish consumption and child health: An observational cohort study from Bangladesh. *World Development*, *137*, 105201.

De Neve, J. W., & Subramanian, S. V. (2018). Causal Effect of Parental Schooling on Early Childhood Undernutrition: Quasi-Experimental Evidence From Zimbabwe. *American journal of epidemiology*, *187*(1), 82-93.

Deaton, A. S., & Tortora, R. (2015). People in sub-Saharan Africa rate their health and health care among the lowest in the world. *Health Affairs*, *34*(3), 519-527.

Desai, S., & Alva, S. (1998). Maternal education and child health: Is there a strong causal relationship? *Demography*, *35*(1), 71-81.

Filmer, D., & Pritchett, L. (1999). The Impact of Public Spending on Health: Does Money Matter? *Social Science and Medicine , 49* (10), 1309-1323

Frost, M. B., Forste, R., & Haas, D. W. (2005). Maternal education and child nutritional status in Bolivia: finding the links. *Social science & Medicine*, *60*(2), 395-407.

Glewwe, P. (1999). Why does mother's schooling raise child health in developing countries? Evidence from Morocco. *Journal of human resources*, 124-159.

Grépin, K. A., & Bharadwaj, P. (2015). Maternal education and child mortality in Zimbabwe. *Journal of health economics*, *44*, 97-117.

Grossman, M. (2000). The human capital model. In *Handbook of health economics* (Vol. 1, pp. 347-408).

Grossman, M. (2006). Education and non-market outcomes. Handbook of the Economics of Education, 1 (577-633).

Grossman, M. (2015). The relationship between health and schooling. What's New? (No.W21609).National Bureau of Economic Research

Güneş, P. M. (2015). The role of maternal education in child health: Evidence from a compulsory schooling law. *Economics of Education Review*, *47*, 1-16.

Imdad, A., Yakoob, M. Y., & Bhutta, Z. A. (2011). Impact of maternal education about complementary feeding and provision of complementary foods on child growth in developing countries. *BMC public health*, *11*(3), S25.

Jukes, M., Simmons, S., & Bundy, D. (2008). Education and vulnerability: the role of schools in protecting young women and girls from HIV in southern Africa. *Aids*, *22*, S41-S56.

Kato, K., Mugarura, A., Kaberuka, W., Matovu, F., & Yawe, B. L. (2018). The effect of public health spending on under-five mortality rate in Uganda. *African Journal of Economic Review, 6*(1), 47-71.

Le, K., & Nguyen, M. (2020). Shedding light on maternal education and child health in developing countries. *World Development*, *133*, 105005.

Lugangira, K., & Kalokola, F. (2017). Morbidity and mortality of children aged 2–59 months admitted in the Tanzania Lake Zone's public hospitals: a cross-sectional study. *BMC research notes*, *10*(1), 502.

Montez, J. K., & Friedman, E. M. (2015). Educational attainment and adult health: under what conditions is the association causal?

Nishiyama, A. (2011). Economic Growth and Infant Mortality in Developing Countries. *European Journal of Development Research , 23(4)*, 630-647

O' Hare. B., Makuta, I., Chiwaula, L., & Zeev, N. B. (2013). Income and Child Mortality in Developing Countries: A Systematic Review and Meta Analysis. *Journal of the Royal Society of Medicine , 106* (10), 408-414.

Patton, G. C., Sawyer, S. M., Santelli, J. S., Ross, D. A., Afifi, R., Allen, N. B., ... & Kakuma, R. (2016). Our future: a Lancet commission on adolescent health and wellbeing. *The Lancet*, *387*(10036), 2423-2478.

Roodman, D. (2009). A note on the theme of too many instruments. *Oxford Bulletin of Economics and statistics*, *71*(1), 135-158.

Sanyang, Y. (2019). Prevalence of Under-Five Years of Age Mortality by Infectious Diseases in West African Region. *International Journal of Africa Nursing Sciences*, 100175.

Smith, G. D., Hart, C., Blane, D., & Hole, D. (1998). Adverse socioeconomic conditions in childhood and cause specific adult mortality: prospective observational study. *Bmj*, *316*(7145), 1631-1635.

Snopkowski, K., Towner, M. C., Shenk, M. K., & Colleran, H. (2016). Pathways from education to fertility decline: a multi-site comparative study. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *371*(1692), 20150156.

Suhrcke, M., & de Paz Nieves, C. (2011). The impact of health and health behaviours on educational outcomes in high-income countries: a review of the evidence.

Torvik, F. A., Eilertsen, E. M., McAdams, T. A., Gustavson, K., Zachrisson, H. D., Brandlistuen, R., ... & Ystrom, E. (2020). Mechanisms linking parental educational attainment with child ADHD, depression, and academic problems: a study of extended families in The Norwegian Mother, Father and Child Cohort Study. *Journal of Child Psychology and Psychiatry*.

UNICEF Data (2019). https://data.unicef.org/topic/child-survival/child-survival-sdgs/

UN-IGME-Child-Mortality (2018). https://www.unicef.org/media/47626/file/UN-IGME-Child-Mortality-Report-2018.pdf.

United Nations Children Fund (2019).Net enrollment for lower secondary school in Sub-Saharan Africa: Regional aggregates based on population coverage.

Viner, R. M., Hargreaves, D. S., Ward, J., Bonell, C., Mokdad, A. H., & Patton, G. (2017). The health benefits of secondary education in adolescents and young adults: an international analysis in 186 low-, middle-and high-income countries from 1990 to 2013. *SSM-population health*, *3*, 162-171.

Wooldridge, J.M. (2005). Instrumental variables estimation with panel data. *Econometric Theory*, 21(4), 865-869

World Bank Development Indicators (2018). *http://data.worldbank.org*

Appendices: List of countries included in the analysis

Angola,Botswana,Benin,Burkina Faso,Burundi,Cameroon, Congo Dem. Rep, Equatorial Guinea, Ethiopia, Gabon, Gambia, Ghana,Guinea,Guinea-Bissau,Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mozambique, Namibia,Niger,Nigeria, Rwanda, Senegal, Sierra Leon,South Africa,Sudan, Tanzania, Uganda, Zambia, Zimbabwe.