SCHOOLING AND IMMUNIZATION OF ORPHANED CHILDREN IN SWAZILAND

By

Yu-Ra Lee

THESIS

Submitted to

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in partial fulfillment of the requirements

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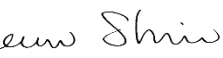
Professor Ja-Eun SHIN, Supervisor 

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Abstract

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Swaziland is a HIV/AIDS prevalent country, with the highest affected rate in the world. As a result, the number of orphans has increased over the years. This paper strives to find factors to eliminate inequality in Swazi orphans in education and health. Children from six to fifteen years of age are selected to examine the effect of household wealth and mother's education level on the enrollment ratio and whether a child is in the officially recommended grade for his/her age in school or not (n=2,970), using logistic regression. Furthermore, children between zero and five years are chosen to see the effect of an immunization card on the number of vaccinations: BCG, polio, and DPT/HepB/Hib (n=1,393) with zero-inflated regression. The data used is from the Swaziland Multiple Indicator Cluster Survey (MICS) in 2010. Although wealth does not significantly affect the education of non-orphans statistically, it becomes more important to orphans along with mother's education level. An immunization card solves the health inequality of orphans in the number of vaccination in Swaziland. These results imply that the country is recommended to enforce policies on education differently by group and to encourage people to use immunization cards to remove the inequality in education and health caused by loss of parents.

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Introduction

This study examines how to eliminate inequality in education of orphaned children between six and fifteen years of age: enrollment ratio and on if they are in the officially recommended grade for their age in school, and in health of them between zero and five years old in Swaziland: full immunization ratio, using the data from the Swaziland Multiple Indicator Cluster Survey (MICS). It is cross-sectional household data and was carried out in 2010 by the Central Statistical Office in cooperation with the United Nations Children's Fund (UNICEF).

As of 2014, 25.8 million people were living with HIV/AIDS in sub-Saharan Africa, which constitutes approximately 70 percent of people with HIV/AIDS in the world (UNICEF, 2015; USAIDS, 2015). Consequently, the level of HIV prevalence is highly associated with increasing number of children who become orphaned after losing their parents to HIV/AIDS. About 13.3 million children under the age of eighteen had lost one or both parents to HIV/AIDS by 2014 (UNICEF, 2015).

While sub-Sharan Africa has suffered from HIV/AIDS, nine countries in particular have the most severe HIV epidemics - Lesotho, Malawi, Mozambique, Botswana, Namibia, Swaziland, South Africa, Zambia, and Zimbabwe. This study focuses on Swaziland because it has the highest HIV/AIDS prevalence rate in the world with 27.73 percent (UNAIDS, 2013; CIA, 2014), which results in a considerable number of orphaned children out of the population.

Orphans are defined as the ones who lost either one or both parents, according to the United Nations Children's Fund (UNICEF), and they are more prone to education and health problems compared to non-orphans in several ways (UNICEF, 2003; UNICEF, UNAIDS & USAID, 2004). Many studies, however, often simply compare orphans to non-orphans or maternal to parental orphans (Ainsworth, 2002; Sharma, 2006; Ainsworth & Filmer, 2002;

Bicego et al., 2003; Case et al., 2002; Lindblade et al., 2003; Reher & González-Quiñones, 2003; Hope, 2005). It may under- or over-estimate the parental effect between groups. Therefore, this study divides children into three groups to identify parental effects more specifically.

In terms of education, schooling plays a pivotal role in children's life opportunities down the road (United Nations, 1994) but is frequently interfered with parental death (Allemano, 2003), and thus orphans are significantly worse off than non-orphans. Most of orphans lag behind in education (Coneus & Mühlenweg, 2014; Sharma, 2006; Ardington & Leibbrandt, 2010). This paper focuses on school enrollment and whether a child is in officially recommended grade for his/her age or not to see the disparity in education outcomes among children.

Moreover, there is no doubt that "immunization is one of the most cost-effective ways to save lives, improve health and ensure long-term prosperity" (Global Alliance for Vaccines and Immunization, 2009). Many studies have researched the determinants of routine immunization coverage, such as family characteristics, parental attitudes and knowledge, and immunization system (Favin, Steinglass, Fields, Banerjee, & Sawhney, 2012; Dwumoh, Essuman, & Afagbedzi, 2014; Tsawe et al., 2015; Fatiregun & Okoro, 2012). Parental death is one of the key factors for children to be less likely vaccinated (Jahn et al., 2008). Thus, this research studies the inequality brought by losing parents in immunization coverage among children under five.

Then how can the government reduce the gap in education and health resulting from the absence of parents and provide all children with the same opportunity to attend school and to be fully vaccinated? It is important to find a key factor to understand the mechanism of how to fill the gaps among children in order to head to the right policy direction. In addition, the fourth goal of the UN Sustainable Development Goals declared in 2015 is to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all", and the third goal is to

"ensure healthy lives and promote well-being for all at all ages" with the detailed target goal of "achiev[ing] universal health coverage (UHC), including financial risk protection, access to quality essential health care services, and access to safe, effective, quality, and affordable essential medicines and vaccines for all" (United Nations, 2015). It is contributable to study the topic of this paper not only at the country level, but also at the global level, addressing the hypotheses below:

1. Both household wealth and mother's education level would function to eliminate the disparity occurring with the absence of parents in enrollment ratio and properly facilitate a child to be in a recommended grade at an appropriate age.
2. Mother's education and wealth would influence education differently by group.
3. An immunization card would play a critical role in reducing the inequality in health of children under five.

This study finds out that there is a group disparity in education among children. Mother's education level is statistically significant in enrollment ratio, but in the case of proper grade, both household wealth and mother's education level influence children to be in an officially recommended grade for their ages. However, between groups, the more vulnerable children tend to be affected by household wealth rather than mother's education level in education. Furthermore, the inequality in immunization among children is eliminated by having an immunization card. Almost the whole children who do not own the immunization card are highly likely not to be vaccinated at all. Also, the number of vaccination a child receives increases as he/she has the immunization card.

The organization of this paper is as follows: Section 2 presents the literature review; Section 3 describes methodology, including the data set description and the econometric specifications; Section 4 provides the results of the tests; Section 5 has a discussion; and finally, the paper concludes with Section 6.

Literature Review

Education

It is no wonder that education is one of the most important instruments in economic growth. Eggoh, Houenivo, and Sossou (2015) prove the strong relation between education and economic growth once again over the period from 1996 to 2010 in 49 African countries. Education, as human capital, is a positive externality on economic growth and favorably influences capital productivity. In addition, Maksymenko and Rabani (2011) find that education has a considerably positive effect on economic growth in both South Korea and India. Gyimah-Brempong (2010) also investigates education's significant and positive impact on development outcomes, and different education levels' effect on the outcomes using panel data between 1960 and 2008. There are plenty research arguing for the importance of education in economic growth in developing countries (Baldwin & Borrelli, 2008; Barro, 1999; de la Croix et al., 2008; Romer, 1990; Atardi & Sala-i-Martin, 2003; Fakuse, 2010; Nelson & Phelps, 2006; Gyimah-Brempong et al., 2006; Ciccone & Papaionnou, 2009; Mamoon & Murshed, 2009).

The education for all monitoring report (UNESCO, 2011) describes that the investment in early childhood education rewards higher labor market outcomes in the future because acquiring cognitive skills in the early age turns out to have a strong impact on learning skills later. It causes to lower later investment by learning more efficiently. Moreover, Stevens and Weale (2003)

present that GDP per capita has risen as school enrollment has increased since 1830. It clearly explains how important children's schooling is on economic growth. Barro (1991) and Baumol, Blackman, and Wolff (1989) estimate subsequent economic growth pertaining to primary and secondary enrollment rate, concluding that higher economic development is the consequence for the higher school enrollment rates. In that sense, children's schooling can be regarded as one of the important tools to estimate education status of a country.

It is proved that a child is more likely to be inaccessible to education if he or she is an orphan in comparison with non-orphans (Evans & Miguel, 2007; Case & Ardignton, 2006; Ainsworth et al., 2005). Case, Paxson, and Abeidinger (2004) argue that orphans are less likely to go to school than non-orphans in the sub-Sharan African countries, using the data from 19 Demographic and Health Surveys between 1992 and 2000. Cluver, Operario, Lane, and Kganakga (2012) state that children who may become orphans, because their parents are suffering from HIV/AIDS, already struggle with school due to the responsibilities of taking care of their parents. Then they hardly go back to school after their sick parents die because they have already fallen behind in study compared to their peers. In addition, Coneus and Mühlenweg (2014) use fixed effect to assert that orphans who live in blended households are inferior to non-orphans who grow up in the same living condition in education outcomes from analyzing eleven sub-Saharan African countries. In this regard, losing parents negatively affects children's education, which brings educational inequality to children.

How do parental deaths impact children's schooling? A main channel through which the deaths of parents have negative repercussions on children's education outcome is the absence of a mother within a household. The role of a mother in a household is crucial in a variety of ways, but one of the most influential ways is children's education. Corwyn and Bradley (2002) find that

children's cognitive and behavioral results directly come from maternal education consistently by cognitively stimulating household environments. Haveman and Wolfe (1995) studies that there are considerable correlation and causal effect of mother's education on their children's education outcomes in developed countries. Moreover, in low and middle income countries, educated mothers are deeply related to children's school participation (Huisman & Smits, 2009). More specifically, it is shown that there is a positive association between mother's education level and the extent of children's access to school (Moyi, 2012). Children whose mothers have attained a higher education level than others show a tendency for higher attendance, longer years of schooling, and higher educational achievements (Plug, 2004; Sacerdote, 2002). These findings suggest that mother's education can be a crucial factor for children's schooling.

As for the influence of mothers' education on children's education, maternal orphans and double orphans are exposed to the most fragile status in education due to the absence of a mother in a household. Gundersen and Kelly (2008) argue that educational chances for orphans and other vulnerable children due to the consequences of HIV/AIDS deteriorate by losing parents, and things are worse for maternal orphans when it comes to school enrollment and attendance in Zimbabwe. Case and Ardington (2006) find that mother's death has a causal effect on negative outcomes of children's education. In addition, Evans and Miguel (2007) state that there has been a considerable decline in school participation after the death of parents in Kenya from five-year panel data sets. Moreover, they find maternal death more detrimental. Consequently, the absence of a mother in a household leads orphans to be more vulnerable to falling behind in education than non-orphans who are under mothers' care, especially in education.

In the case of double orphans, they are likely to be adopted by their relatives or non-relatives after losing their parents. Damien De Walque (2009) estimates the relation between the

education of adoptive parents and the schooling outcomes of adoptive children with the data from 1999 to 2001 in Rwanda using an instrumental variable approach. The author mentions that "the education of the most educated female adult in the new household has a positive and significant effect of the schooling of the child welcomed into the household." Then the author concludes that "the magnitude of the effect is similar to the effect in a biological mother-child relationship from the information on biological mother's education." This paper uses the education level of a female adult who takes on the role of a mother in the household to which a double orphan is adopted as a substitute for biological mother's education level in the case of double orphans.

Through what mechanism does mothers' education affect children's education? Female education confers onto many advantages with women not least of which are economic benefits. Kamanda, Madis, and Schnepf (2016) describe that mother's education is typically employed as a proxy for socio-economic status. In other words, the more educated females are, the more income they are likely to earn than those who are less educated. Higher earning power is closely linked to economic independence and autonomy in households with regard to household decisions (Heaton et al., 2005; Woldemicael & Tenkoran, 2010). Educated mothers are more capable of meeting education costs for their children with more resources to invest in their children's education (Paxton & Scahdy, 2007). Also, Andrabi, Das, and Khwaja (2012) study that educated mothers are more inclined to send their children to school and to encourage them to remain in school. This is because the educated mothers are exposed to the values of school, and they want their children to experience them as well. Women's education experience in school, higher earning power, and increased autonomy in households introduce another advantage for their children on education.

A financial issue is considered as another channel via parents' deaths to have negative impacts on children's schooling. It happens especially when working-age parents die (Lundberg,

Over, & Mujinja, 2000; Yamano & Jayne, 2004). Yamano, Shimamura, and Sserunkuuma (2005) find that orphans whose ages are between 15 and 18 are less likely to enroll in school than non-orphans, but there is no difference among children between 6 and 14 years old in Uganda. The authors maintain that it does not burden parents to send their children to public primary school in Uganda, but secondary school fee is not as affordable as primary one. Consequently, it leads households that have lost parents to be reluctant to send their children—orphans—to secondary schools. Roby, Erickson, and Nagaishi (2016) say that household wealth is consistently the strongest predictor of schooling, analyzing the data from five African countries for eight country-years. In the same vein, children residing in the poorest households are three times less likely to be in school compared to ones in affluent households (United Nations, 2013b). In addition, Beegle, Weerdt, and Dercon (2006) find wealth inequality an obstacle factor among orphans to access school. Thus, financial problems caused by parental deaths play one of the key roles that prevent children from keeping going to school.

However, some studies find that orphans are not particularly more vulnerable than equally poor non-orphans (Foster, Shakespear, Chinemana, Jackson, Gregson, Marange, & Mashumba, 1995). If wealth is controlled for, parental deaths make little difference on children's educational opportunities (Lloyd & Blanc, 1996). Lundberg and Over (2000) also argue that wealth is just a means of insurance in times of crisis brought from parental deaths, but the network with family and friends is more important in children's education status. Case, Paxson, and Ableidinger (2004) claim that adult deaths adversely affect access to resources for all children, which does not explain additional impacts on investments in orphans. In this view, the parental effects on education between orphans and non-orphans resulted from parents' deaths may disappear when

education costs do not weigh on all households in having all their children receive a chance to get education.

Swaziland is chosen for this research as a case study. The country is landlocked and surrounded by South Africa and Mozambique. It has a small population of about one million as of July, 2016 (Swazi Central Statistical Office, 2016). GDP per capita in 2014 was recorded at USD 3,477.1 and 63 percent of the population is in poverty (World Bank, 2016; Swaziland Central Statistical Office, 2007). Also, Swaziland is one of the low human development index countries as ranked 150th out of 188 countries according to the 2015 Human Development Index. The country records a poor health condition with only 49 years of life expectancy at birth, which is mainly caused by the highest HIV/AIDS prevalence in the world. Approximately 27 people are infected with AIDS virus out of 100 whose ages lie between 15 and 49 (UNDP, 2015). In 2007, the Government of Swaziland established the Poverty Reeducation Strategy and Action Programme (PRSAP). The PRSAP addresses the issue of human capital development in Swaziland, particularly focusing on implementing quality basic education for all (Swaziland Ministry of Education & Training, 2015).

Education in Swaziland is not mandatory and not free for most of the students. The Swaziland education system consists of three parts: primary, secondary, and tertiary. Primary education is composed of seven levels: Grade 1-2 and Standard 1-5. The official school age to go to school is six years old. In 2010, the first two grades in primary school became free in order to encourage more children to attend school. Secondary school enrollment rates are not as high as primary one because it is not free and family needs labor force to work on farms. Therefore, families tend to send only one child to school. Secondary education is made up of five levels: Form 1-3 and Form 4-5. If a child completes the first three years, he or she gets a Junior

Certificate from the Swaziland Ministry of Education, which is the common entry-level qualification to be employed. During the next two years, students prepare the Cambridge Overseas School Certificate (C.O.S.C.) examinations to enter tertiary-level schools. Few students receive tertiary education; only about five percent out of the school-aged students. Based on the Swaziland education system, this paper only focuses on Grade1-2 and Standard 1-5 as primary education, and Form 1-3 as secondary education. The tertiary education entrance rates are very low and after completing Form 1-3, students tend to leave school with Junior Certificates (Swazi Legacy, Inc., 2011).

Health

Under-five mortality rate (U5MR) is used as a leading indicator to gauge the level of child health as well as overall development in countries (Demographic Health Survey, 2009). The sub-Saharan Africa countries have the highest under-five mortality rates, which account for about six times higher than the average of developed countries (United Nations, 2012). HIV/AIDS prevalence is fatal to increasing U5MR, and Swaziland is at the heart of the matter with the highest HIV/AIDS prevalence in the world. Swaziland's U5MR shows a decrease of 64.7 percent between 1960 and 1990, from 211.7 deaths per 1,000 live births to 74.7 deaths per 1,000 live births respectively; however, between 1990 and 2003, it displays an increase of 78.9 percent in U5MR with 133.7 deaths per 1,000 live births in 2003. It then declines again to 60.7 deaths per 1,000 live births in 2015 according to the World Bank (2015). This unstable trend of U5MR requires the country to come up with interventions to keep U5MR down.

Immunization is the most common way to reduce U5MR. Since 1974, the Expanded Program on Immunization (EPI) by the World Health Organization has been implemented

throughout the world with the objective to get all children vaccinated. In 1984, the WHO set up a standardized vaccination schedule: Bacillus Calmette-Guérin (BCG), oral polio, measles, and diphtheria-tetanus-pertussis (DTP). With much research on following immunologic factors of disease, the WHO added recommended vaccines on the list of EPI: Hepatitis B (HepB), rubella, tetanus, Haemophilus influenzae meningitis (Hib) conjugate vaccine, and yellow fever in countries with high disease burden (World Bank, 2006). The effort to prevent infectious diseases by immunization led to complete eradication of small pox and 99 percent of polio and measles in the western hemisphere (Halperin, 2004).It also led to a substantial reduction in morbidity and mortality caused by vaccine-preventable diseases (Saffar et al., 2013).

The main reason for using immunization programs to reduce U5MR is that immunization is the most successful and cost-effective health intervention (Miller & Hinman, 2004; Hadler, 2004). Even though immunization programs demand funding for infrastructure, for example, cold-chain maintenance, investment in purchasing vaccines, and enough medical staffing, the decreased morbidity and mortality convert into long-term cost savings and potential growth in economy (Ehreth, 2003). In addition, Chabot, Goetghebeur, and Gregoire (2004) argue that immunization programs are more cost-effective than other public health interventions, such as encouraging wearing of seat-belts and quitting smoking, and chlorination of drinking water. Another reason is that the immunization programs help developing countries to strengthen their own primary healthcare service systems. To progress the programs, they need fundamental infrastructure and personnel to run effective and sustainable immunization programs, particularly in healthcare services for an infancy period (Shearley, 1999; Ruff et al., 1995; Martines et al., 2005). In the sense, immunization is an effective instrument to reduce mortality rate of children under five, especially in developing countries.

Why do many of the young children suffer from incomplete or no vaccination? The main cause stems from the fact that young children's vaccination status is strongly related to parental knowledge and attitudes. Favin, Steinglass, Fields, Banerjee, and Sawhney (2012) study factors of keeping young children from being fully vaccinated and emphasize the role of parents in immunizing their children. The lack of information is one of the main reasons behind missed vaccination opportunities for children. Brown (2016) suggests a solution to solve the problem: an immunization card. He argues that immunization cards work in ameliorating parental awareness and in leading parents to be involved in their child's health care. Also, it is studied that missed opportunities to be vaccinated are often resulted from the lack of parental awareness of the benefits of vaccines as well as vaccination schedule of when their children are due for next vaccine (Tugumisirize, Tumwine, & Mworozi, 2002; Khan et al., 2005). There is several research which studies the impact of immunization cards on visiting count to healthcare service centers in Pakistan (Usman, Akhtar, Habib, & Jehan 2009; Usman et al., 2011). Those studies demonstrate potential benefits on elevated follow-up immunization visits by highlighting the role of redesigned immunization cards. As a parent-controlled and child-centered piece of information, an immunization card improves parents' consciousness in health by giving basic information; kinds of other routine vaccinations, dates of revisits, and locations of healthcare services centers, for example. Thus, immunization cards can be considered as an instrument to reduce health inequalities by providing basic information on vaccinations.

Furthermore, immunization cards function to collect data for users, which ultimately helps to monitor quality management of healthcare service and public health. Luman, Ryman, and Sablan (2009) claim that the validity of estimates derived from parental recalls on their children's medical records is insufficient to be used as a source of vaccination coverage by

conducting the study in the Western Pacific's Northern Mariana Islands. Without documented information on medical records, especially about immunization services received, more possible recall errors are caused to disturb measuring correct immunization coverage (Valadez & Weld, 1992). David (2016) says that immunization card is underutilized to estimate public health status, even though it is an inexpensive intervention in health. In this context, immunization cards are useful for a country to inexpensively collect objective information on children's health status.

When immunization rates improve nationally, do all children equally receive benefits in being vaccinated? Berkley, Chan, Elias, Fauci, Lake, and Phumaphi (2012) find that there is still inequality among children despite increased vaccination rate. To be specific, children whose parents are more educated, richer, and live in urban areas are more likely to be fully vaccinated. It describes how health inequalities continue to exist even when morbidity and mortality decrease nationwide, leading herd immunity to fail. Polonijo and Carpiano (2013), and Phelan and Link (2013) theorize that "individuals with more resources, including money, knowledge, power, prestige, and beneficial social connections, will access vaccination more, more rapidly, and more effectively to influence survival". A growing number of research prove that socio-economic status is highly related with children's vaccinations (Wado, Afework, & Hindin, 2014; Nankabirwa, Tylleskar, Tumwine, & Sommerfelt, 2010; De Waroux et al., 2013). Among the factors affecting immunization rates, Clouston, Kidman, and Palermo (2014) assert that "increased household wealth and parental education were robustly associated with improved vaccination in children". This also supports previous studies in other African countries (Ndirangu et al., 2009; Wado, 2014; Nankabirwa et al., 2010; Mekonnen et al., 2013; Sjursen, 2011; Bawah, 2010).

Another factor that gives rise to health inequality in immunization is orphanhood. If a child is an orphan, marked inequality in health exists in comparison to non-orphans. Also, Coneus and Mühlenweg (2014) study eleven sub-Saharan African countries to estimate the effect of parental death on children's education between the ages of six and fourteen, and on one's health between birth and four. They conclude that children who lost their parents and live with others show worse outcomes for both education and health. In terms of immunization, Aneni, De Beer, Hanson, Rijnen, Brenan, and Feeley (2013) observe that orphans and vulnerable children are less likely to be immunized versus non-orphans in Namibia. In this regard, orphans are more vulnerable to health inequality arising from immunization.

In Swaziland, immunization cards do not work properly unfortunately. Daly, Nxumalo, and Biellik (2003) study missed opportunities for vaccination in Swaziland. They find that "of those children eligible for vaccination attending the facilities, 46 percent were vaccinated and 54 percent were missed opportunities. Interestingly, almost three-quarters of children not in possession of a card were found to be eligible for vaccination, but the opportunity to vaccinate was missed. This group made up over one-third of all the missed opportunities found". In addition, the authors argue that it is because of the lack of integration of healthcare service that children under two year of age to miss chances to be vaccinated. Swazi health workers do not check cards and vaccinate because patients come on a day when vaccinations are not given. It means that Swazi health staff also are not quite aware of the importance of immunization cards and their function, causing missed opportunities for children to be immunized.

The rationale behind the selection of Swaziland as a case study is twofold. First, the country has the highest HIV/AIDS prevalence rate in the world, which may cause the number of orphans to increase (UNICEF, 2015). Mostly, orphans are less likely to go to school when

parents are absent. This gives rise to inequality in education, which may makes it hard to achieve the fourth of Sustainable Development Goals (SDGs). Additionally, fewer orphans under five are likely to be immunized, which is associated with Goal 3.2 of SDGs: by 2030 end preventable deaths of newborns and under-five children. The second rationale for this study is that it is necessary to find the way to remove the disparities in education and health among children caused by parental deaths because those disparities would create a substantial barrier on economic activities later, be it personal or national. Therefore, in the following sections, this paper will identify the impacts of mother's education level and household wealth on children's education and the impact of immunization cards on children's full vaccination rates in Swaziland to find a factor to eliminate the disparities between non-orphans and orphans.

Methodology

Data

Household surveys are used for this study as a primary source of data to assess some of the questions of which factor can reduce parental effects of orphans to let all children go to school as well as be immunized in Swaziland. This study relies on the Swaziland Multiple Indicator Cluster Survey (MICS) of 2010, which includes rich information on children's characteristics, current education and vaccination status, household living arrangement, and the financial status of the households. The Swaziland MICS is the fourth round of the Global MICS program. It is cross-sectional data collected by Central Statistical Office in cooperation with the United Nations Children's Fund (UNICEF). The survey for this study uses a multi-stage, stratified cluster sampling approach to select samples. The first stage of stratification for the sampling of the enumeration areas accords with the regions (domain of analysis)—the four regions (Hhohho,

Manizini, Shiselweni, and Lubombo), by urban and rural strata. At the second level of sampling frame, households are chosen from the household listing, using circular systematic sampling with a random start (UNICEF, 2011).

The Swaziland MICS conducts the survey of 5,340 households composed of 21,607 individuals. Since the interest for this study is in targeted children on school enrollment ratio (NER), and whether a child is in a proper grade for his/her age, this study firstly focuses on the group of children whose ages are between six and fifteen; in other words, the age at beginning of a school year, accounting for 5,617 children. Secondly, 3,846 children are selected whose ages are under five to investigate the full immunization coverage.

This paper puts stress on the more detailed grouping of orphans than previous studies to see whether the effects of the key variables—mother's education level, household wealth, and immunization card—can narrow the inequality in orphaned children's schooling and health or not. As a control group, non-orphans are defined as Group A who live with their both living parents for certain. This is because children who are raised under both living parents show better education outcomes, such as in cognitive skills, compared to those who live with a single parent (Carlson & Corcoran, 2001; Fields & Casper, 2001; Hetherington & Clingempeel, 1992; McLanahan & Sandefur, 1994; Pryor & Rodgers, 2009), and higher vaccination rates (Jahn et al., 2008). Therefore, parental effects would be underestimated between non-orphans and orphans if non-orphans are just referred to as Group A without considering co-residence with their living biological parents. There are two different kinds of single orphans: first is the one who lost one of the biological parents and lives with the remaining parent within the same household, and the other is the one who does not live with the remaining one within the same household for some reason. Only the former is regarded as the single orphan in this study as Group B. However, the

latter physically has no difference in parents' care from double orphans who lost both biological parents, and it comes under double orphan's category, named Group C. In addition, to see the effect of mother's education level, only paternal single orphans are selected as Group B.

- Group A: the ones whose biological parents are both alive and live together within the same household
- Group B: the ones who lost biological father and live with the remaining mother within the same household
- Group C: the ones who lost one biological parent and do not live with the remaining living parent within the same household, and the ones who lost both biological parents.

The sample population for the education analysis with children between 6 and 15 years consists of two parts: The official primary school age in Swaziland is between 6 and 12 years (n: A=822, B=435, C=745), and secondary is between 13 and 15 years (n: A=281, B=217, C=470). For the health outcome, the samples are under five years (n: A=986, B=165, C=242).

Variables

Education.

Education outcome variables are defined as follows: (1) Enrollment ratio: whether a child has answered to be currently enrolled in school or not; the question asked is: "During this 2010 school year, did you attend school at any time?" Answers are: 1=Yes or 0=No; (2) Proper grade placement: whether the current grade is equivalent to what is officially recommended for the age of the child or not (1=Yes, 0=No). This dependent variable would reflect late school entries or dropouts. Several potential confounders are considered: (1) gender of a child (1=Female,

0=Male); (2) school age of a child in three categories: 6-7 (base), 8-12, 13-15; because school fee for children of 6 to 7 years is fully covered by the Swazi government, it is categorized as a base, from 8 to 12 it is a primary school-aged category not for free, and from 13 to 15 it is a secondary one not for free; (3) religion of a child (1=Christian, 0=Non-Christian) since 91.4 percent of the population are Christians; (4) area of a child's residence (1=Rural, 0=Urban); (5) four regions of a child's residence (four dummies: 1=Hhohho, 0=otherwise; 1=Manzini, 0=otherwise; 1=Shiselweni, 0=otherwise; 1=Lubombo, 0=otherwise); (6) dependency ratio: number of children/ number of adults in a household. This ratio is expected to demonstrate the weight of childcare by household. For example, if the ratio is less or equal to one, it means a household has more adults than children who can support children's education fees; (7) parent's AIDS symptoms; since this MICS data set does not expose a sample's HIV infection directly, three questions are chosen to estimate parent's AIDS symptoms: "During the last 12 months, have you had a disease through sexual contact?", "During the last 12 months, have you had pungent abnormal genital discharge?", and "During the last 12 months, have you had a genital sore or ulcer?" Answers are: 0=No, or 1=Yes. If the score is greater than or equals to 1, it is regarded as 1 for this variable, and otherwise is 0; (8) water sanitation (1=Piped Water, 0=Otherwise); (9) ratio of the sick: it is calculated by dividing the number of sick people by the number of children in a household. The selection of variables is informed by previous research, and the variables used in this study are shown to be associated with school attendance and attending school at proper age (Kamada et al., 2016; Kürzinger et al., 2008, Cluver et al., 2012; Christopher, 2000; Maurin, 2002).

The key explanatory variables are mother's education level and household wealth to see how they reduce the inequality in education among the orphaned in comparison with non-orphans.

The variable of mother's education level consists of four categories: 0=None, 1=Primary, 2=Secondary, 3=Higher, and the one of household wealth consists of five: 0=Poorest, 1=Second, 2=Middle, 3=Fourth, and 4=Richest. The MICS wealth index is composed based on the possessions and assets, such as the materials used to build a house, hectares of agricultural lands owned, television, electricity, access to sanitation facilities, and so on.

Health

A health outcome variable is whether a child is fully immunized against Bacillus Calmette-Guérin(BCG), polio, and diphtheria-pertussis-tetanus/hepatitis B/Haemophilus influenzae type B (DPT/HepB/Hib). This study excludes measles because the country has had two measles campaigns in 2006 and 2009 nationally, which may cause the impact of immunization card on full vaccination rates to be overestimated. According to the immunization schedule, the vaccination against BCG is required one time, polio four times, and DPT/HepB/Hib three times in a child's life (WHO, 2015). When a child successfully receives all protective inoculations, he or she is counted as 1, otherwise 0. Confounders for the health outcome are almost the same as the ones for education dependent variables, excluding religion and the ratio of sick since too many samples would be dropped to run regressions if the religion and the ratio of the sick variable were to be added. In addition, it is examined that those are related to neither the health outcome variable at this data set nor the other control variables. One control variable is added: exposure to media—the number of television and radio at home—to be assumed as a channel to make people be informed of the information on vaccination.

The key variable to examine the effect for health disparity pertaining to orphans is an immunization card. The variable has two values: "Do you have a card where (child's name)'s

vaccinations are written down?" Answers are: 1=Yes, seen (a respondent has an immunization card and showed it to an enumerator), 2=Yes, not seen (a respondent used to have an immunization card but did not show it to an enumerator), 3=No card (a respondent has never had an immunization card). The immunization card variable takes Yes, seen and Yes, not seen from the answers into 1, and otherwise into 0.

Empirical Strategies

Education.

This study uses logistic regression analysis to estimate the impact of mother's education level and household wealth on children's school enrollment ratios and whether they currently attend the officially recommended grade for their ages as the instruments to reduce the disparity of education opportunities. The logistic model helps to estimate the effect of independent variables on the log odds to measure the relative possibilities compared to the base, Group A. The dependent variables in the logistic model are binary responses, and this research models the log odds of the enrollment and being in the proper grade. The model is estimated as,

$$l\,n\left[\frac{p_i}{1-p_i}\right] = \beta_0 + \beta_1 GrB_i + \beta_2 GrC_i + \beta_3 Wealth_i + \beta_4 Medu_i + X'_i\beta + \varepsilon_i$$

Where *p* denotes the probability of the two dependent variables for each individual i: school enrollment rate and being in the officially recommended grade. On the left side of the equation, natural logarithm of the odds, called the log odds, and on the right side, βs are parameter estimates corresponding to the effects of the regressors. *GrB* and *GrC* refer to Group B and Group C as a dummy variable respectively; *Wealth* and *Medu* index household wealth and mother's education level; the vector X' contains all control variables such as school age, gender,

area, religion, parents' AIDS symptoms, dependency ratio, the sick ratio, and dummy variables controlling four regions; and ε refers to error.

This paper uses several steps as described in Table 3 to show how mother's education level and household wealth impact the disparities among groups, referring Group A to the base. It begins with presenting the discrepancy in school enrollment ratio and being in proper grade by group. Next, wealth and mother's education level are added to check main effects of the two variables by turns.

Health.

To estimate the group difference in full immunization rate, this paper firstly uses logistic regression analysis as shown in Table 6. Those outcome variables from the first three models are binary responses, and log odds of being fully vaccinated against all three routine vaccines: BCG, polio, and DPT/HepB/Hib are illustrated with the model below:

$$ln[\frac{p_i}{1-p_i}] = \beta_0 + \beta_1 GrB_i + \beta_2 GrC_i + \beta_3 Wealth_i + \beta_4 Medu_i + \beta_5 ImmuCard_i + X'_i\beta + \varepsilon_i$$

All expressions are the same as education outcome model, estimating *p* as a probability of being vaccinated for each individual *i*, and *ImmCard* refers to whether a child has an immunization card or not. Since it is expected that some of children may never have been vaccinated at all, causing excess zeros in estimating the number of vaccinations received, another econometric model is used for this study to estimate the number of times fully vaccinated among children under five: zero-inflated Poisson model (ZIP). This model is useful when excess zeros arise, and there are a lot of zeros who do not get vaccinated as seen at Figure 3. The zero-inflated Poisson distribution for the sample *i* can be defined as:

$$P(Y_i = y_i) = \begin{cases} P_i + (1 - P_i)e^{-\mu_i}, & y_i = 0 \\ (1 - P_i)\frac{e^{-\mu_i}\mu_i^{y_i}}{y_i!}, & y_i > 0 \end{cases}$$

Logistic regression is used to estimate the probability of being an excess zero (P_i), thus it is estimated using:

$$P_i = \frac{1}{1 + e^{-\pi_i}}$$

A set of regressors is expressed as π_i. By using a combining distribution, a zero-inflated model throws more weight on the probabilities of observing zeros. Thus, in the ZIP model, the probabilities of observing zeros comprise two sections: the sum of observing the excess zeros and the one from the Poisson model. Likewise, the ZIP model proceeds two separate parts. The first step forms the structural zeros: logistic regression. The second step forms the Poisson distribution conditional on the excess zeros: Poisson regression modeling the sampling zero and counts (Rose et al., 2006).

Results

Education

Sample Characteristics.

This paper primarily depends on descriptive statistics to check the means and standard deviations of the main variables. Table 2 shows the means for two main education outcomes, two key variables, and several control variables in the data set. Means are displayed separately by group, along with *t* statistics for the null hypothesis that the means are equal in Group A and B, and in Group B and C. Column 1 shows the means of each variable of all samples who are between six and fifteen of age (n=5,617); Column 2 is of Group A (n=1,103); Column 3 is of Group B (n=652); and Column 4 is of Group C (n=1,215).

Out of the total number of the children in the sample population, Group A accounts for 20 percent, Group B 12 percent, and Group C 22 percent, and these portions are 5 percent, 3 percent, and 6 percent respectively out of the whole population. It illustrates that Group C, those who cannot get the care from any biological parent in education, is quite as large as Group A who receive the care from both living parents at home in Swaziland.

In the enrollment ratio, Figure 1 presents how the gap between groups for the enrollment ratio gets bigger in secondary education, showing the gravity of the inequality in secondary education among children. The mean of NER in Group A is higher than that in Group B, and Group C shows the lowest mean value according to Table 2. Also, Figure 2 demonstrates that children are less likely to be in a proper grade as they get older throughout all groups. In Table 2, the mean of proper grade describes the same pattern by group to NER, but the statistical difference appears in *t* statistics. In NER, there is a statistical difference between Group A and B, but in the case of proper grade, between Group B and C. It implies that it is harder for orphans, no matter which group they belong to (Group B or C), to enroll in school compared to non-orphans (Group A), but once they enroll, single orphans living with their remaining parent are more likely to stay in school than the other orphans in Group C.

Group A overall has the highest means in mother's education level and household wealth; on the contrary, Group C shows the lowest means. In mother's education level variables, there are stark differences in None and Higher among groups, but there is no difference in Primary and Secondary between Group A and B. Yet, the statistical difference in wealth gets shown between non-orphans (Group A) and orphans (Group B and C). It illustrates that the difference in mother's education level occurs between Group B and C, but the wealth difference occurs between Group A and B.

There is no gender difference among the groups. The children in Group B are older in terms of age at the beginning of the school year than those in Group A, and the ones in Group C are older than those in Group B. It describes that the children living with alive biological parents tend to go to school at appropriate ages, but the vulnerable ones are expected to be neglected for a while for some reasons. More Christians are in Group B than in Group A and C. The more vulnerable one group is, the more likely they are to live in rural area. The parents of Group A suffer more from AIDS symptoms than those of Group B and C. Also, they have a better access to quality of water using pipes. The households of orphans in Group B and C have higher dependency ratio and the sick ratio, which means there are more number of children in a household for whom an adult has to support, and more number of sick people in a household per child.

Main Analysis: Logistic Regression

A logistic regression is conducted to explore the impacts of mother's education level and wealth on education among children. Table 3 presents odds ratios of education outcomes from logistic regressions. The first column shows the impact of control variables on NER, household wealth is added in Model (2), and mother's education level is appended in Model (3) in regular series. The same method is repeated for proper grade.

Group B and C are less likely to enroll in school than Group A resulting from Model (1). Holding other control variables constant, 0.227 odds ratios for Group B is the odds of a child in Group B enrolling in school divided by the odds of one in Group A enrolling in school (OR=0.227, $p<0.001$). Also, 0.154 odds ratios for Group C is the odds of a child in Group B being in school divided by the odds of one in Group A being in school (OR=0.154, $p<0.001$). In

other words, if 100 children go to school in Group A, only about 23 children are found to go to school in Group B, and only about 15 in Group C. This demonstrates how the group difference caused by parental death affects children's school enrollment. Adding household wealth variable, the group difference is similar to Model (1) with the impact of wealth in Model (2). Higher household wealth is observed to be statistically significantly related to higher odds of attending school. One unit increase in household wealth index level corresponds to a 138.7 percent increase in odds of enrolling in school across the groups (OR=1.387, $p<0.01$). However, wealth is no longer statistically significant with mother's education level in Model (3). One-level increase in mother's education level giving rise to 153.3 percent increase in the odds of the enrollment in school is expected (OR=1.533, $p<0.01$). It is interpreted with the result that female education is more effective to have children attend school considering household wealth in Swaziland. Nevertheless, there is still a group difference left between Group A and B, and between Group A and C (OR=0.200, $p<0.001$; OR=0.217, $p<0.001$).

There is no group difference between Group A and B in proper grade, but the difference exists between Group A and C, showing that only 71 percent of children in Group B are in a proper grade for their ages compared to Group A (OR=0.710, $p<0.01$) in Model (5). Wealth affects children to stay in a proper grade for their age by 125.2 percent with the one level increase (OR=1.252, $p<0.001$) in Model (6). On the contrary to NER, wealth still has an influence after adding mother's education level (OR=1.161, $p<0.001$), but mother's education has a little more influence on proper grade than on wealth (OR=1.179, $p<0.001$) with a remaining group difference between Group A and C (OR=0.768, $p<0.05$).

Since Grade 1 and 2 receive universal education in Swaziland for free, it is a base group for the age. The secondary school ages are less likely to enroll in school than Grade 1 and 2 when

controlling only for household wealth (OR=0.349, $p<0.01$), but it disappears with controlling for mother's education level in Model (3). There is no statistically significant difference within the primary school ages in NER. In the case of proper grade, children are less likely to be in the recommended grade for their ages as they get older, not only in primary but in secondary (OR=0.297, $p<0.01$; OR=0.126, $p<0.01$). It implies that there are many children who do not receive officially recommended education in school for their ages across the country with a large number of children not going on to secondary school. Interestingly, there is scarcely gender difference in NER, but there is in proper grade. Female students tend to go on to school more often than male ones (OR=1.387, $p<0.001$). Those living in rural areas look harder to stay in a proper grade than others in urban areas (OR=0.733, $p<0.01$).

Table 4 shows the impacts of wealth and mother's education level on children's education within each group. Following the result from Table 3, mother's education level statistically significantly affects NER of children overall more so than household wealth, even though neither seem to be important to Group C. In Group A, wealth does not matter to children's enrollment but mother's education level does (OR=2.257, $p<0.1$). In Group B, both wealth and mother's education level are statistically significant in children enrolling in school with more impact from mother's education level than from household wealth (Mom's education level OR=1.920, $p<0.05$; Wealth OR=1.762, $p<0.05$). On the other hand, wealth is more influential in proper grade than mother's education level, especially in Group B and C. The impact of mother's education level gradually disappears as a group becomes more vulnerable, from Group A to C. In proper grade, the age of a child has a negative impact as a secondary school child is less likely to be in a recommended grade for his/her age. Even in the same secondary age group, less percentage of children receives a proper grade education compared to Grade 1 and 2 as a group gets more

vulnerable (Group A OR=0.135, p<0.001; Group B OR=0.114, p<0.001; Group C OR=0.101, p<0.001).

Health

Sample Characteristics.

Table 5 displays sample summary statistics in health of whose ages are between birth and five. It shows the means of health outcomes and standard deviations of variables. The main outcome variable is full vaccination ratio of each vaccination: BCG, polio, and DPT/HepB/Hib, and three key variables are: immunization card, mother's education level, and household wealth in addition to several control variables. *t* test is done to estimate the mean difference between Group A and B, and between Group B and C with the null hypothesis that the means are equal. The first column shows the means of all children under five on each variable (n=3,846); the second is of Group A (n=986); the third is of Group B (n=165); and the fourth is of Group C (n=242). These sample numbers account for 26 percent on Group A; 4 percent on Group B; and 6 percent on Group C out of the population of children under five respectively.

There are studies arguing for the risk of incomplete vaccination (Jani et al., 2008; Mavimbe et al., 2005) and thus, this study focuses on the status of full immunization of children. Although there is no difference in the number of fully injected vaccines among groups, it comes into sight in the comparison of each vaccine. The differences are remarkable between non-orphans (Group A) and orphans (Group B and C) in all vaccines. It implies that some children have gotten full shots against a certain vaccine while some have against a different vaccine. This immunization situation is not good for the country especially when it wants to foster strong herd immunity in the long-term.

An immunization card is used as a key variable of this study to see if a child has it or not, and 83 percent of whole children under five own the card. The more vulnerable children tend to not possess the card, but there is no statistically significant group difference. Moreover, if a group is more vulnerable, mother's education level is lower, and wealth status is worse than the others as expected. The mean difference of mother's education level and household status has a similar pattern with that of those between six and fifteen for the education outcomes.

No gender difference is found here, though. The children's ages selected into Group A show younger than the others in Group B and C. If a child belongs to a more vulnerable group, he/she is more likely to live in a rural area. The parents of children in Group A show more HIV/AIDS related symptoms than the other groups. They also were more likely to use piped water compared to Group B and C.

Main Analysis: (1) Logistic Regressions of Being Fully Vaccinated

If a child owns an immunization card, is he/she more likely to get full routine vaccinations: BCG, polio, and DPT/HepB/Hib? A logistic regression is conducted to explore the parental effects among the groups and factors associated with whether a child gets fully vaccinated against the vaccines by group. To estimate that, Table 6 firstly presents full vaccination rates across the groups. Only a child is counted into 1 for the outcome when he/she has received one time BCG, four times polio, and two times DPT/HepB/Hib, otherwise 0 for the first three columns. Model (1) in Table 6 includes two group dummy variables, having Group A as base and other demographic characteristics as predictors of immunization outcome of young children under five. The household wealth and mother's education level variables are added in Model (2). The third model

appends the immunization card variable in Model (3) to see if there is an impact of possession of an immunization card on children's immunization rate of the three vaccines.

Group A and B do not show differences in full vaccinations overall; however, the odd ratio for Group C illustrates the group difference between Group A and C (OR=0.658, $p<0.05$). When examining those vaccinated against all three vaccines fully, just 65.8 percent of children in Group C were vaccinated compared to those in Group A. Yet, this group difference disappears with immunization card. With the card's existence, no group difference is found, and it allows 147 times more chances for a child to get fully vaccinated (OR=147.241, $p<0.001$).

Main Analysis: (2) Zero-inflated Poisson Regression

Zero-inflated Poisson model is used to see how an immunization card affects the number of inoculations for a child to get fully vaccinated. It is assumed that many of children may be never vaccinated from having no immunization card, and it causes excess zeros in vaccination numbers. Figure 3 describes the distribution of the number of vaccinations a child receives. As shown, excess zeros occur at none of vaccinations to be gained. Of all children in Group A, B and C, 30.65 percent of them are not vaccinated at all, and almost all of them do not have an immunization card. On the other hand, 720 children (51.65 percent of the samples) have fully vaccinated against BCG, polio, and DPT/HepB/Hib, and 97.78 percent of them possess the card.

The impact of having an immunization card is explained in detail by zero-inflated Poisson regression in Table 6. The coefficient of immunization card is -161.634, showing that those owning an immunization card are less likely to never get vaccinated with about 162 times lower odds of those not having the immunization card when comparing to the other children with the same age, gender, the extent to expose to media, area, water sanitation, and dependency ratio in

the same period. It is equivalent to the result of immunization card in Poisson regression part. It shows a positive coefficient, meaning that a child is more likely to get more number of vaccines with possession of an immunization card. If a child with an immunization card is vaccinated at least one full dose of any vaccine, holding the other variables constant, the expected number of vaccinations the child would receive will be 1.658 times bigger than those without the card. What is interesting is the odds of immunization card in logit (inflate) part. If a child were to have an immunization card, the odds that he/she would be in the "certain excess zero" group would increase by a factor of *exp*(-161.634)=6.357e-71, which is almost equal to zero. It demonstrates that having the immunization card causes a child to be in non-vaccinated group (a certain excess zero group) almost by zero percent.

Discussion

This paper studies the key factors to reduce inequality in education and health among orphans caused by parental death. Even though the data is from Swaziland Multiple Indicator Cluster Survey (MICS) of 2010 collected by Swazi Central Statistical Office and UNICEF, there are some limitations to consider. It is cross-sectional data, which does not permit to see the effects of the factors over time. The survey answers for the enrollment ratio as an education outcome is measured from "enrolled or not", which does not include the times of attendance. If a child has been to school only one week of year, then he/she is counted as "enrolled". It does not give the information on how many more days a child can go to school by the increase of wealth level and mother's education level. Therefore, these results may have a possibility to overestimate real and regular school attendance. In addition, this study exclusively focuses on school enrollment and placement in proper grade as means of schooling outcomes. While other

education variables to estimate the status of children's education can be used, such as schooling attainment, the days of attending school last week, and so on, the lack of information from the data set does not allow us to estimate those in-depth.

As a factor of eliminating health inequality in orphans, an immunization card's role is used for this study. There are some more variables considered that impact children's immunization: distance to healthcare center, health staff performance, lack of logistics, and false contraindications (Favin et al., 2012). These information is limited to get from the data, and also to check the use of maternal healthcare services, the number of respondents of the questions is very small, which makes the study to omit the variable. These limitations may cause overestimation of the effect of immunization card on children's vaccination rates. Moreover, the study relies on mother's recall whether her child has been vaccinated against each vaccine if she does not have an immunization card. It may give rise to recall error as one of the measurement errors.

Education

The results of this study indicate that mother's education level is important for a child to enroll in school, but both wealth and mother's education level are crucial for a child to get education in the officially recommended grade for his/her age. Overall, wealth and mother's education have a positive effect on children's education. This finding supports previous studies that determine household wealth and mother's education level are protective factors for vulnerable children (Berk, 1985; Chernichovsky, 1985; Davis-Kean, 2005; Reardon, 2011; Tsujita, 2013; Sinha et al., 2016). Each key factor works differently by group. As for children in Group A living with both alive biological parents in the same household, wealth has nothing to

do with both enrollment ratio and with having them in a proper grade; however, mother's education has a positive influence on both education outcomes. Especially, in NER, the effect of mother's education level is most influential than the other groups though statistical significance is weak. Children in Group B who lost biological father, and live with the remaining biological mother in the same household are influenced by both wealth and mother's education level on their NER and proper grade. Even though wealth and mother's education level do not look influential on children's enrollment ratio in Group C who lost both biological parents, or lost one biological parent and do not live with the remaining one, wealth affects them to go on to the proper grade for their ages.

The result of Group A explains that if a child is guaranteed a certain level of wealth, then mother's education level becomes more important to his/her education. However, orphans in Group B and C are more likely to be vulnerable to wealth so their education is affected by wealth in addition to mother's education level. The more vulnerable a child is to parental death, the more his/her education is affected by wealth. Moreover, NER is not different no matter how old a child is, but as a child gets older he/she tends to not attend class in the proper grade for their ages, which is glaringly obvious in the secondary school ages. Meanwhile, female children are more in the proper grade than male ones in Group A and B. With an increase in age, males become more labor force "ready" and are led towards paid labor (Sinha et al., 2016). Yet, the same situational result does not show up in Group C, which means female children in Group C do not go on to proper grade for their age as much as males. Parental deaths affect the females in Group C more seriously in proper grade compared to those in the other groups. These findings build on previous studies by Erickson and Nagaishi (2016), Moyi (2012), and Beegle, Weerdt, and Dercon (2006). These results suggest that wealth and mother's education level significantly affect children's

education, and orphans are more seriously influenced by those. Besides, it can be speculated that wealth is prioritized to encourage orphans' schooling, but mother's education level is regarded as a factor to increase education of children who are not orphaned.

Health

This study finds that an immunization card can function to eliminate the health inequality among orphans in Swaziland. The absence of the card may be related to missing vaccination information or reduce contact with healthcare system. In general, there is no group difference between Group A and B in terms of immunization rates against routine vaccines: BCG, polio, and DPT/HepB/Hib. However, with an immunization card, the group difference disappears in being fully vaccinated.

An immunization card may differently affect each vaccine to be fully vaccinated. BCG vaccination is recommended as soon as a child is born (WHO, 2015). That may cause a low immunization card effect on BCG in addition to no significance on age. On the other hand, parents are asked to bring their children to a healthcare center four times to get them fully vaccinated against polio, which may lead to very high effect of the card on polio and age difference. As for DPT/HepB/Hib, it is required for parents to take their children to a healthcare center two times. This is expected to weaken the impact of immunization card compared to polio; nevertheless, there still is age effect like polio. Plus, exposure to media is added to find the source of information given, but it shows statistically insignificant when adding the immunization card variable. Therefore, people are less likely to immunize their children because of the lack of information coming from non-possession of an immunization card, not from advertisements or news on televisions or radios.

Furthermore, this paper studies how an immunization card affects the number of vaccination for a child to fully receive. There is a binomial distribution of the number of times vaccinated. As the nature of immunization causes excess zeros, the analysis is done in two parts (McClintock, 2012). When excluding the cases of zero times being vaccinated, a child is more likely to get more vaccines by having an immunization card. In the part of excess zeros, it is found that if a child has an immunization card, the chance that he/she might not be immunized at all is almost zero percent. Thus, possessing the card itself has a great influence for child's immunization. This reaches to the same results with the previous studies that encouraging people to use immunization cards increases them to revisit healthcare centers, consequently resulting in improved immunization rates of children (Usman et al., 2009; Pegurri, Fox-Rushby, & Damian, 2005).

Household wealth and mother's education level do not play important roles in increasing the number of vaccination. The age of a child is statistically significant to increase the chances to vaccinate the child. It demonstrates that some parents in Swaziland do not visit healthcare centers following the recommended immunization schedule. If all parents vaccinated their children according to the indicated regular immunization schedule, there might not be an age difference. Female children are slightly less likely to be vaccinated against the same number of vaccines than male ones.

Conclusion

The Universal Declaration of Human Rights addresses that "children are entitled to special care and assistance" (United Nations, 1948) because of their inherent vulnerability and demand for protection. Also, the United Nations Convention on the Rights of the Child proclaims that

education is to be a fundamental human right. With an increasing number of orphaned children due to the highest HIV/AIDS prevalence in Swaziland, the government, non-government agencies, and international organizations have the responsibility to defend the rights of every single child as defined by national policies and the Convention of the Rights of the Child (UN General Assembly, 1989). As of 2015, the Sustainable Development Goals (SDGs) were established, highlighting the key targets of each goal. To achieve the first target of the fourth education SDG: "by 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes", the education equity of the vulnerable children should be ensured. In line with other studies focusing on ensuring access to education for all vulnerable children, this paper independently corroborates another evidence that considerable gains have been made. Nevertheless, challenges still remain that the group differences in education caused by parental death are not eliminated completely.

In 1974, the Expanded Programme on Immunization (EPI) was launched by the World Health Organization (WHO). By way of the Millennium Development Goals (MDGs), the importance of immunization for all children lasts to the SDGs with the target: "achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all". The health equity of orphaned children should be guaranteed. In terms of health equity, vaccination is the most cost-effective way to save children. Furthermore, it contributes to increasing herd immunity as well. In return, vaccine programs boost development by medical savings directly and by economic benefits indirectly at the national level. This study finds that the use of an immunization card can remove the health inequality in immunizing children. Hence, it

is recommended for the country to administrate an immunization card and let people use it to achieve vaccination for all children.

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Table 1

Definition of Study Variables

Variables	Operational Definition	Categories & Coding
Education Outcomes		
Enrollment ratio	A child is currently enrolled in school	No(0), Yes(1)
Proper grade	A child is attending in the officially recommended grade for the age	No(0), Yes(1)
Health Outcomes		
Fully vaccinated	A child has been fully vaccinated against each vaccine: BCG, Polio, DPT/HepB/Hib	No(0), Yes(1)
Key Variables		
Wealth	A child's household wealth index	Poorest(0), Second(1), Middle(2), Fourth(3), Richest(4)
Mother's education level	A child's mother's education level	None(0), Primary(1), Secondary(2), Higher(3)
Immunization card	A child has an immunization card	No(0), Yes(1)
Control Variables		
Female	Gender of a child	Male(0), Female(1)
School age	A child's age at beginning of school year	6-7(0), 8-12(1), 13-15(2)
Christian	A child's religion	Non-Christian(0), Christian(1)
Rural	Area of a child to live	Urban(0), Rural(1)
Dependency ratio	Number of children/Number of adults in a household	
Parent's AIDS symptoms	A parent shows HIV/AIDS symptoms	No(0), Yes(1)

Water sanitation	A child uses piped water	No(0), Yes(1)
The sick ratio	Number of sick people/Number of children in a household	
Mother's age at birth	A mother's age when a child was born	Less than 20(0), 20-34(1), 35-49(2)
Exposure to media	Number of televisions and radios at home	
Region	Where a child lives(four dummies)	Hhohho, Manzini, Shiselweni, Lubombo

Note: Variables with coding are categorical where 0 indexes a reference category. The ones without coding matrices are continuous variables.

Table 2

Education: Sample Summary Statistics

	All children (6≤schage≤15)	Tested children			t[a]	
		Group A	Group B	Group C		
Living with parents within the same household or not		Both alive, living together	Left single parent, living together	Left single parent, not living together or lost both	Group A – Group B	Group B – Group C
Groups						
Group A	0.20					
	(0.40)					
Group B	0.12					
	(0.32)					
Group C	0.22					
	(0.41)					
Outcomes						
Enrollment ratio	0.97	0.99	0.96	0.94	3.64***	2.19*
	(0.18)	(0.09)	(0.19)	(0.24)		
Primary	0.98	1.00	0.97	0.97	2.77**	0.96
	(0.14)	(0.06)	(0.16)	(0.18)		
Secondary	0.94	0.98	0.94	0.90	2.11*	1.73
	(0.24)	(0.14)	(0.24)	(0.30)		
Proper grade[b]	0.31	0.36	0.31	0.22	1.92	4.36***
	(0.46)	(0.48)	(0.46)	(0.41)		
Primary	0.37	0.42	0.38	0.29	1.31	3.27**
	(0.48)	(0.49)	(0.49)	(0.45)		
Secondary	0.15	0.19	0.18	0.11	0.12	2.30*
	(0.36)	(0.39)	(0.39)	(0.32)		
Key Variables						
Mother's Education Level	1.45	1.69	1.49	1.16	4.06***	6.51***
	(1.02)	(1.01)	(0.98)	(0.99)		
None	0.18	0.12	0.16	0.23	-2.02*	-3.74***
	(0.38)	(0.33)	(0.37)	(0.42)		
Primary	0.34	0.34	0.37	0.32	-1.25	2.24*
	(0.47)	(0.47)	(0.48)	(0.47)		
Secondary	0.21	0.26	0.26	0.14	-0.10	6.15***
	(0.41)	(0.44)	(0.44)	(0.35)		
Higher	0.19	0.28	0.19	0.11	4.35***	4.43***
	(0.39)	(0.45)	(0.39)	(0.31)		
Wealth Index Quintiles	1.84	2.12	1.68	1.69	6.20***	-0.14
	(1.40)	(1.52)	(1.37)	(1.34)		
Poorest	0.23	0.22	0.27	0.25	-2.54*	1.08
	(0.42)	(0.41)	(0.44)	(0.43)		
Second	0.22	0.18	0.22	0.25	-1.85	-1.51
	(0.41)	(0.38)	(0.41)	(0.43)		
Middle	0.20	0.16	0.20	0.20	-2.45*	0.33
	(0.40)	(0.36)	(0.40)	(0.40)		

Fourth	0.19	0.17	0.19	0.19	-0.85	-0.20
	(0.39)	(0.38)	(0.39)	(0.39)		
Richest	0.16	0.28	0.12	0.12	8.24***	0.31
	(0.37)	(0.45)	(0.33)	(0.32)		
Demographic Characteristics						
Population[c]	0.26	0.05	0.03	0.06		
	(0.44)	(0.22)	(0.17)	(0.23)		
Female	0.50	0.49	0.48	0.49	0.08	-0.24
	(0.50)	(0.50)	(0.50)	(0.50)		
Age at beginning of school year	10.44	10.19	10.86	11.26	-4.85***	-3.02**
	(2.85)	(2.80)	(2.77)	(2.70)		
Christian	0.92	0.87	0.94	0.91	-5.33***	2.84**
	(0.27)	(0.32)	(0.23)	(0.29)		
Rural	0.79	0.68	0.76	0.86	-3.58***	-4.88***
	(0.41)	(0.47)	(0.43)	(0.35)		
Parents' AIDS Symptom	0.08	0.14	0.07	0.04	5.27***	2.28*
	(0.26)	(0.35)	(0.25)	(0.20)		
Water Sanitation	0.62	0.69	0.61	0.59	3.23**	0.93
	(0.48)	(0.46)	(0.49)	(0.49)		
Dependency Ratio	2.13	1.47	2.12	2.13	-9.72***	-0.11
	(1.64)	(0.80)	(1.58)	(1.49)		
The Sick Ratio	0.12	0.09	0.14	0.12	-2.23*	0.60
	(0.44)	(0.27)	(0.44)	(0.56)		
Regional characteristics						
Hhohho	0.23	0.28	0.25	0.20	1.67	2.16*
	(0.42)	(0.45)	(0.43)	(0.40)		
Manzini	0.22	0.29	0.23	0.20	2.67**	1.55
	(0.42)	(0.45)	(0.42)	(0.40)		
Shiselweni	0.30	0.21	0.30	0.33	-4.08***	-1.45
	(0.46)	(0.41)	(0.46)	(0.47)		
Lubombo	0.26	0.22	0.22	0.27	-0.22	-2.07*
	(0.44)	(0.41)	(0.42)	(0.44)		
Sample Size	5,617	1,103	652	1,215		
Primary	3,993	822	435	745		
Secondary	1,624	281	217	470		

Note: See text for definitions. Standard deviations are given in parentheses.

[a]Test of equality of means in Group A and B, and in Group A and C. *** p<0.001, ** p<0.01, * p<0.05

[b]Whether a child is in the officially recommended grade for the age or not.

[c]The percentage out of the whole population of all ages.

Table 3

Education: Odds Ratios from Logistic Regressions

	Enrollment ratio			Proper grade		
	Base (1)	With Wealth (2)	With Wealth and Mom's Education (3)	Base (5)	With Wealth (6)	With Wealth and Mom's Education (7)
Parental Effect (Group A omit.)						
Group B	0.227***	0.245***	0.200***	0.989	1.032	1.053
	(0.092)	(0.098)	(0.084)	(0.121)	(0.128)	(0.131)
Group C	0.154***	0.157***	0.217***	0.710**	0.720**	0.768*
	(0.058)	(0.059)	(0.090)	(0.079)	(0.081)	(0.089)
Wealth		1.387**	1.234		1.252***	1.161***
		(0.143)	(0.173)		(0.050)	(0.052)
Mother's Education			1.533**			1.179**
			(0.283)			(0.068)
Age at beginning of school year (6≤schage≤7 omit.)						
8≤ schage ≤ 12	1.120	1.097	1.121	0.300***	0.291***	0.297***
	(0.422)	(0.412)	(0.422)	(0.035)	(0.035)	(0.036)
13≤ schage ≤15	0.374**	0.349**	0.501	0.129***	0.120***	0.126***
	(0.134)	(0.125)	(0.193)	(0.018)	(0.017)	(0.019)
Demographic characteristics						
Female	1.306	1.285	1.557*	1.447***	1.451***	1.387***
(Male omit.)	(0.277)	(0.273)	(0.398)	(0.131)	(0.133)	(0.130)
Rural	1.318	1.941*	1.810	0.561***	0.728*	0.733**
(Urban omit.)	(0.381)	(0.639)	(0.717)	(0.065)	(0.092)	(0.095)
Christian	1.478	1.258	1.228	1.391*	1.285	1.275
(Non-Christian omit.)	(0.494)	(0.434)	(0.522)	(0.222)	(0.211)	(0.213)
Parents' AIDS Symptom	1.008	0.993	1.478	0.934	0.943	0.988
	(0.508)	(0.522)	(0.933)	(0.148)	(0.152)	(0.162)
Water Sanitation	1.043	0.892	1.139	1.016	0.896	0.902
	(0.231)	(0.192)	(0.288)	(0.101)	(0.092)	(0.096)
Dependency Ratio	1.043	1.094	1.248*	0.965	1.005	0.998
	(0.083)	(0.090)	(0.151)	(0.036)	(0.038)	(0.039)
The Sick Ratio	0.782*	0.781	0.879	1.092	1.105	1.152
	(0.088)	(0.110)	(0.151)	(0.098)	(0.095)	(0.111)
Constant	140.688***	72.107***	30.989***	1.622*	0.944	0.846
	(84.204)	(44.781)	(22.255)	(0.386)	(0.244)	(0.232)
Control for regions	yes	yes	yes	yes	yes	yes

Observations	2,965	2,965	2,704	2,970	2,970	2,708
Pseudo R-squared	0.100	0.115	0.106	0.105	0.115	0.107

Note: Robust standard errors clustered are in parentheses. All regressions include controls for region. The estimates report the odds ratios for the probability of orphans (Group B or C) to non-orphans (Group A) based on logit models. *** p<0.001, ** p<0.01, * p<0.05

Table 4

Education: By Group, Odds Ratios from Logistic Regressions

	Enrollment ratio			Proper grade		
Variables	Group A (1)	Group B (2)	Group C (3)	Group A (4)	Group B (5)	Group C (6)
Wealth	0.957	1.762*	1.138	1.006	1.323**	1.283**
	(0.270)	(0.449)	(0.213)	(0.071)	(0.127)	(0.102)
Mother's Education	2.257	1.920*	1.168	1.255*	1.273*	1.038
	(1.006)	(0.530)	(0.288)	(0.117)	(0.166)	(0.101)
Age at beginning of school year (6≤schage≤7 omit.)						
8≤ schage ≤ 12[a]		2.417	0.912	0.313***	0.235***	0.292***
		(1.636)	(0.477)	(0.056)	(0.064)	(0.060)
13≤ schage ≤15	0.246	0.616	0.741	0.135***	0.114***	0.101***
	(0.225)	(0.372)	(0.415)	(0.031)	(0.035)	(0.029)
Demographic characteristics						
Female	1.930	0.835	2.511*	1.380*	1.715**	1.208
(Male omit.)	(1.391)	(0.402)	(0.982)	(0.200)	(0.334)	(0.199)
Rural[b]		11.297***	0.887	0.488***	1.310	1.088
(Urban omit.)		(7.066)	(0.668)	(0.093)	(0.359)	(0.286)
Christian	0.530	0.808	1.631	1.232	2.761	1.029
(Non-Christian omit.)	(0.644)	(0.897)	(0.866)	(0.277)	(1.679)	(0.298)
Parents' AIDS Symptom	1.341	3.147	0.751	1.154	0.660	0.700
	(2.056)	(2.385)	(0.704)	(0.236)	(0.255)	(0.366)
Water Sanitation	1.302	2.397	0.753	1.220	0.977	0.674*
	(0.969)	(1.226)	(0.256)	(0.209)	(0.215)	(0.118)
Dependency Ratio	0.869	1.452	1.285	0.985	1.038	0.984
	(0.454)	(0.352)	(0.185)	(0.091)	(0.066)	(0.062)
The Sick Ratio	0.794	1.416	0.777	1.230	1.187	1.145
	(0.614)	(0.509)	(0.122)	(0.296)	(0.212)	(0.144)
Constant	100.723*	1.413	15.596**	1.181	0.149*	0.823
	(232.322)	(2.224)	(15.674)	(0.498)	(0.117)	(0.400)
Control for regions	yes	yes	yes	yes	yes	yes
Observations	857	638	963	1,103	638	967
Pseudo R-squared	0.161	0.231	0.0692	0.124	0.126	0.0997

Note: Robust standard errors clustered are in parentheses. All regressions include controls for region. The estimates report the odds ratio for the probability of enrolling in school and of being in the proper grade. *** p<0.001, ** p<0.01, * p<0.05

[a]Regression (1): All in Group A whose ages are between 6 and 7 are enrolled in school, and thus 8≤ schage ≤ 12 is the base for 13≤ schage ≤15, which makes the sample size be shrunk from 1,103 to 857.

[b]Regression (1): All in Group A living in an urban area are enrolled in school, so it is omitted.

Table 5

Health: Sample Summary Statistics

	All children (0≤schage≤5)	Tested children			t^a	
		Group A	Group B	Group C		
Living with parents within the same household or not		Both alive, living together	Left single parent, living together	Left single parent, not living together or lost both	Group A – Group B	Group B – Group C
Groups						
Group A	0.26					
	(0.44)					
Group B	0.04					
	(0.20)					
Group C	0.06					
	(0.24)					
Outcomes						
Fully Vaccinated	0.32	0.35	0.32	0.26	0.96	1.19
	(0.47)	(0.48)	(0.47)	(0.44)		
BCG	0.70	0.75	0.58	0.50	4.37***	1.59
	(0.46)	(0.58)	(0.50)	(0.50)		
Polio	0.53	0.58	0.43	0.37	3.57***	1.18
	(0.50)	(0.49)	(0.50)	(0.48)		
DPT/HepB/Hib	0.61	0.65	0.51	0.46	3.34**	0.92
	(0.49)	(0.48)	(0.50)	(0.50)		
Key Variables						
Immunization Card	0.83	0.86	0.80	0.72	1.39	1.56
	(0.38)	(0.34)	(0.40)	(0.45)		
Mother's Education Level	1.65	1.88	1.60	1.06	3.38***	5.59***
	(1.00)	(0.95)	(0.98)	(0.93)		
None	0.13	0.08	0.16	0.31	-2.71**	-3.61***
	(0.34)	(0.27)	(0.37)	(0.46)		
Primary	0.34	0.29	0.28	0.41	0.22	-2.71**
	(0.47)	(0.46)	(0.45)	(0.49)		
Secondary	0.27	0.31	0.36	0.18	-1.30	3.91***
	(0.45)	(0.46)	(0.48)	(0.39)		
Higher	0.26	0.32	0.20	0.09	3.60***	3.00**
	(0.44)	(0.47)	(0.40)	(0.29)		
Wealth Index Quintiles	1.84	2.30	1.58	1.35	6.23***	1.67
	(1.42)	(1.49)	(1.35)	(1.29)		
Poorest	0.24	0.18	0.30	0.36	-3.14**	-1.24
	(0.43)	(0.38)	(0.46)	(0.48)		
Second	0.20	0.15	0.21	0.22	-1.74	-0.17
	(0.40)	(0.36)	(0.41)	(0.41)		
Middle	0.20	0.18	0.22	0.23	-1.06	-0.22
	(0.20)	(0.39)	(0.41)	(0.42)		
Fourth	0.18	0.17	0.16	0.12	0.12	1.35
	(0.39)	(0.37)	(0.37)	(0.32)		

Richest	0.17	0.32	0.11	0.08	7.38***	0.88
	(0.38)	(0.47)	(0.31)	(0.28)		
Demographic Characteristics						
Population[b]	0.18	0.05	0.01	0.01		
	(0.38)	(0.21)	(0.09)	(0.11)		
Female	0.50	0.52	0.55	0.48	-0.65	1.51
	(0.50)	(0.50)	(0.50)	(0.50)		
Age	2.27	2.11	3.08	3.29	-7.02***	-1.37
	(1.77)	(1.75)	(1.62)	(1.44)		
Christian	0.91	0.87	0.92	0.93	-2.20*	-0.48
	(0.28)	(0.34)	(0.27)	(0.25)		
Rural	0.75	0.59	0.73	0.88	-3.51***	-3.77***
	(0.43)	(0.49)	(0.45)	(0.33)		
Parents' Sickness	0.08	0.15	0.05	0.03	4.40***	1.02
	(0.27)	(0.35)	(0.23)	(0.18)		
Domestic Violence	0.06	0.17	0.01	0.03	10.49***	-1.22
	(0.24)	(0.37)	(0.11)	(0.17)		
Water Sanitation	0.64	0.72	0.61	0.58	2.70**	0.55
	(0.48)	(0.45)	(0.49)	(0.49)		
Dependency Ratio	1.98	1.30	2.25	2.27	-6.83***	-0.09
	(1.55)	(0.73)	(1.77)	(1.45)		
Mother's Age at birth	0.79	0.89	0.90	0.71	-0.31	3.08**
	(0.54)	(0.52)	(0.55)	(0.56)		
Exposure to Media	1.06	1.28	0.90	0.89	5.65***	0.19
	(0.78)	(0.75)	(0.79)	(0.76)		
Regional characteristics						
Hhohho	0.22	0.29	0.22	0.19	2.12*	0.58
	(0.42)	(0.46)	(0.41)	(0.40)		
Manzini	0.25	0.34	0.25	0.19	2.18*	1.52
	(0.43)	(0.47)	(0.44)	(0.39)		
Shiselweni	0.29	0.16	0.36	0.32	-5.14***	0.86
	(0.45)	(0.37)	(0.48)	(0.47)		
Lubombo	0.24	0.21	0.16	0.29	1.46	-3.15**
	(0.43)	(0.41)	(0.37)	(0.46)		
Sample Size	3,846	986	165	242		

Note: See text for definitions. Standard deviations are given in parentheses.

[a]Test of equality of means in Group A and B, and in Group A and C. *** p<0.001, ** p<0.01, * p<0.05

[b]The percentage out of the whole population of all ages.

Table 6

Health: Full Vaccination Rates from Logistic Regressions & Number of Times Vaccinated from Zero-inflated Poisson Regression

	Fully Vaccinated[a]			Number of Times Vaccinated[b]			
	Base Sample (1)	Wealth and Mom's Edu (2)	Immunization Card (3)	***Poisson (Count)***	$exp^{Coef.}$	***Logit (Inflate)***	$exp^{Coef.}$
Parental Effect (Group A omit.)							
Group B	0.749	0.748	0.710	-0.015	0.985	135.365***	6.141e+58
	(0.151)	(0.150)	(0.244)	(0.027)		(5.466)	
Group C	0.658*	0.679*	0.887	-0.004	0.996	295.301***	1.769e+128
	(0.118)	(0.123)	(0.329)	(0.026)		(9.400)	
Wealth		0.925	1.049	-0.004	0.996	-69.042***	1.036e-30
		(0.072)	(0.123)	(0.010)		(2.375)	
Mother's Education		1.057	1.047	0.012	1.012	70.795***	5.568e+30
		(0.085)	(0.133)	(0.011)		(3.022)	
Immunization Card			147.241***	0.505***	1.658	-161.634***	6.357e-71
			(64.150)	(0.036)		(4.572)	
Demographic characteristics							
Age	0.554***	0.554***	1.971***	0.053***	1.055	-14.419***	5.469e-7
	(0.023)	(0.023)	(0.209)	(0.007)		(1.089)	
Female	1.025	1.024	0.586*	-0.041*	0.960	-50.812***	8.564e-23
(Male omit.)	(0.130)	(0.130)	(0.123)	(0.017)		(2.858)	
Exposure to Media	1.134	1.214	1.193	0.018	1.018	-67.027***	7.774e-30
	(0.104)	(0.145)	(0.207)	(0.014)		(2.727)	
Rural	1.469*	1.405	1.063	-0.004	0.996	-119.256***	1.613e-52

(Urban omit.)	(0.240)	(0.253)	(0.274)	(0.021)		(3.878)	
Parents' AIDS Symptom	0.755	0.763	0.687	-0.038	0.963	-8.696**	1.672e-4
	(0.146)	(0.147)	(0.227)	(0.031)		(3.306)	
Water Sanitation	1.364*	1.389*	1.217	0.013	1.013	-46.677***	5.352e-21
	(0.204)	(0.213)	(0.301)	(0.021)		(1.696)	
Dependency Ratio	1.138*	1.135*	0.952	-0.004	0.100	-15.328***	2.203e-7
	(0.069)	(0.069)	(0.107)	(0.009)		(0.778)	
Constant	2.332**	2.317**	0.019***	0.434***	1.543	-249.385***	4.936e-109
	(0.658)	(0.733)	(0.012)	(0.050)		(15.412)	
Control for Regions	yes	yes	yes	yes	yes	yes	yes
Observations	1,393	1,391	982	982(Nonzero obs: 965, Zero obs: 17)			
Pseudo R-squared	0.170	0.170	0.371				

Note: Robust standard errors clustered are in parentheses. All regressions include controls for regions. *** p<0.001, ** p<0.01, * p<0.05

[a]Regression (1)-(3): the estimates report the odds ratios for the probability of being fully vaccinated of all vaccines and of being not vaccinated at all from logistic regressions.

[b]Regression: Zero-inflated Poisson model is used to estimate coefficients. The expected number of being fully vaccinated changes by $\boldsymbol{exp}^{\boldsymbol{Coef.}}$ for each unit increase in the corresponding predictor.

Figure 1
Primary and Secondary School Enrollment Ratio by Groups

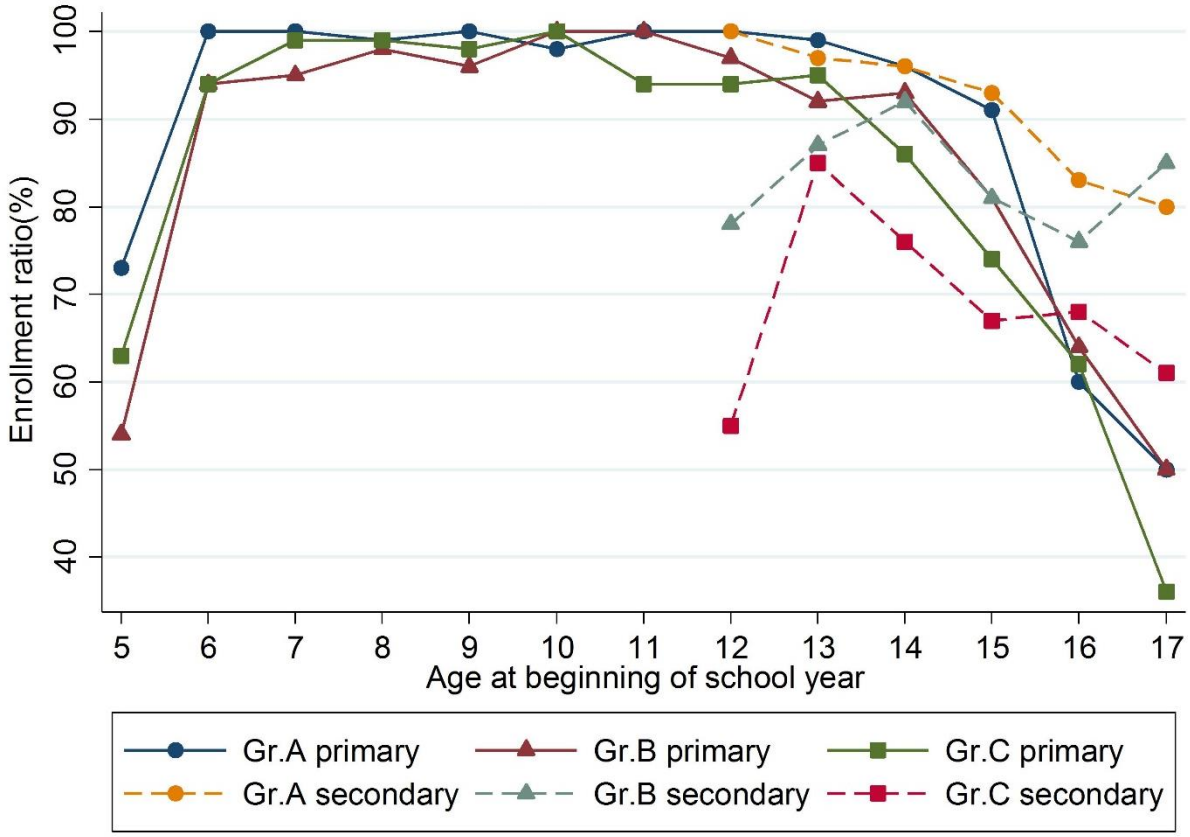

Figure 2
The Ratio of Whether a Child is at the Proper Grade at the Age or Not

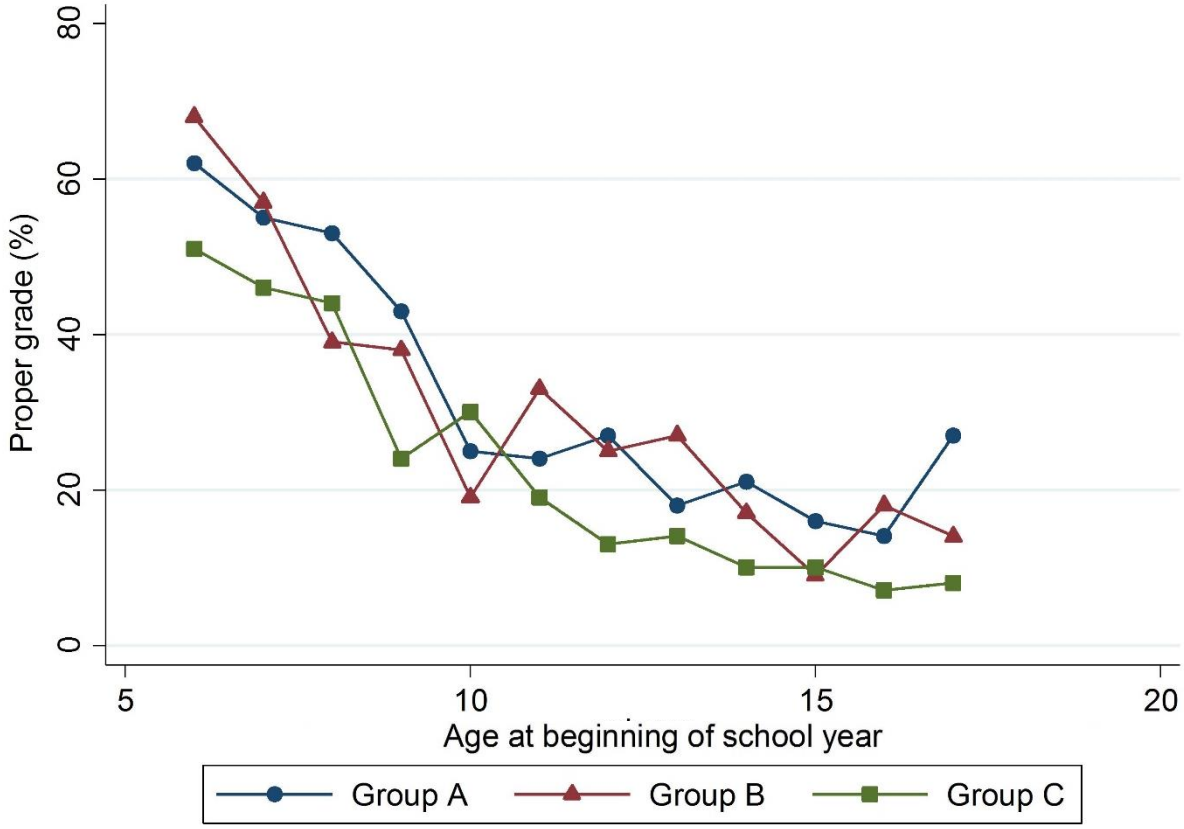

Figure 3
Histogram of the Number of Times Vaccinated by Immunization Card