THE POWER OF A MOTHER’S KNOWLEDGE: WOMEN’S KNOWLEDGE OF HIV AND THEIR CHILDREN’S BIRTH WEIGHTS IN LESOTHO

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By

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ABSTRACT

Ranking third in the world for HIV prevalence in adults age 15-29, Lesotho is facing a generalized HIV epidemic. There is strong evidence that HIV status is associated with giving birth to children with low birth weights, increasing the likelihood of lifelong health problem in those children. The uptake of antiretroviral therapy among pregnant women has marked a decrease in the occurrence of low birth weights among HIV-positive women. Given this dynamic, and the evidence that health knowledge is associated with health outcomes, HIV knowledge may be a better indicator for women at risk of giving birth to children with low weight than HIV status. Using DHS data from Lesotho, we analyzed the relationship between a mother’s HIV knowledge and her children’s birth weights. Two metrics of knowledge were used: a score variable, created by tallying answers to eight HIV related questions in the data, and a factor variable, created through factor analysis to identify the underlying element associated with how women answered these questions.

An OLS model controlling for confounding factors and using instrumental variables was utilized for both measures of HIV knowledge. This study found that a one-unit increase in the score variable is associated with approximately a 3.84 percent increase in birth weight (p=0.001) and a one-unit increase in the factor variable is associated with approximately a 19.72 percent increase in birth weight (p=0.005). While there are limitations to this study and more research is needed, this initial evidence can be used to advocate for a
reinvestment of funds into education-based HIV programming. This will not only enable women to advocate for their own health through knowledge but also ensure their children have the best possible health outcomes.
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Margaret V McCarten-Gibbs
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1. Introduction

It has been well established that there is a relationship between a mother’s HIV status and her child’s birth weight. Infants exposed to HIV in utero consistently have lower birth weights, which can have lifelong consequences. With the uptake of antiretroviral therapy (ART) among pregnant women, which has been shown to decrease the occurrence of HIV-related low birth rates, HIV status may no longer be a good indicator of mothers at risk for giving birth to children with low birth weights. This study aims to determine whether a mother’s knowledge of HIV is associated with her children’s birth weights.

Lesotho has one of the highest HIV rates in the world, as well as a high percentage of infants with low birth weights. Given the high prevalence of both issues, Lesotho not only serves as an opportune population in which to analyze this relationship, but also an ethically sound one. The high prevalence of HIV in such a small country shows a need for more inventive and holistic interventions. Studying the relationship between HIV and birth weight may result in a push for interventions that address both problems.

Through this study, we hope to contribute evidence of this relationship to the existing literature. Current literature includes numerous studies on the relationship between a mother’s HIV status and her children’s birth weights, as well as the effect of health education or knowledge on behavior, but there is little evidence specifically tying HIV knowledge to birth weight. The results of this study can serve as justification for investing in more education-based HIV interventions, to address not only infection but also the effect of low birth weights in children.
2. Background

Over 95 percent of HIV infections take place in developing countries ("HIV/AIDS," n.d.), and women are at a much higher risk of contracting the infection than men. In 2013, women between the ages of 15 to 24 accounted for 60 percent of all new HIV infections among young people and HIV was the leading cause of death among women of reproductive age ("Women and HIV and AIDS,” 2016). This issue is even more severe in sub-Saharan Africa, which is home to two-thirds of HIV infections globally ("HIV/AIDS," n.d.) and 80 percent of all young women living with HIV ("Women and HIV and AIDS,” 2016). Lesotho, one of sub-Saharan Africa’s smallest countries, is facing a generalized HIV epidemic, ranking third in the world for HIV prevalence in adults age 15-29 ("Country comparison,” n.d.).

Lesotho is a country of around 2 million people with a ground area of 30,355 sq km, which is slightly smaller than Maryland. The country is completely surrounded by South Africa and ruled by a parliamentary monarchy. It is led by Prime Minister Pakalitha Mosisili, with King Letsie III serving as a ceremonial figurehead. The country has ten distinct districts. Maseru is the most populous district, housing the country’s capital and largest city. It is a mountainous country made up of highlands, with many of its villages unreachable by road ("The world factbook," 2017). Its ethnic makeup is very homogenous, with 99.7 percent of the population identifying as Basotho. Around 43 percent of its population lives below the international poverty line of US$1.25 per day ("Statistics: Lesotho,” 2013).

According to the 2015 Lesotho HIV and AIDS Spectrum Estimates Report, the prevalence of HIV in Lesotho is around 23 percent. Women bear a greater burden of this
epidemic than men, with a prevalence of 27 percent among women compared to 18 percent among men ("LDHS," 2009). Prevalence also varies among subgroups, with sex workers and men who have sex with men being among the groups with the highest prevalence. Pregnant women are also considered a high-risk group, with a prevalence of 25.9 percent. While the prevalence among pregnant women is lower than that of women in general, it is higher than the national prevalence. Furthermore, mother-to-child transmission (MTCT) of HIV accounts for 15 percent of new infections ("Global aids response progress report," 2015), making HIV infections among pregnant women an important area of focus. MTCT also creates a major obstacle for the campaign to achieve a generation without AIDS.

Lesotho did not meet its target of reducing HIV incidence by 50 percent by 2015, but there have been increases in rates of HIV testing and counseling (HTC) and a significant decline in the proportion of people who had never been tested for HIV ("Global aids response progress report," 2015). The 2009 and 2014 LDHS show that 28 percent fewer men and 19 percent fewer women reported never having been tested for HIV. While HTC has increased, LDHS data show that comprehensive knowledge on HIV has historically been low and has shown little improvement.

Lesotho is participating in the PEPFAR’s Accelerating Children’s HIV/AIDS Treatment Initiative, a program that provides children living with HIV/AIDS with ART. This program includes HTC, voluntary medical male circumcision, and preventive measures for MTCT. In 2016 alone, PEPFAR spent US$41 million in Lesotho to provide ART for 127,706 people, HTC for over 623,180 people, medical care for 37,407 orphans and vulnerable children affected by HIV/AIDS, and ART for 6,233 pregnant women living with HIV to
reduce MTCT (“Partnering to Achieve Epidemic Control,” 2016). The country also enacted its own nationwide campaign in 2008 called “Know Your Status,” in which the Prime Minister of Lesotho, Pakalitha Mosisili, was publicly tested for HIV in his home village. He then challenged all government officials and leaders to get tested, setting an example and attempting to break the stigma around HIV ("WHO applauds Lesotho," n.d.).

Between 2014 and 2018, the available financing for HIV response in Lesotho is estimated to be US$344 million. This leaves a funding gap of US$249 million for HIV programming according to the country’s Ministry of Health. In 2014, the Government of Lesotho contributed about 26 percent of the financial resources committed to the HIV response and in 2015 the domestic contribution was increased to 34 percent. Projections of international contributions expect to see a 25 percent decline, expanding the existing gap in funding ("HIV and AIDS in Lesotho," 2016). The Global Fund, PEPFAR, the EU, and the UN family provide much of the international funds received by Lesotho. (“Global aids response progress report,” 2015).

3. Previous Evidence

Many women face barriers to accessing effective and appropriate health care, many of which are created by social structures, such as gender-based discrimination and health systems without services tailored to women’s needs. In many places, this issue is compounded by low literacy rates, lack of education, and limited income. These factors limit a woman’s ability to seek appropriate health care and make informed decisions about her health. These barriers can become even more of a challenge when a woman becomes pregnant. Without the autonomy to seek and access adequate health care, women face
numerous complications that can affect their physical and mental health ("Women and Health." 2009). In addition to facing barriers, women also are at a greater risk of contracting HIV than men. The rate of male to female HIV transmission is two to three times higher than the rate of female to male transmission. There is evidence that the cells of the cervix, as well as vaginal inflammation, can facilitate entry of the virus. Furthermore, during pregnancy a woman’s immune function is suppressed increasing her susceptibility to infection ("HIV in pregnancy," 1998).

A woman’s increased risk of contracting HIV and the barriers to accessing help can have lifelong health implications for her children. There is a well-established link between a mother’s HIV status and her children’s birth weights. A 1996 study examined the association between the risk of low birth weights and HIV infection in mothers. It followed a cohort of 2,377 who had delivered a live-born child and were enrolled in the New York State Medicaid program, 772 of which were HIV-positive women. In the sample, 29 percent of HIV-infected women delivered a low birth weight child compared to 9.3 percent of non-infected women. After adjusting for maternal clinical, demographic, and health care delivery factors, they found that women with HIV still had two times higher risk of giving birth to a child with a low birth weight [odds ratio (OR) = 2.04; 95 percent confidence interval (CI) = 1.54-2.69] (Markson et al., 1996).

This relationship was also found in a 1990 case-control study in Kenya. The study included 177 HIV-positive and 326 HIV-negative women and their newborns. The mean birth weight of a child born to an HIV-positive woman was significantly lower than that of a child born to an HIV-negative woman: 3090 grams compared to 3220 grams (p = 0.005). Low birth weights, less than 2500 grams, represented 9 percent of cases and 3 percent of
controls (OR = 3.0; p = 0.007). (Braddick et al., 1990)

A 2006 study using data from the longitudinal Pediatric Spectrum of HIV Disease study cohort found that with the increased use of ARTs among pregnant women, the rate of low birth weights among children of HIV-positive women has decreased. The study analyzed trends in low birth weights among 11,321 infants of HIV-infected women in the United States. It found that HIV testing increased from 32 percent to 97 percent from 1989 to 2004, and low birth weights among the infants of HIV-positive women decreased from 35 percent to 21 percent during that same period. They also found that, despite an observed rate decrease, low birth weight was still significantly higher among infants born to HIV-infected women. They found prevalence rates as high as 48 percent for HIV-infected women compared to 8 percent for non-infected women. This study offers evidence that low birth weight has declined among infants born to HIV-positive women during a period of increased emphasis on HIV testing of pregnant women and ART (Schulte et al., 2006).

Understanding this link is essential to children’s health. Around of 11 percent of children born in Lesotho have a low birth weight, compared to only 8 percent in the United States. Low birth weight has serious and long-lasting effects on a child. A low birth weight is considered any newborn weight less than 2,500 grams. Low birth weight is a strong indicator of a child’s health and is associated with an increased likelihood of dying early in life. Low birth weight is also associated with impaired immune function and an increased risk of contracting disease. Infants with low birth weights are also likely to have reduced muscle strength, cognitive abilities, and IQs, and are more likely to suffer from diabetes and heart disease as adults (“Undernourishment in the womb,” 2016).
Both studies conducted in the 1990’s, before PEPFAR’s establishment and the global push to address HIV, showed a strong and significant relationship between a mother’s HIV status and her children’s birth weights. The 2006 study found an increase in testing and in ART use, as well as a decrease in low birth weights among the children of HIV-positive women. With the uptake of ART among pregnant women, HIV status may no longer be a good indicator of mothers at risk of giving birth to children with low birth weights. A mother’s knowledge of HIV, on the other hand, influences her ability to advocate for her health, engage in healthy behaviors, and seek proper prenatal care.

There is also an abundance of studies analyzing the relationship between health knowledge and health outcomes. A 2004 school-based study analyzed the associations between condom use, sexual behaviors, and HIV/AIDS knowledge. The study included 13,293 students, ages 11 to 24, from a random sample of public schools in the central Mexico. The students answered a questionnaire and the researcher used logistic regression to analyze the propensity for condom use and certain sexual behaviors in relation to HIV knowledge. The study found that men with high levels of HIV knowledge had an increased probability of using condoms (OR=1.4; CI=1.1-1.7), while women with the same level of HIV had a decreased probability of using condoms (OR=0.7; CI=0.5–1.0). When is came to number of sexual partners though, more knowledgeable men participated in riskier behaviors than knowledgeable women, with men being more likely to have had three or more sexual partners (OR=1.7; CI=1.3–2.2) and women being more likely to have had one lifetime sexual partner (OR=0.6; CI=0.4–0.9) (Tapia-Aguirre et al., 2004). This study found a strong relationship between health knowledge and health behavior, but the findings were
not able to establish an overall direction of this association. Furthermore, the gender differences in these findings may be due to social pressures and expectations.

A 2012 study aimed to analyze the relationship the availability of interactive features on an eHealth application and individuals’ health outcomes, mediated by health knowledge and empowerment. They recruited 165 participants and randomly assigned them to three study groups with differing levels of functional interactivity. They found that the main variable of interest, functional interactivity, had no impact on empowerment or knowledge, but they did find a strong relationship between knowledge and health outcomes. They found that knowledge positively affected health outcomes \( (p = .02) \) (Camerini & Johannes Schulz, 2012). Although this study’s ultimate goal was not to analyze the relationship between health knowledge and health outcomes, it serves as strong evidence that there is indeed a connection between these two factors.

Evidence of this relationship is strengthened by a 2004 study analyzing the effect of a participatory intervention with women on birth outcomes. The study pair-matched 42 clusters in Nepal and then randomly selected 12 and assigned one of each pair to an intervention or control group. The intervention was comprised of women’s group meetings lead by a female facilitator nine times a month. In these meetings, the facilitator used an action-learning cycle to identify perinatal problems and formulate strategies to address them. Although none of the facilitators were health professionals, they received training in perinatal health. The facilitators discussed issues regarding childbirth and health behaviors. One result of these meetings was that women sought additional information about perinatal health. The study analyzed the birth outcomes of 28,931 women, 8 percent of which had participated in the women’s group meetings.
The study found that the neonatal mortality rate was 26.2 per 1,000 in the intervention group compared with 36.9 per 1,000 in controls (OR= 0.70; CI=0.53–0.94) and the maternal mortality ratio was 69 per 100,000 in the intervention group compared with 341 per 100,000 in controls (OR=0.22; CI=0·05–0·90). They also found that women in the intervention group were more likely to have antenatal care, institutional delivery, trained birth attendance, and hygienic care than controls (Manandhar et al., 2004). This study shows that gaining health knowledge through these group meetings was associated with a decrease in negative birth outcomes and an increase in positive health behaviors, such as seeking appropriate prenatal care. It is reasonable to assume, based on this study, a similar program focusing on HIV would also result in positive birth outcomes, such as higher birth weights.

Based on the evidence that HIV status is associated with negative birth outcomes and health knowledge is associated with health outcomes, it seems likely that increases in HIV knowledge would be associated with healthier birth weights. Adding to the evidence of this relationship may encourage the creation of policy and programs that focus on educating mothers and young women who may become mothers about HIV, instead of solely implementing programs that focus on increasing the uptake of pre-exposure prophylactics and ART. While these drugs are highly effective in decreasing the spread of HIV and HIV-related low birth weights, evidence showing a positive relationship between a mother’s HIV knowledge and her children’s birth weights may encourage programs to implement more education-based activities. This would allow mothers to advocate for themselves and consciously choose health behaviors that would decrease their likelihood of contracting HIV. This type of programming could both increase HIV-positive women’s
awareness about the precautions they should take if they become pregnant and encourage increased awareness in non-infected pregnant women.

UNAIDS and PEPFAR documentation commonly list achieving “a generation without HIV” among their goals, referring to MTCT. This goal should include not only eliminating MTCT, but also the other health implication of being born to an HIV-positive mother. A generation born without HIV, but with an increased likelihood of dying early in life and impaired immune function, which increases their likelihood of contracting HIV later on in life, due to a low birth weight is not necessarily better off than the preceding generation. If, as we hypothesize, a mother’s knowledge of HIV is associated with low birth weights than HIV programming can utilize this relationship and expand HIV education programming, to not only address the HIV epidemic in Lesotho but to also address the effect of low birth weights.

4. Conceptual Framework

This study utilizes two conceptual theories through which to understand how a mother’s knowledge of HIV would affect the birth weight of her infant. These are the economic-based Grossman’s health production function and the public health-based Social Cognitive Theory. These two frameworks conceptualize how people understand their health and how people behave in regards to their health.

Economists use Grossman’s health production function to model health-related behavior. A person’s underlying level of health is treated as a capital good, also called Health Capital, which cannot be acquired immediately but can be increased by investments over time. Health Capital relates to a person’s overall, such as her predisposition for
disease and her ability to perform daily tasks. This model assumes that an individual decides how much to invest in her Health Capital by calculating costs and benefits over time. Grossman’s model estimates that the optimal level of investment in health capital occurs where the marginal cost equals the marginal benefit. The gross investment production function can be written as

\[ I = I(M, TH) \]

where \( I \) represents the health investment, \( M \) represents the market health inputs, such as medical services and prescription drugs, and \( TH \) represents the time spent improving one’s health (Laporte, 2015). This framework can elucidate how women chose to invest in their health through education.

The Social Cognitive Theory postulates that behavior is determined by expectancies and incentives. There are three types of expectancies in this theory. They are expectancies about environmental cues, the consequences of one’s actions, and one’s ability to perform the behavior needed to influence outcomes, also known as self-efficacy. Self-efficacy is especially important in understanding health. A woman who believes she has the ability to influence the outcome of a situation is much more likely to actually be able to influence that situation through her choices. This dynamic is crucial for health education in which a person taking control of her own health is essential. Incentives are the value of an outcome, for instance, health status. This aspect of the theory suggests that behavior is determined by its consequences, but that individuals understand the same consequences differently. For example, women who have never heard of HIV will have a lower expectation of consequences associated with the disease than those who are familiar with
the disease, and thus are likely to participate in high-risk behaviors. (Rosenstock, Strecher, & Becker, 1988.)

Figure 1. visually represents the relationship between our dependent birth weight variable and independent mother's HIV knowledge variable, given our utilization of Grossman’s health production function and the Social Cognitive Theory.

![Figure 1. Conceptual Model](image)

Through this lens, we can understand how a mother’s knowledge of HIV affects decision-making abilities about behaviors and how much she is willing to invest in her health. With this framework in place, we can begin our analysis.

5. Data and Empirical Strategy

This study uses data from the Lesotho Demographic and Health Surveys (LDHS) in 2004, 2009, and 2014. The LDHS were implemented by the Lesotho Ministry of Health and
Social Welfare. The surveys were comprised of three questionnaires: the Household Questionnaire, the Woman’s Questionnaire, and the Man’s Questionnaire. This study uses data from the Woman’s Questionnaire, which includes questions covering birth history, knowledge of family planning methods, marriage, and sexual activity, and information on children’s health, as well as other question covering health and background characteristics. In addition to collecting information, LDHS also conducted HIV testing. This testing protocol was reviewed and approved by the Research and Ethics Committee at the Ministry of Health and Social Welfare and by the ICF Macro Institutional Review Board. The HIV testing was anonymous. A unique identification number was assigned to each respondent who was tested, and that code was attached to the blood sample and the completed questionnaire.

The cross-sectional data collected by this questionnaire was broken into 7 separate datasets: birth recode, children’s recode, HIV test recode, household member recode, household recode, individual recode, and men’s recode for each year. The HIV test recode and individual recode data are used in this analysis. The individual recode data has one record for every eligible woman, which includes usual household members and visitors. Each individual record provides space for up to 6 children under age 5. Women from the individual recode were identified by their numeric ID and matched with their HIV status from the HIV test recode. The data was then reshaped from mother-level data to child level data and recoded between years to ensure the measure units were consistent across time.

LDHS only collects birth weight data for children under five, therefore only children under the age of 5 with a recorded birth weight were included in this analysis. Of the children in this sample, 13,050 (56.8 percent) had a missing value for birth weight, 2,452
(10.67 percent) were marked as ‘not weighed at birth,’ and 151 (0.66 percent) were marked as ‘don’t know.’ These individuals were not included in this analysis.

LDHS collects birth weights as recorded from a health card or from the mother’s recall. After excluding observations without a recorded birth weight from the sample, we found that 483 (4.93 percent) observations were marked as ‘not weighed’ for their method of collection. We further excluded these observations, as the conflicting labeling makes it impossible to ensure their accuracy. After excluding those observations, 5,349 (60.85 percent) of recorded weights were collected from a health card, 3,389 (38.55 percent) were collected from mother’s recall, and 52 (0.59 percent) were collected from another method.

The LDHS Woman’s Questionnaire includes eight questions used to determine a women’s knowledge of HIV/AIDS. These questions are: 1) Can you reduce the chances of getting AIDS by always using condoms during sex? 2) Can you reduce the chance of getting AIDS by having only 1 sexual partner with no other partners? 3) Can you get AIDS from mosquito bites? 4) Can you get AIDS by sharing food with a person who has AIDS? 5) Can a healthy looking person have AIDS? 6) Can you transmit AIDS to your child during pregnancy? 7) Can you transmit AIDS to your child during delivery? 8) Can you transmit AIDS to your child by breastfeeding? The HIV knowledge score variable was created using these questions. Individuals received plus one point for each correct answer and minus one point for each incorrect answer. Answers of ‘don’t know’ or missing responses received a 0 and thus did not change the score. Once tabulated, a value of eight was added to each score to shift all scores into the positive range. Those who answered ‘no’ to the question ‘have you ever heard of AIDS?’ received an overall score of eight.
Incorrect answers were given a negative point because it is more difficult to change a person’s beliefs once they have embraced them. Individuals with misconceptions about HIV are less likely to be receptive to HIV education and thus these beliefs negatively affect their knowledge of HIV. Answers of ‘don’t know’ or missing responses don’t necessarily have the same effect. For ‘don’t know’ answers, individuals may be more receptive to learning about HIV in the future and thus this does not have a negative or positive effect on their current HIV knowledge. Similarly, the knowledge of individuals with missing responses is unknown so they also received a zero for that question. People who responded ‘no’ to the question ‘have you ever heard of AIDS?’ have in effect answered ‘don’t know’ to every question.

The HIV knowledge factor variable was created using factor analysis. Factor analysis takes multiple variables and identifies similar patterns of responses associated with a latent variable. Using the eight HIV question variables from the dataset, we ran factor analysis to identify the underlying knowledge factor associated with how each woman answered the questions. Each factor explains a certain amount of variation in the observed variables shown by an eigenvalue. As shown in Table 1., the eigenvalues of Factor 1 explained the most variation for questions 1, 6, 7, and 8, as well as the most overall variation. Based on the high eigenvalues, Factor 1 was included in the model as the HIV knowledge factor variable.
The wealth index variable included in this analysis is one created by DHS. It is a measure of the household’s living standard. DHS gathers data on whether a household owns a number of assets, such as televisions, bicycles, farm animals, and access to water and sanitation facilities. This variable is created with principal components analysis, which places individual households on a continuous scale of relative wealth and then separates the households into five wealth quintiles.

All other variables included in this model consist of raw data and were not created from other variables.

### 5.1 Descriptive Statistics

The tables below describe the variables that are included in the model. Weighted mean, standard deviation, and minimum and maximum values are included for continuous variables, while category or response and the corresponding distributions are included for discrete variables. This analysis includes data from 6,793 child-level observations.
Table 2. Continuous Variables

<table>
<thead>
<tr>
<th>Description</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth Weight (grams)</td>
<td>3147.931</td>
<td>8.475575</td>
<td>500</td>
<td>6500</td>
</tr>
<tr>
<td>HIV Score</td>
<td>13.47725</td>
<td>0.0325797</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>HIV Factor</td>
<td>0.0175287</td>
<td>0.744683</td>
<td>-3.169077</td>
<td>0.5096994</td>
</tr>
<tr>
<td>Birth Order</td>
<td>2.258878</td>
<td>0.0219027</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>Mother’s Current Age</td>
<td>27.40816</td>
<td>0.0957222</td>
<td>15</td>
<td>49</td>
</tr>
<tr>
<td>Mother’s Age at 1st Birth</td>
<td>20.21296</td>
<td>0.0503741</td>
<td>10</td>
<td>45</td>
</tr>
<tr>
<td>Total # of Children Born</td>
<td>2.390506</td>
<td>0.0221667</td>
<td>1</td>
<td>12</td>
</tr>
</tbody>
</table>

The average birth weight of a child in Lesotho is around 3147.9 grams, which is in the healthy birth weight range. The lowest birth weight is 500 grams, which is a dangerously low weight for a newborn, and the highest is 6500, which is very large for a newborn. The average value for the HIV score is around 13.4, meaning that most of the individuals surveyed have a moderate to high understanding of HIV. The average age of a woman in Lesotho at the time of her first birth is around 20.2 and she will have an average 2.4 children. This being said both of these variables have large ranges, with women having children as young as 10 and as old as 45, both of which are considered high-risk ages to give birth. The total number of children born to a woman ranges from 1 to 12.

Around 15 percent of the children in this study fall into the low or very low birth weight categories, which is higher than the national rate of 11 percent. The women included in this study are evenly distributed among the wealth quintiles, with approximately 20 percent of the observations in each. Over half of the women have visited a health facility in the last 12 months, but only 5.7 percent have been visited by a family planning worker in that same period. The most commonly cited source of prenatal care is a
nurse or midwife, with 93.15 percent of women reporting having received care. Only 11.48 percent of women reported receiving prenatal care from a doctor.

**Table 3. Discrete Variables**

<table>
<thead>
<tr>
<th>Description</th>
<th>Category</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth weight (category)</td>
<td>very low</td>
<td>0.66</td>
</tr>
<tr>
<td></td>
<td>low</td>
<td>14.79</td>
</tr>
<tr>
<td></td>
<td>normal</td>
<td>80.11</td>
</tr>
<tr>
<td></td>
<td>high</td>
<td>4.43</td>
</tr>
<tr>
<td>Wealth index</td>
<td>poorest</td>
<td>19.67</td>
</tr>
<tr>
<td></td>
<td>poorer</td>
<td>20.21</td>
</tr>
<tr>
<td></td>
<td>middle</td>
<td>20.15</td>
</tr>
<tr>
<td></td>
<td>richer</td>
<td>20.24</td>
</tr>
<tr>
<td></td>
<td>richest</td>
<td>19.73</td>
</tr>
<tr>
<td>Have you been visited by a family planning</td>
<td>no</td>
<td>94.3</td>
</tr>
<tr>
<td>worker in the last 12 months?</td>
<td>yes</td>
<td>5.7</td>
</tr>
<tr>
<td>Have you visited a health facility in the last</td>
<td>no</td>
<td>43.61</td>
</tr>
<tr>
<td>12 months?</td>
<td>yes</td>
<td>56.39</td>
</tr>
<tr>
<td>Receive prenatal care from a doctor</td>
<td>no</td>
<td>88.52</td>
</tr>
<tr>
<td></td>
<td>yes</td>
<td>11.48</td>
</tr>
<tr>
<td>Receive prenatal care from a nurse/midwife</td>
<td>no</td>
<td>6.85</td>
</tr>
<tr>
<td></td>
<td>yes</td>
<td>93.15</td>
</tr>
<tr>
<td>Receive prenatal care from another source</td>
<td>no</td>
<td>99.04</td>
</tr>
<tr>
<td></td>
<td>yes</td>
<td>0.96</td>
</tr>
<tr>
<td>Receive no prenatal care</td>
<td>no</td>
<td>96.52</td>
</tr>
<tr>
<td></td>
<td>yes</td>
<td>3.48</td>
</tr>
<tr>
<td>Prenatal care information is missing</td>
<td>no</td>
<td>86.83</td>
</tr>
<tr>
<td></td>
<td>yes</td>
<td>13.17</td>
</tr>
<tr>
<td>Tested HIV-positive</td>
<td>no</td>
<td>87.71</td>
</tr>
<tr>
<td></td>
<td>yes</td>
<td>12.29</td>
</tr>
<tr>
<td>Tested HIV negative</td>
<td>no</td>
<td>64.33</td>
</tr>
<tr>
<td></td>
<td>yes</td>
<td>35.67</td>
</tr>
<tr>
<td>Test results were indeterminate</td>
<td>no</td>
<td>99.88</td>
</tr>
<tr>
<td></td>
<td>yes</td>
<td>0.12</td>
</tr>
<tr>
<td>No HIV test info available</td>
<td>no</td>
<td>48.08</td>
</tr>
<tr>
<td></td>
<td>yes</td>
<td>51.92</td>
</tr>
</tbody>
</table>
Approximately 12 percent of women in the study had positive HIV test result, which is surprisingly low given that the national prevalence is 23 percent overall and 27 percent among women. This disparity between the national rate and the rate in our sample may be due to the low rate of available HIV status data, with only 48 percent of our sample providing HIV test results. The majority of the women in this study reported primary school as their highest level of education. The women in this study were distributed fairly even among districts, ranging from 8.2 percent to 13.46 percent, with the largest number of respondents being from Maseru.

Initial bivariate analysis shows a slight positive relationship between mean birth weight and HIV knowledge score unit (Figure 1.). As women receive a higher score based on the eight HIV related questions in the DHS questionnaire, the mean birth weight for women who received that score generally trends upward. Given the strong linear relationship between the HIV knowledge score and HIV knowledge factor (Figure 2.), it is
probable that there is a positive relationship between mean birth weight and HIV knowledge factor score also. This provides preliminary evidence that there will be an association between birth weights and the HIV knowledge variables once we run our full model.

Figure 2. Mean Birth Weights per HIV Score
In order to study the relationship between a mother’s knowledge of HIV and her children’s birth weights, we will utilize an IV regression model. Our hypothesis is that an increase in HIV knowledge is associated with an increase in birth weight. Our model will be adjusted for a number of confounding factors, including age, wealth, having been visited by a family planning professional in the last year, visiting a medical facility in the last year, age at first birth, birth order of the child, total number of births, district, education level, source of prenatal care, HIV status, and year.

Young age at first birth is associated with lower birth weights and is confounded by the fact that young mothers have less wealth than older mothers (Dennis & Mollborn,
2013). Furthermore, both factors impact access to HIV knowledge. Young, poor women face many barriers to accessing health care and facilities that would likely provide health education. Similarly, women who have not been visited by a family planning professional or been to a health facility in the last year are less likely to have been exposed to knowledge about HIV. They are also less likely to have received adequate prenatal care, which helps identify women who are at risk of preterm birth and can provide interventions to reduce the occurrence of low birth weights (Alexander & Korenbrot, 1995).

The source of prenatal care could affect birth weight and HIV knowledge, depending on how comprehensive the care was and whether practitioners integrated education or imparted sound knowledge during visits. The order of a child’s birth also affects birth weight and HIV knowledge. Increasing birth order has been found to be associated with increased birth weights (Seidman et al., 1988) and presumably as a woman has more children she will have more access to trained medical professionals, who will likely impart health knowledge during her visits. Undoubtedly HIV status would have a relationship with both factors as well. The existing body of epidemiological evidence has shown that HIV is associated with low birth weights, and being HIV-positive would likely be associated with a low knowledge of HIV prior to infection, as the individual most likely did not take the necessary precautions to prevent infection. This being said, infidelity complicates this factor because partnered couples rarely use prophylactics, meaning that a woman could have a comprehensive knowledge of HIV and still contract the virus through her partner.

Our complete model is specified as:

\[ Y = \beta_0 + \beta_1 HIV_{kn} + \beta_2 BO + \beta_3 Age + \beta_4 Age^2 + \beta_5 WI + \beta_6 FP + \beta_7 HC + \beta_8 D_1 + \beta_9 D_2 + \beta_{10} D_3 + \beta_{11} D_4 + \beta_{12} D_5 + \beta_{13} D_6 + \beta_{14} D_7 + \beta_{15} D_8 + \beta_{16} D_9 + \beta_{17} Edu + \beta_{18} AFB + \beta_{19} TC + \beta_{20} P_{dr} + \beta_{21} P_{mn} + \beta_{22} P_{ot} + \beta_{23} P_{no} + \beta_{24} P_m + \beta_{25} H_m + \beta_{26} H_p + \beta_{27} H_{mi} + \beta_{28} Yr + \varepsilon \]
Where \( Y \) is a logged dependent variable denoting birth weight in grams and \( \text{HIV}_{kn} \) represents the independent variable of interest, HIV knowledge, which will be represented by an HIV score variable and an HIV factor variable in separate models. The control variables are denoted as such: (BO) Birth Order, (Age) Mother’s Age, (Age\(^2\)) Mother’s Age Squared, (WI) Wealth Index, (FP) Visited by a family planning worker in the last 12 months, (HC) Visited a health clinic in the last 12 months, (D\(_1\)) District: Butha Buthe, (D\(_2\)) District: Leribe, (D\(_3\)) District: Berea, (D\(_4\)) District: Mafeteng, (D\(_5\)) District: Mohale’s Hoek, (D\(_6\)) District: Quthing, (D\(_7\)) District: Qasha’s Nek, (D\(_8\)) District: Mokhotlong, (D\(_9\)) District: Thaba-Tseka, (Edu) Education Level, (AFB) Mother’s age at 1st birth, (TC) Total children ever born, (P\(_{dr}\)) Receive prenatal care from a doctor, (P\(_{nm}\)) Receive prenatal care from a nurse, (P\(_{ot}\)) Receive prenatal care from another source, (P\(_{no}\)) Receive no prenatal care, (P\(_{mi}\)) Prenatal care info missing, (P\(_p\)) HIV-positive, (P\(_m\)) HIV test indeterminant, (P\(_m\)) HIV status missing, and (Y) Year.

6. Effect of HIV Knowledge on Birth Weight

6.1 Validity of Relevant and Exogenous Instruments

A valid instrument must be both relevant and exogenous, meaning that the instrument is correlated with the endogenous variable \( X \) (corr \((Z, X) \neq 0\)) and not correlated with the error term (corr \((Z, e) = 0\)). For instrumental variables, we identified “frequency of reading newspaper or magazine” and “frequency of listening to radio.” Conceptually, the frequency of which one accesses media would correlate with how much one hears about HIV and the resulting knowledge of HIV. Because Lesotho has been experiencing a generalized HIV epidemic for years, HIV information is routinely provided through media campaigns and
public service announcements. The Onelove Campaign Lesotho was one such program, which utilized radio and newspapers. The program focused on multiple concurrent partnerships, which has been identified as a key driver of the HIV pandemic in Southern Africa. The Onelove Campaign utilized activities such as a radio, public service announcements, a radio drama, and newspaper advertisements (“Onelove Campaign Lesotho,” n.d.). Furthermore, because these instruments measure actual access to media and not ownership of a radio or newspaper subscription, it is less likely to be associated with socioeconomic factors.

To demonstrate relevance, we regress the instruments, along with the control variables from our full model, on the exogenous HIV knowledge score and HIV knowledge factor variables. The F-statistics for the overall first stage regressions are strongly significant for both the HIV knowledge score and factor variables, with an F-statistic of 33.98 (p=0.000) and 10.56 (0.000) respectively. This shows that both “frequency of reading newspaper or magazine” and “frequency of listening to radio” are relevant to the exogenous HIV knowledge score and factor variables.

To demonstrate exogeneity, we regress the instruments, along with the control variables from the full model, on the residuals from the full model. For both the HIV knowledge score and factor variables, the overall regression, as well as the coefficients for the instruments, is highly insignificant. The overall p-value for the regression using the residuals from the full HIV knowledge score model is 1.000, with the p-values for coefficients on “frequency of reading newspaper or magazine” and “frequency of listening to radio” of 0.957 and 0.944 respectively. The overall p-value for regression using the residuals from the full HIV knowledge factor model is 1.000, with the p-values for
coefficients on “frequency of reading newspaper or magazine” and “frequency of listening to radio” of 0.629 and 0.659 respectively. These tests show “frequency of reading newspaper or magazine” and “frequency of listening to radio” to be valid instruments for both HIV knowledge score and factor variables.

6.2 Main Results

We ran four separate OLS regressions to analyze the relationship between a woman’s knowledge of HIV and her children’s birth weights. We looked at the raw HIV knowledge score, based on the women’s answers to the ten HIV knowledge questions included on the LDHS women’s survey, as well as the factor variable, which was created using factor analysis. For each of these variables, we ran an OLS regression and an IV regression.

| Model                                      | Coef.  | Std. Err. | z    | P>|z| | [95% Conf. Interv|al] |
|--------------------------------------------|--------|-----------|------|------|-----------------|------|
| OLS using HIV score variable without IV    | 0.0015516 | 0.0012928 | 1.20 | 0.230 | -0.0009827       | 0.0040858|
| OLS using HIV score variable with IV       | 0.0383989 | 0.0118791 | 3.23 | 0.001a| 0.0151163        | 0.0616816|
| OLS using HIV factor variable without IV   | 0.0076786 | 0.0041075 | 1.87 | 0.062c| -0.0003733       | 0.0157306|
| OLS using HIV factor variable with IV      | 0.1972028 | 0.0706514 | 2.79 | 0.05a | 0.0587286        | 0.335677|

a. significant at alpha 0.01
b. significant at alpha 0.05
c. significant at alpha 0.10

Of the four models, only the OLS regression using the HIV knowledge score variable without instrumental variables was insignificant (p=0.230). The OLS regression using the
HIV knowledge factor variable without instrumental variables was significant at an alpha level of 5 percent (p=0.230). OLS regressions on both HIV knowledge variables using instrumental variables were highly significant at an alpha level of 1 percent (p=0.001; p=0.005). Because true knowledge is difficult to measure and is affected by many aspects of life, both observable and not, it is highly likely that both HIV knowledge variables are, in fact, endogenous. This means using either OLS model that does not utilize instrumental variables would be inappropriate. As such, we use the IV regressions to analyze the relationships between birth weight and HIV knowledge score and between birth weight and HIV knowledge factor.

Table 5. IV OLS Regression Results

<table>
<thead>
<tr>
<th></th>
<th>HIV Knowledge Score</th>
<th>HIV Knowledge Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>lbirthweight</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HIV Knowledge</td>
<td>0.0383989&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.0118791</td>
</tr>
<tr>
<td>Birth Order</td>
<td>0.0085527</td>
<td>0.042027</td>
</tr>
<tr>
<td>Mother's Age</td>
<td>0.0058525</td>
<td>0.0039816</td>
</tr>
<tr>
<td>Mother's Age Squared</td>
<td>-0.0000922</td>
<td>0.0000624</td>
</tr>
<tr>
<td>Wealth Index</td>
<td>-0.0041015</td>
<td>0.0036295</td>
</tr>
<tr>
<td>Visited by a family planning worker in the last 12 months</td>
<td>0.0130209</td>
<td>0.0135984</td>
</tr>
<tr>
<td>Visited a health clinic in the last 12 months</td>
<td>-0.0136161&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.0066664</td>
</tr>
<tr>
<td>Butha -Buthe</td>
<td>0.0184562</td>
<td>0.0109247</td>
</tr>
<tr>
<td>Leribe</td>
<td>0.0227971&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.0100033</td>
</tr>
<tr>
<td>Berea</td>
<td>0.03238&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.0110504</td>
</tr>
<tr>
<td>Mafeteng</td>
<td>0.0161715</td>
<td>0.0127478</td>
</tr>
<tr>
<td>Mohale's Hoek</td>
<td>0.0162149</td>
<td>0.0122741</td>
</tr>
<tr>
<td>Quthing</td>
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<td>0.0125722</td>
</tr>
<tr>
<td>Qasha's Nek</td>
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<td>0.0123484</td>
</tr>
<tr>
<td>Mokhotlong</td>
<td>-0.0015618</td>
<td>0.0120078</td>
</tr>
<tr>
<td>Thaba-Tseka</td>
<td>0.0069422</td>
<td>0.0131644</td>
</tr>
</tbody>
</table>
In the IV OLS model for the HIV knowledge score variable, the HIV knowledge score (p=0.001), the dichotomous variable showing whether a woman had visited a health clinic in the last 12 months (p=0.041), the district variables for Leribe (p=0.023) and Berea (p=0.003) compared to Maseru, mother’s age at the time of her first birth (p=0.021) and year (p=0.000) were statistically significant.

Having visited a health clinic in the last 12 months is associated with a 1.36 percent decrease in birth weight, which seems surprising, but it is possible that only women who had existing health issues or high-risk pregnancies visited health clinics which would account for this relationship. Living in Leribe compared to Maseru is associated with a 2.27
percent increase in birth weight, while living in Berea compared to Maseru is associated with a 3.23 percent increase in birth weight. Being one year older at the time of first birth is associated with a 0.32 percent decrease in birth weight. Again this relationship seems surprising because birth weight tends to increase with maternal age up to the 24, and then tends to level off (Ghaemmaghami et al., 2013). The reason for this relationship is not immediately clear, but may be tied to other factors, such as socioeconomic status or birth order.

A one-unit increase in HIV knowledge score is associated with approximately a 3.84 percent increase in birth weight. In other words, for every extra question a woman answers correctly about HIV, we can expect to see a corresponding 3.84 percent increase in her child’s birth weight. This relationship is highly statistically significant, with a p-value of 0.001. This shows a strong positive relationship between HIV knowledge and birth weight. This is encouraging evidence for education-based HIV interventions. One concern about this model is that the HIV knowledge score variable weighs all eight questions equally even though knowing about some aspects of HIV might be more important that knowing others. In order to understand the underlying factors of why women answer the HIV questions the way they did, we turn to the model that analyzes the HIV knowledge factor variable.

In the IV OLS model for the HIV knowledge factor variable, the HIV knowledge factor variable (p=0.005), the dichotomous variable showing whether a woman had visited a health clinic in the last 12 months (p=0.043), the district variables for Buthabuthe (p=0.028), Leribe (p=0.010) and Berea (p=0.039) compared to Maseru, mother’s age at the time of her first birth (p=0.022) and year (p=0.014) were statistically significant.
Having visited a health clinic in the last 12 months is associated with a 1.61 percent decrease in birth weight, which again may be because only women who had existing health issues or high-risk pregnancies visiting health clinics. Living in Buthabuthe compared to Maseru is associated with a 2.99 percent increase in birth weight, living in Leribe compared to Maseru is associated with a 3.09 percent increase in birth weight, and living in Berea compared to Maseru is associated with a 2.51 percent increase in birth weight. Being one year older at the time of first birth is associated with a 0.35 percent decrease in birth weight. This shows the same surprising relationship as the other model, but again may be tied to other factors.

A one-unit increase in HIV knowledge factor is associated with approximately a 19.72 percent increase in birth weight. This relationship is also highly statistically significant, with a p-value of 0.005. While the power of this relationship is substantial, it is more difficult to understand conceptually. It can be most clearly interpreted as follows: as the underlying factor that influences a women’s answers to the HIV questions on the LDHS questionnaire increases by 1 unit, we can expect to see a corresponding 19.72 percent increase in her child’s birth weight.

This is a complicated relationship to unravel. We are unsure what the factor identified in our factor analysis is composed of and even less certain of what one unit of this factor would imply. Because of this, directly interpreting this relationship is not particularly useful. Instead, it is the direction and strength of this association that can be used to better understand the relationship between HIV knowledge and birth weight. What this model shows us is that there is some underlying factor regarding a woman’s knowledge of HIV that is associated with an almost 20 percent increase in birth weight.
While this relationship is not necessarily quantifiable, it shows a strong relationship between a mother’s knowledge of HIV and her child’s birth weight.

7. Discussion and Policy Implications

Programs that emphasize HTC are very popular because the results are easy to report to donors. In an era of evidence-based interventions, it is much simpler to request funding for programs that are easily measured. Staff can clearly identify how many people are getting tested or receiving ART. It is much more difficult to report on knowledge attainment, and reporting on how many people participated in an education-based program does not necessarily reflect program success.

Although most HIV programs do include some aspect of education, the emphasis usually falls on HTC. A perfect example of this emphasis is the UNAIDS 90-90-90 goal. The goal that 90 percent of all people living with HIV will know their HIV status, 90 percent of all people with diagnosed HIV infection will receive sustained ART, and 90 percent of all people receiving ART will have viral suppression by 2020 (“90-90-90,” 2014) While this goal is admirable and meeting it would have a profound effect on the state of HIV globally, this goal focuses solely on testing and treatment. As we get closer to making a generation without AIDS a reality, we need to think beyond just status. If, as this study finds, there is a strong connection between HIV knowledge and birth weight, it would be short-sighted not to expand HIV education in prevention programs. An HIV-free generation plagued by the lifelong negative effects of being born with low birth weights is not necessarily better off than the previous generation.
In combatting HIV, we need to take a programmatic approach that addresses all repercussions of the disease. Focusing on HTC has saved millions of lives, and as we come closer to reaching our goals, it is important that we re-strengthen the areas of HIV programming that may have fallen to the wayside. This study can serve as evidence that HIV education has broader impacts than may have previously been thought. The strong statistical relationship of both the HIV knowledge score and the HIV knowledge factor with birth weights can be used to encourage policymakers, funders, and program facilitators to ensure that education is adequately represented in HIV programming.

7.1 Limitations

While this study is statistically strong, it has a number of limitations. This type of study cannot establish temporality, meaning that the women in the study may have attained their knowledge of HIV after giving birth. Also while factor analysis and the use of instrumental variables help adjust for the effects of endogeneity, it is difficult to completely address the effect. Furthermore, due to the difficulty of measuring knowledge, both knowledge variables have issues. The knowledge score variable weighs all questions equally and the factor variable is difficult to interpret because of its very nature. Additionally, this data set had quite a bit of missing or unreliable data. 13,050 (56.8 percent) had a missing value for birth weight and 3,389 (38.55 percent) of those with recoded birth weights were collected from mother’s recall, which is less reliable than birth record data.
8. Conclusion

This study has shown a statistically significant relationship between a mother’s knowledge of HIV and her children’s birth weights. While there are limitations to this study and more research is needed, this initial evidence can be used to lobby for a reinvestment of funds into education-based HIV programming. The magnitude of ART’s positive effects of the global HIV epidemic is not to be ignored, but as technology has advanced and ART has become more accessible, education-based programming has not been maximized. This new evidence should be used to support funding that not only enables women to advocate for their own health through knowledge, but also ensures their children have the best possible health outcomes.
References


Lesotho Demographic and Health Survey 2004 [Dataset]. LSIR41DT.DTA. LSAR41DT.DTA.

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