

Cost-effectiveness Analysis of Surgical Repair for Obstetric Fistula in Ethiopia



BY

MIHIRET WAKE ABZA

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Department of Global Public Health and Primary Care Medicine, University of Bergen

Supervisors

- Professor Øystein A. Haaland: Department of Global Public Health and Primary Health Care, University of Bergen.
- Professor Kjell Arne Johansson: Department of Global Public Health and Primary Health Care, University of Bergen.

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List of Abbreviations

Abbreviation	Meaning
ANC	Antenatal Care
BCEPS	Bergen Center for Ethical and Priority Setting
CEA	Cost Effectiveness Analysis
DCP	Disease Control Priorities
DCP-UHC	Disease Control Priority Universal Health Coverage
DALYs	Disability Adjusted Life Years
EPHI	Ethiopian Public Health Institute Ethical Clearance Committee
GBD	Global Burden of Disease
GDP	Gross Domestic Product
ICERs	Incremental Cost Effectiveness Ratios
REK	Regional Ethical Committee
RVF	Rectovaginal Fistula
UIB	University of Bergen
VVF	Vesicovaginal Fistula
YLD	Years Living with Disability
YLL	Years of Life Lost

Foreword

Ethiopia has made significant progress in terms of material health and is regarded as one of the most promising countries for improvements in reproductive health. The government's establishment of a network of health extension workers, as well as strong donor assistance, non-governmental and public–private partnerships, are all credited with this. The creative health extension initiative made health services available close to the community, which in turn resulted in improvement of maternity associated health indicators. However, there are still some gaps on early marriage and young age at delivery, far site of birth, unavailability of an experienced obstetrician, and a prolonged duration of labor.

Ethiopia is one of the low-income countries with the lowest per-capita health spending. It also lacks well-informed facts and figures needed for decision-making. to achieve Universal Health Coverage (UHC) in Ethiopia it is key to allocate the limited financial and economic resources available to the health system efficiently to enhance adequate coverage and improve the quality of care.

Therefore, in this study, we estimate the cost and evaluate the cost-effectiveness of obstetric fistula from the health care provider perspective.

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Introduction

Although several of the Millennium Development Goals have been successfully met, many sub-Saharan African nations have yet to accomplish Millennium Development Goal 5: a 75 percent reduction in maternal mortality (1). Since the year 2000, Ethiopia's maternal mortality rate has decreased from about 1,030 to about 412 maternal deaths per 100,000 live births, due to a significant investment in maternal health (2). Although the reduction has been substantial, the Sustainable Development Goals Target 3.1 is to further reduce this number to less than 70 maternal deaths per 100,000 live births (3). However, in addition to maternal death, maternal morbidity is a major health issue, particularly in low-income settings.

General Overview of Obstetric Fistula

Obstetric fistula is a birth injury that causes chronic incontinence in the mother, and it is among the most serious of pregnancy-related disorders (4). These injuries occur when a woman experiences prolonged, obstructed labor that is not supported by an emergency obstetric intervention, such as a Caesarean section. The major types of obstetric fistula are simple tears, vesico-vaginal fistula (VVF), and rectovaginal fistula (RVF). A simple tear occurs when trauma is happened in the perineum area during spontaneous vaginal delivery. A vesico-vaginal fistula occurs when an inappropriate opening occurred during spontaneous vaginal delivery between the bladder and the vaginal wall. A rectovaginal fistula occurs when tears in the perineum extended to the colon and cause harm to the anal sphincter, the muscle rings at the end of rectum that help to keep stool in place. Classifying according to severity, simple tears can be regarded as minor, uncomplicated VVFs as moderate, and RVFs and complicated VVFs as major.

Apart from the often-terrible physical effects, the illness has a devastating effect on a young girl's or woman's social status. As a result, obstetric fistula has earned a standing as a highly stigmatizing disorder, one capable of breaking marriages, dissolving family bonds, reducing communal supports, and the reduction of a young woman to a social outcast. A young African girl who has been pushed into a "child" marriage is today's typical fistula victim (5). She gives birth before she is physically mature, resulting in problems during delivery and, eventually, postpartum incontinence. Her relatives and husband leave her and exile her to a hut on the outskirts of her town due to the constant flow of her excretions and their conspicuous odor.

The girl hopefully finds her way to an urban fistula facility, where a physician can restore her continence, enabling her to return to society. It suffices to say that the sooner a patient can be healed, the better. The longer she remains incontinent, the more likely it is that she will be abandoned (6). When there is no hope of recovery, abandonment is almost unavoidable. If obstetric fistula is left untreated, it can cause complications such as infertility, malnutrition, and mental problems (7).

Physical Consequences of Fistula

The term "obstructed labor injury complex" was coined by Arrowsmith and colleagues (8) to describe the severity of personal and social injuries caused by fistulas. Nearly 80 percent of women with fistulas experience chronic excoriation of the skin (i.e., picking at one's own skin repeatedly, resulting in skin sores and causing severe disruption in one's life.) because of urine's direct irritation. They may also experience amenorrhea (i.e., Menstruation absence is commonly characterized as missing one or more menstrual periods.), infertility, vaginal stenosis (i.e., The vaginal (birth canal) gets smaller and shorter in this disease. The vaginal lining may also be thinner and drier, with scar tissue present), infection, bladder calculi (i.e., Bladder calculi is the medical word for bladder stones. Bladder stones form when some urine remains in the bladder after you have peed.), and foot drop (i.e., Foot drop, often known as drop foot, refers to the inability to lift the front half of the foot.) due to neurological injury.

According to Evoh and Akila (9), 41 percent of women with fistula who were brought to Lagos University Hospital for surgical repair developed secondary amenorrhea, which they attributed to acute malnutrition and anemia. At the Benin Teaching Hospital in Nigeria, a substantially greater proportion of amenorrhea 84 percent was found. Because of hypothalamic dysfunction, panhypopituitarism (Sheehan syndrome), and intrauterine scarring, nearly two-thirds of women with obstetric fistulas may develop amenorrhea, according to Wall (10). Amenorrhea can also be caused by psychological stress. A substantial number of women with fistulas also had amenorrhea when they were evaluated for care, according to several studies (11–13). There was no attempt in any of the studies we found to distinguish between postpartum amenorrhea and secondary amenorrhea. Postpartum amenorrhea is likely to be shortened due to the increased likelihood of fetal and perinatal fatalities linked with obstructed labor and is most likely attributable to the negative effects of the acquired fistula.

Women who suffer fistula are often malnourished and underweight before becoming pregnant, according to several studies (14–16). Nutritional insufficiency contributes to protracted labor in two important ways. First, it can cause a constricted pelvis and an increased risk of cephalopelvic disproportion and obstructed labor by stopping or slowing the normal development of the pelvis during childhood and adolescence. Second, it also causes weariness during pregnancy, and in women who are too weak to expel the fetus, uterine muscle inertia can develop. Nutritional inadequacy is not only a cause of fistula, but also a result of it. Kelly and Kwast (17) stated that a woman is too weary to move after a long and painful labor and can lie on the floor for an extended period of time; as a result, she is vulnerable to fistula formation as well as pressure sores and infection. The physical and mental stress that a woman suffers because of a fistula, combined with the anguish she feels because of unexpected social isolation and financial difficulties, dramatically increases her risk of developing nutritional deficiencies. In the Kelly and Kwast (17) study, 36.6 percent of the women with fistulas suffered significant weight loss and starvation, and 8.5 percent had limb contractures. In the presence of extreme malnutrition, fistula repair could be dangerous, and postoperative healing could be delayed.

Social and Economic Consequences of Fistula

Fistula is regarded as a "social tragedy" (2), and women who have fistulas are frequently shunned by their spouses, families, and communities. The ailment is frequently misdiagnosed as a sexually transmitted disease and perceived as a divine punishment. Most women with fistulas have troubled socio-psycho-sexual lives and are frequently abandoned by their husbands. According to a study in Africa, 14 percent of new patients were divorced by their husbands immediately after the fistula occurred, and only 42 percent continued to live with their husbands; and if the condition persisted, 28 percent of the women were divorced, and only 11 percent were allowed to stay (18). In Niger, 63 percent of women suffering from fistulas were divorced (19). Married women with fistulas are frequently taken back to their parents' homes until they are treated, where they are not allowed to cook, participate in social gatherings, or perform religious rites (18,20). In a study of how women with fistulas in Nigeria view societal reactions to them, the majority (53 percent) believe they are shunned (21). According to a research conducted in Addis Ababa, 39 percent of women with fistulas rely on relatives for food and 22 percent beg or live on donations since they do not have assistance from their spouses or the means to earn a living (22). Kelly (22) described their social isolation

in dramatic detail. “Cure my fistula first,” she said when it was proposed that she treat a blind woman with a fistula for her blindness first, “people will sit with me and talk to me if I’m blind, but no one will come near me if I’m wet and smelly.” This illustrates how reducing stigma remains a serious barrier when handling obstetric fistula (23).

Emotional and Psychological Consequences of Fistula

Only a few studies have investigated the emotional and psychological well-being of women suffering obstetric fistulas. Not only does a mother with a fistula from obstructed childbirth typically have to mourn her dead child, but she often must struggle for her own survival, social standing, and value in society. She is tormented and shattered mentally. According to a study conducted in Nigeria, roughly 33 percent of women with fistulas were depressed, while another 51 percent felt resentful about their lives (21). A qualitative case study of 53 women from northern Nigeria looked at the psychological impacts of fistula, including anger, despair, and life dissatisfaction. The majority reported low self-esteem, as well as tension and worry (20). When their husbands gave emotional support, however, the women reported having a more positive outlook on life. Islam and Begum (1992) conducted a study on the psychosocial effects of having a fistula in Bangladesh (24). 61.4 percent of women said they were embarrassed in social situations, 39.4 percent said they were always sick, and 33.3 percent said it was difficult to maintain a sexual connection. About half of the participants reported a major drop in libido, and there was a 59 percent fall in coitus frequency and a 45 percent reduction in reaching orgasm. Further, 52 percent of husbands reported a decrease in sexual pleasure with their wives. 87 percent said they were embarrassed in social situations, 67.4 percent said they could not pray, and 62 percent said they were unhappy in their marriage. Dyspareunia was reported by 37.9 percent of the women in the study. Another study, from Joh JT and colleagues, on the psychosocial impact of fistula in Bangladesh found that women with fistulas have low self-esteem, with many experiencing sadness and anxiety (25).

Obstetric Fistula in Low- and Lower Middle-Income Countries

Obstetric fistula was previously very common across the world. Through improved obstetric care, Europe and North America practically eradicated the condition between 1953 to 1960 (26). Because the industrialized world and many developing countries have been successful in their fight against fistula, we know that feasible treatments could be implemented, even in

resource-poor settings. Still, an estimated 2–3 million women worldwide currently live with obstetric fistula, with most cases occurring in Sub-Saharan Africa and South Asia (27).

However, there is much uncertainty associated with such estimates since data on the epidemiology of obstetric fistula is limited, especially in low-income settings (28). Women are typically unwilling to report their illness and prefer to isolate themselves, so obtaining accurate statistics on the prevalence of obstetric fistulas is difficult (28). In 2015, Mathieu Maheu-Giroux and colleagues estimated the lifetime and point prevalence of vesicovaginal fistula in 19 countries in Sub-Saharan Africa (29). This was a meta-analysis of demographic health surveys and the prevalence of obstetric fistula symptoms ranged from 0.4 fistulas per 1,000 women of childbearing age in Burkina Faso to 19.2 fistulas per 1,000 women of childbearing age in Uganda (29). These estimates are likely to be higher, as both obstetric and non-obstetric causes of incontinence are considered. However, this is the first study to use population-level data from multiple countries and nationally representative surveys to estimate the prevalence of vaginal fistula (both obstetric and non-obstetric).

Medical records and self-reported questionnaires are the two most common sources of data for obstetric fistula. Because of the population affected by fistula and their limited access to medical care, medical records grossly underestimate the prevalence and incidence of obstetric fistula. Self-reported data from surveys, on the other hand, has a limited diagnostic value for maternal problems.

Obstetric Fistula in Ethiopia

As we discussed on the above paragraphs data on the epidemiology of obstetric fistula is scarce, especially in low-income areas, prevalence estimates are fraught with ambiguity. One large Ethiopian community-based study conducted in 2005 found that the prevalence was 2.2 per 1,000 reproductive-age women in Ethiopia (30). Ethiopia's 2015 prevalence of fistula dropped to 0.6 per 1,000 women of reproductive age, according to another published study (31).

Maternal health has been prioritized since 2005, and the Ethiopian government took steps in the final two phases of its Health Sector Development Program (32) to dramatically increase the number of health centers and maternal healthcare providers and provide a fleet of ambulance services for transporting women in labor to higher degree care services. At the same

time, the government raised the number of medical school spots and developed a program for health officers that enhanced training in emergency surgery and obstetrics (32). The goal of the health officer's surgical training program was to develop a new generation of health professionals who could perform Cesarean sections in remote health facilities and health centers. As a result, in areas with a higher risk of fistula formation the procedure is likely to be performed by health officers.

In 2008, Ethiopian treatment centers repaired 1447 fistula patients despite the fact that there are more than 3000 new cases registered each year (33). According to a 2021 cross-sectional study based on Demographic and Health Survey data 2016, there were 4.2 per 1000 population women with obstetric fistula among the 7590 women who had given birth in the previous 5 years (34). More than 72.8 percent were attributed to labor that was complicated and prolonged. The outcome was 64 percent of these women developed obstetric fistula with alive babe while 23.1 percent developed obstetric fistula with a stillbirth babe.

Overview of the Ethiopian Health System from an Obstetric Fistula

Management Perspective

Ethiopia has established various efforts to enhance obstetric care given at basic health institutions in response to the United Nations Population Fund's (UNFPA) global Campaign to End Fistula. This entails increasing the number of providers working across the country as well as creating and maintaining fistula-specific health delivery infrastructure (35,36). Among women who receive fistula treatment between 7 and 40 percent of women experience persistent urine incontinence after their fistula is closed (33,37). This issue, dubbed the "continence gap," is gaining traction in Ethiopia, where fistula rates have decreased in recent years while other pelvic floor diseases and delivery complications have increased (27,33). Age, the number of years with a fistula, previous attempts at fistula repair, and the severity of the damage were all indicators of residual incontinence (27).

Hamlin Fistula Ethiopia also supporting the government and it is committed to eradicate obstetric fistulas through its preventative policy of supplying skilled midwives in the country's rural areas (35). It is a non-profit organization committed to the treatment and prevention of obstetric fistulas in Ethiopia. After witnessing the awful plight of Ethiopian women suffering from obstetric fistulas, Drs. Catherine and Reg Hamlin created this organization in 1974.

Hamlin Fistula Ethiopia is responsible for the following: Addis Ababa Fistula Hospital, the world's first fistula hospital; five regional hospitals that provide health treatment to rural women; and Hamlin College of Midwives, a world-class center for performing and training doctors in obstetric fistula surgery, and where patients can receive rehabilitation treatments such as physiotherapy, counseling, and skills training to help them rebuild their self-esteem, find productive work, and reintegrate back into village life (35).

Effective Management of Obstetric Fistula

Surgical repair is the best treatment of obstetric fistula. Because of the significant medical and socioeconomic consequences for women who are affected, such treatment should be provided. Additionally, investments in better gynecologic surgical care for obstetric fistula will also benefit other surgical problems affecting women of reproductive age. The WHO's considers a success rate >85 percent as a measure of good quality of care (38).

In a study from Rwanda, the success rate of fistula repair was 88.5 percent among women who had their initial closure attempt (39). Overall, 86 percent of fistulas were closed, whereas 88.5 percent of individuals who had their first fistula repair experienced a favorable outcome.

Previous studies in other low- and lower middle-income settings found lower closure rates: 78 percent in a Ugandan study and 73 percent in a Zambian study (40,41). Higher success rates (>90 percent) were reported in another Ugandan study (42). These disparities in the rate of successful repair could be due to differences in the severity of cases handled by each health facility, the rationale for selecting the type of repair surgery, surgeon skill, and the quality of fistula repair services provided at the various study locations.

Parity, fistula type, underlying fistula etiology, duration with fistula, type of surgical treatment, and past failed attempts to repair were identified as variables that strongly influenced surgical repair results, either alone or in combination (39). Other factors that influence fistula closure results include fistula access, scarring severity, surgical expertise, and post-surgical care.

In another study, conducted in Rwanda Egziabher *et al.* 2015 found that approximately 86 percent of all obstetric fistulas treated with sugary via the abdominal route were effective. When compared to the vaginal route, using the abdominal route for repair was associated with an 82 percent reduction in the chance of a successful repair outcome (39). Other research has yielded mixed outcomes, including a study by Kriplani *et al.* 2005, showing that women who

had an obstetric fistula fixed vaginally had much less incontinence (7.1 percent) than women who had an abdominal fistula corrected or who had a mixed treatment (32.8 percent)(43). Even though there was too much uncertainty conclude that there was a difference between the two arms, all the failures in the vaginally repaired fistula group were women with difficult to access fistula who were subsequently fixed abdominally with successful outcomes (44).

In Egziabher *et al.*, the severity of fistula damage may have influenced access method, with the abdominal route being favored for instances with severe, challenging, and often scarred fistulas.

These findings underline the need of considering all factors that influence effective repair outcomes, particularly among women who are about to receive their first fistula surgery. Delays in obtaining medical help and getting to a hospital, both of which are important factors in complete emergency obstetric treatment, have been linked to poor health outcomes(45,46). In Egziabher *et al* survey, almost 35 percent of women said they had been in labor for three days, and 64 percent said they had lived with the fistula for one year (39). These findings point to a significant gap in the availability and accessibility of complete emergency obstetric treatment, which is critical for reducing the risks of obstetric emergencies.

Obstructed labor is the major cause of fistula in the developing countries. Unfortunately, a lack of high-quality obstetric care, as well as other socioeconomic issues that aren't well understood, can also lead to a delay in seeking care when it is available. Egziabher *et al.* found that women who reported being in labor for more than 2 days had 2.5 times the risk of having a poor repair outcome compared to those who reported being in labor for 0–2 days. The tissue damage and scarring caused by ischemia necrosis of the soft tissues around the vagina, bladder, or rectum worsens as labor progresses (47). Furthermore, given the scarcity of surgical facilities, it is possible that most obstructed labors may be managed by more aggressive methods such as tool deliveries.

Because most affected women live in resource-constrained environments, poor peri-operative care, particularly a lack of catheterizations, increases the risk of developing a fistula. Egziabher *et al.* also found that, for at least a year, 64 percent of women with obstetric fistula reported leakage from the fistula. Women who had had the fistula for longer than a year had a lower chance of success. Repairs made within 3 months of fistula formation were more likely to result in fistula closure (93.9 vs. 87.0 percent) than repairs made after 3 months in 581 women

from Kenya, Tanzania, and Uganda (48). The longer the leaking occurs, the more the obstetric fistula tissues become fibrotic, making surgical repair more difficult. Part of the reason for the delays could be a lack of understanding of and access to existing fistula repair services. To enhance vertically delivered health institution-based fistula repair services, community-level activities to identify and support women with fistulas to expand access to fistula repair treatments are required. 13.8 percent of the fistula repairs reported in the Egziabher *et al* study was performed on women who had previously failed repeat efforts. Women who had at least one previous unsuccessful attempt had a substantially lower chance of success compared to first-time repair attempts, as documented elsewhere (49,50). In one study, women who had repeat fistula repair treatments were more likely than those who had a primary repair to have residual incontinence. However, in a multivariate analysis, as reported elsewhere (51), this effect did not stay statistically significant. It is possible that each consecutive fistula repair effort causes more tissue damage and scarring, and that multiple surgeries therefore lower the likelihood of restoring physiological function. This emphasizes the importance of skilled surgeons and the importance of achieving good fistula repair outcomes on the first attempt.

Quality obstetric care, which includes the availability of and attendance at ANC (Antenatal Care), as well as the provision of quality emergency obstetric procedures, can help to reduce the burden of obstetric complications, such as the development of fistulas. In Ethiopia, ANC attendance has been reported at 98 percent for second trimester and 65 percent third trimester, with the bulk of first ANC visits (52). These high numbers underline the importance of screening pregnant women to identify and actively follow-up on individuals who are at risk of complex pregnancies, such as teen mothers who are at risk of obstructed labor. The lack of medical personnel with the expertise to provide quality general surgical obstetric treatment at most health institutions, as well as the operationalization of methods to avoid or successfully manage fistula issues, often impedes the provision of high-quality obstetric care.

Cost-Effectiveness of Obstetric Fistula Surgery

There is a lack of studies on the cost and cost effectiveness of fistula repair surgery in Africa. A study by Epiu *et al.* 2018 from Uganda is the first in Africa to quantify the cost and cost-effectiveness of surgical treatment for obstetric fistulas (53). The study found that fistula surgery reduces obstetric fistula disability at a cost of US\$54 per DALY avoided, a figure that

is well below Uganda's per capita GDP of US\$620 (53), indicating that fistula repair is highly cost-effective according to WHO cost effectiveness thresholds (54).

Still, the surgical care necessary to prevent and treat obstetric fistula in low-income countries competes for resources with infectious diseases and noncommunicable diseases. With 38 per 1000 people, Sub-Saharan Africa is predicted to have the largest proportion of DALYs due to surgical disorders (55) by 2006. Despite a growing recognition of the significance of improving surgical capacity around the world, as evidenced by the World Bank's inclusion of surgery in its Disease Control Priorities (55), many national governments do not prioritize funding for basic surgical treatment (56). However, considerable advancements in maternal health are required to fulfill the 2030 global goal of sustainable development—both to treat all obstetric fistula patients and to prevent the occurrence of new cases. This requires the development of health systems and surgical workforces to deliver low-cost fistula surgery and address the gaps that lead to protracted obstructed labor in low- and lower middle-income countries. A 2017 assessment identified numerous hurdles to fistula treatment occurring at the individual, community, and national levels, in addition to the restricted availability of clinics that offer fistula repair and the financial costs of the process. Depression, stigma, and humiliation are among them, as are a lack of community-based referral systems, transportation issues, gender power imbalances, community reintegration, and political leadership's competing agendas (57).

The Rationale of this Study

Estimates of obstetric fistula surgical repair costs are required to inform health decisions in low-and lower middle-income countries. As outlined in previous sections, the implementation of policies for treatment and prevention is key when addressing obstetric fistula.

In Ethiopia, the costs of surgical repair for obstetrics fistula have not yet been identified and documented. This thesis would document these costs and use them to conduct a cost-effectiveness analysis of surgical repair by comparing with no surgical repair. This will provide government, policymakers, and all other stakeholders with information and may contribute towards the reduction of women's suffering from fistula in Ethiopia and other low- and lower middle-income countries. This would be an important step towards achieving universal health coverage for a particularly vulnerable group: young, poor women living in rural areas.

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Article:

Fistula surgery in Ethiopia: A cost-effectiveness study

Mihiret Wake Abza^{1,2,3}; Mulu Muleta and Torvid Kiserud; Øystein Ariansen Haaland^{1,2};

Kjell Arne Johansson^{1,2}

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Fistula Surgery in Ethiopia: A Cost-Effectiveness Study

Mihiret Wake Abza ^{1,2,3}; Mulu Muleta and Torvid Kiserud; Øystein Ariansen Haaland^{1,2};

Kjell Arne Johansson ^{1,2}

¹ Department of Global Public Health and Primary Care, University of Bergen, Bergen, Norway

² Bergen Centre for Ethics and Priority Setting, Department of Global Public Health and Primary Care, University of Bergen, Bergen, Norway

³ Ministry of Health Ethiopia

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Introduction

The World Health Organization (WHO) estimates that more than 300 million women worldwide are currently suffering from obstetric complications. About 20 million new cases occur each year (1). In low-income countries, obstructed labor is a common cause of maternal mortality (2). Obstructed labor happens when the fetus is blocked when passing through the birth canal. Often this happens due to congenital anomalies in the child, but in very young mothers it is also common that the child's head is disproportionate to the mother's pelvis bone. Obstructed labor requires emergency C-section, otherwise, there is a high risk that the baby will die and that the mother will die from bleeding or develop complications like obstetric fistula (3). WHO estimates that 50,000 to 100,000 women worldwide develop obstetric fistulas each year and that more than two million women currently live with the condition, particularly in Africa and Asia (4).

Fistula formation is more common in low-income countries due to inadequate maternal health services, poor nutrition that leads to small pelvic bone, as well as socioeconomic and cultural factors that prevent antenatal care and delivery at health care services (5,6). Commonly reported risk factors for obstetric fistula include early marriage and young age at delivery, place of birth, absence of an experienced obstetrician, an extended duration of labor, lack of prenatal care, and lack of family planning utilization (7). Even though the risk of obstetric fistula is increased in young mothers, any woman can develop obstetric fistula if she is exposed to a large fetus, malpresentation of the baby during delivery, or if she has had four or more pregnancies (8).

Women with obstetric fistula often experience terrible conditions, either due to the fistula itself or due to the prolonged or obstructed labor which caused it (9,10). The most common sequelae are incontinence, whether urinary, fecal, or both. Because of that fistula is associated with social marginalization and stigma (11). Many sets of cases show high rates of divorce or separation, lack of sexual intercourse, loss of fertility, amenorrhea, and depression (11). Obstetric fistula could be prevented by avoiding early marriage, delaying the age of first pregnancy, and timely access to appropriate obstetric care (12). This could allow for the identification and proper intervention before the labor is obstructed. Access to emergency C-

sections is also important for the prevention of obstetric fistula. However, lack of such access is common in low-income countries (13).

The most effective treatment of obstetric fistula is surgical repair, with a success rate of about 90% for uncomplicated fistulas and 60% for complicated fistulas (14,15). The surgery could be performed at minimal cost with low technology (does not need complicated surgical equipment's) and surgical operations performed under spinal anesthesia (local anesthesia) doesn't need to give generalized anesthesia (16,17). Although such surgery requires very basic surgical services, it is not sufficiently available in low-income countries like Ethiopia. The most common challenges area high number of cases. For example, in Ethiopia between 2010 and 2013, an average of fewer than 2,000 women underwent surgical repair for obstetric fistula each year. Without access to adequate health services, the women may live the rest of their life with the fistula (18).

In Ethiopia, the prevalence of obstetric fistula (women who reported having an obstetric fistula) varies by location. Tigray area was found to have the highest household level prevalence of obstetric fistula of all births (6.1%), followed by Somali (5.9%) and SNNPR (5.0%)(19). Fistulas are possible to prevent with good access to essential obstetric care. About half of births in Ethiopia take place in health facilities, and between 43% and 74% have access to antenatal care from skilled providers (20). Fistula patients in Ethiopia are often young girls living in rural areas who marry in their teens with men who have little or no education (21,22). The girls typically have difficult household responsibilities and are also poorly educated. They do not have access to health facilities for antenatal care services during pregnancy and even during labor they are often helped by traditional birth attendant women of the village to deliver at home (22). In case of obstructed labor, the risk of stillbirth is high, and labor often last for days (23).

Health economic evaluations are important evidence for priority setting and health policies, particularly in resource constrained settings like Ethiopia. Estimates of obstetric fistula surgical repair costs are required to inform important health decisions in low-income countries like Ethiopia. The implementation of policies for treatment is key when addressing maternal and women health. We have only identified one other cost-effectiveness study on fistula surgery in a low-income setting and this is from Uganda (24). The authors conclude that this service is highly cost-effective. In Ethiopia, the costs of surgical repair for obstetrics fistula have not yet

been identified and documented and coverage is currently low. Hence, policy makers lack important information when taking measure to reduce maternal and women's health in Ethiopia and other low-income countries.

In this study we conduct a cost analysis and health economic evaluation of surgical treatment of obstetric fistula surgery from Specialized Fistula Hospitals in Addis Ababa, Ethiopia.

Methods

Study Area

The primary data was collected from Addis Ababa Fistula Hospital, which is a world class fistula hospital and a national referral fistula hospital in Ethiopia. Data on cost and outcome indicators were gathered in a one-year data period from January 2019 to January 2020. On average, one surgeon at Addis Ababa Fistula Hospital performs 135 fistula surgeries per year, and the total yearly average performed surgery in Addis Ababa Fistula Hospital was 674.

Data Collection and Analysis on Costs

The study was conducted from a health care provider's perspective and only expenditures due to hospital care were considered when calculating average yearly patient care. We did not account for household and social costs, such as disease-related losses in quality of life. All resources needed to provide fistula surgery were identified, and the Cost Analysis in Primary Health Care: A Manual for Programme Managers was used to facilitate data collecting (25). Because the hospital is a non-government entity, all its resources were provided by other agencies such as non-governmental organizations and the donor community.

All necessary equipment to perform fistula surgery was identified by interviewing medical experts from Addis Ababa Fistula Hospital. Health care providers were asked to list all the equipment generally needed to perform fistula surgery care, and the cost of this equipment (in local currency). All the cost data was collected from Addis Ababa Fistula Hospital medical stores catalogue. The pharmacy department's data store supplied information on the pricing and quantities of medications and other recurrent medical supplies given to the hospital. The hospital records also provided information on the human resources used in the provision of care as well as disease outcomes. Monthly salary cost data was collected from the finance department at the hospital by assuming that the surgeons and supportive staff would participate 24 hours in surgery care and converted to an average time spent per surgery. The average cost of fistula surgery was identified as the sum of all specific prices for all equipment plus the cost of human resources.

The 2019 GDP deflator was used to adjust all costs to 2019 prices (26). Items were valued in Ethiopian Birr (ETB) and converted to US\$ at the average exchange rate of 41.76 ETB per

US\$ (27). Costs were divided into two categories: economic and financial. Financial costs only considered expenses incurred in the purchase of commodities, whereas economic costs included the opportunity cost of resource usage. Costs were also divided into two categories: capital and recurring. Buildings, equipment, and vehicles with a useful life of more than one year were included in capital costs. Personnel and supplies were examples of recurring costs that might be replaced within a year. Cutlery, buckets, and garden implements were considered recurrent costs because they cost less than US\$100, even though they may last for more than a year. To determine the exact amount and condition of all capital objects, such as furniture and equipment, a physical count was performed. For costing purposes, only functional items were included. The finance department of the hospital, which is the superintendent of all information of buildings, provided costs of buildings. Capital costs were annuitized to account for the fact that such resources are purchased in a single year but have a long useful life (28). The annual financial cost of capital assets was determined using the straight-line depreciation approach, which divides an item's total cost by the number of years it would be used. The economic cost of capital items was computed using a literature-recommended interest rate of 6% (29). The useful life of all the hospital's buildings was anticipated to be 30 years, while the useful life of the equipment was estimated to be between 2 and 20 years. All capital assets, except buildings, were given useful life years based on the costs and prices used in the WHO Choosing Interventions that are Cost Effective (WHO-CHOICE) analysis (30).

Costs were classified as follows in each department: Salaries, perks, and allowances are all included in personnel costs. Buildings, vehicles, furniture, and equipment such as x-ray machines are all examples of capital costs. Cleaning materials, as well as medicinal and surgical supplies included in recurrent cost. Buildings, automobiles, and general repairs are all in need of maintenance. We factored in beds, inpatient maintenance and supplies, and duration of stay for each ailment when calculating inpatient expenditures. Patient care costs, which were costs incurred in the patient care departments, were separated from overhead expenses, which were costs incurred in the overhead departments. All the patient care units shared the expenditures of overhead departments. These expenses were divided among the patient-care departments based on the expected proportion of visits, bed days, manpower, and floor space. The services offered by each patient care department were the intermediate outcomes. In the hospital department, bed days were used to measure output, while in the outpatient department, visits were used to measure output. The total number of lab tests performed during the study

period served as the units of measurement in the laboratory. Instead of bed days, visits were used in the surgery ward. People who came to the hospital for the first time (new attendees) as well as those who returned were included in the total number of visits and admissions.

Average Costs and Outputs

To calculate average costs, we categorize the fistula surgery based on time spend for surgery and severity of the fistula, categorized as minor (simple tears), moderate (uncomplicated vesicovaginal fistula), and major (rectovaginal and complicated vesicovaginal fistula). The overall costs were divided by entire outputs. For example, to calculate the average cost of inpatient care, divide the total cost of the inpatient ward by the total number of bed days in the reference period.

Assumptions

Over the course of a lifetime, we followed a hypothetical Ethiopian birth cohort. The evaluation of annual health benefits considered the rest of the patient's life. We used the 2021 currency. The time-horizon for costs was during the time of surgery and follow-up, which is typically less than one year, so discounting was not necessary. Generally, obstetric fistula is a complication resulting from prolonged obstructed labor with 0.34 disability weight for vesicovaginal fistula and 0.5 disability weight for rectovaginal fistula (31). A disability weight is a measure of health loss, where 1 is no health (death) and 0 is full health.

Sensitivity Analyses for Cost-Effectiveness

Sensitivity analyses were carried out by considering Worst-case and Best-case scenarios as follows. For the Worst-case scenario, efficacy was reduced by 20% and costs were increased by a third (that is, multiplied by 1.5), and for the Best-case scenario we increased the efficacy by 20% and reduced the cost by a third (that is, divided by 1.5). Then cost-effectiveness ratios were calculated for each scenario.

Results

In this section we will first present estimates of expenditures related to fistula surgery, and then move on the cost-effectiveness analysis.

Expenditures

The costs of laboratory investigations, anesthetic supplies and equipment, and surgical supplies and equipment used in fistula surgery are shown in Table 1.

Table 1: Input for model: Cost of Surgery Equipment, Supplies and Drugs, coverage, and effectiveness

Items	Cost (USD)	Cost per Surgery (USD)	Useful life
Oxygen Cylinder 40-50 liter	257.04	0.384	5 Years
Coagulation machine	329.07	0.492	5 Years
Anesthesia Machine	1394.57	2.085	5 Years
Suction Machine for OR	218.85	0.327	5 Years
Spinal needle no_20	1.39	0.002	Single use/surgery
Spinal needle no_22	3.64	0.005	Single use/surgery
IV fluid, normal Saline	0.86	0.001	Single use/surgery
Adrenaline 1mg/ml	0.75	0.001	Single use/surgery
Antibiotics			
Ceftrizon IV	0.31	0.0005	Single use/surgery
Gentamicin IV 160mg/ml	0.03	0.00004	Single use/surgery
Analgesics			
Tramadol 100mg	0.18	0.0003	Single use/surgery
Pethidine 50mg	1.2	0.002	Single use/surgery
Diclofenac 75mg/ml	0.04	0.0001	Single use/surgery

The average personnel per unit of surgery in all the surgeries are given in Table 3. Minor surgery requires four physicians and nurses, whereas moderate surgery requires six, and major surgery nine. The cost of an outpatient visit in the outpatient department was US\$90 for minor surgery, US\$126 for moderate surgery and US\$168 for major surgery, whereas an inpatient visit was an average of US\$9 for all the surgery types.

As seen, outpatient visits were more common among patients requiring moderate surgery. This is because mostly the major fistula surgery cases after receiving their first critical surgical care and get improved they will be out visit care takers. Then because they get better health status, they receive so many cares including psychological and nutritional care as out visit caretaker under moderate fistula surgery.

Table 2: Human resource per surgery, inpatient, and outpatient cost

	Minor surgery	Moderate surgery	Major surgery
Personnel			
Surgeon	1	1	1
Assistant Doctor	0	1	3
Anesthetist	1	1	2
Circulating nurses	1	2	2
Scrub Nurse	1	1	1
Inpatient costs			
Length of stay (mean days)	15	21	28
Cost per Day	6	6	6
Mean total inpatient cost per patient (US\$).	90	126	168
Outpatient costs			
Visits	505	2263	422
Cost per visit	3	3	3
Mean total outpatient cost per patient	9	9	9

Table 2 shows the annual costs incurred in the fistula surgery care departments. The entire direct costs per surgery amounted to a total of to US\$108 for minor surgery, US\$260 for moderate surgery and US\$344.7 for major surgery with recurrent expenses accounting for US\$47.9 and capital expenditure accounting for US\$37.1 for each surgery type. Hence, differences were only due to personnel cost.

Table 3: Unit cost per patient for fistula surgery care (2021 US\$), including utilization of services and effectiveness of surgical care

	Minor	Moderate	Major
Total cost per surgery (US\$)	108	260	345
Capital cost per surgery (US\$)	37,1	37,1	37,1
Personnel cost per surgery (US\$) *	23	175,4	259,7
Recurrent cost	47,9	47,9	47,9
Time per surgery (hours)	1	6	9
Incidence (new cases per year)	1876	4071	3053
Prevalence (total cases)	4795	10404	7801
Utilisation (annual surgeries performed) ***	409	887	665
Coverage	0,22	0,22	0,22
Disability weight (0=best, 1=worst) **	0,34	0,50	0,50
Effectiveness of surgery (relative reduction of Dw) ***	0,96	0,89	0,83

* Including surgeon (1 per operation), 4/1/0 assistant doctors for major/moderate/minor fistula surgery, anesthetist, nurses, supporting staff

** Salomon JA *et al.* Disability weights for the Global Burden of Disease 2013 study. The Lancet Global Health. 2015 Nov 1;3(11):e71

*** From health information system of hospitals performing fistula surgery in Addis Ababa, Bahir Dar, Harar, Mettu, Yirgalem and Mekell

Cost-Effectiveness

The incremental costs per DALY gained in the deterministic analysis were varied based on the discount rates we give (Table 4). As we can see from Table 4 we have done the analysis on discount rate of health 0 and cost 0, discount rate of health 0 and cost 3 and discount rate of health 3 and cost 3.

Table 4: Cost- effectiveness result (per surgery)

Type of surgery	ICER	Health Discount 0 and Cost Discount 0						Health Discount 0 and Cost Discount 3						Health Discount 3 and Cost Discount 3							
		20% Target Coverage		40% Target Coverage		60% Target Coverage		20% Target Coverage		40% Target Coverage		60% Target Coverage		20% Target Coverage		40% Target Coverage		60% Target Coverage			
		Total Cost US\$	DAL Ys Averted	Total Cost US\$	DAL Ys Averted	Total Cost US\$	DAL Ys Averted	Total Cost US\$	DAL Ys Averted	Total Cost US\$	DAL Ys Averted	Total Cost US\$	DAL Ys Averted	Total Cost US\$	DAL Ys Averted	Total Cost US\$	DAL Ys Averted	Total Cost US\$	DAL Ys Averted		
Minor	13.5	61458	4547	156010	11544	250562	18541	11.3	51607	4547	131004	11544	210400	18541	15.9	51607	3236	131004	8215	210400	13193
Moderate	35.0	88871	2539	225598	6421	362324	10313	29.4	74626	2539	189437	6421	304248	10313	41.5	74626	1800	189437	4569	304248	7339
Major	33.9	39224	1156	99570	2935	159916	4714	28.5	32937	1156	83610	2935	134283	4714	40.0	32937	822	83610	2088	134283	3355

DAL Ys: Disability adjusted life years
ICER (Cost per DALYs Averted) : Average cost-effectiveness ratio
Baseline Coverage:7%

Sensitivity analyses were carried out by adjusting unit cost and intervention effects as explained above for each of the three scenarios in Table 4. As seen in Table 4 and Table 5, minor fistula surgery has an ICER of 13.5 (best-case 8.6; worst-case 25.6), moderate fistula surgery has an ICER of 35.1 (best-case 20.8; worst-case 68), and major fistula surgery has an ICER of 39.9 (best-case 18.8; worst-case 67).

Table 5: Controlling distinct factors in a one-way sensitivity analysis

Interventions	Case Scenario	Health Discount 0 and Cost Discount 0							Health Discount 0 and Cost Discount 3							Health Discount 3 and Cost Discount 3						
		ICER	20% Target Coverage		40% Target Coverage		60% Target Coverage		ICER	20% Target Coverage		40% Target Coverage		60% Target Coverage		ICER	20% Target Coverage		40% Target Coverage		60% Target Coverage	
			Total Cost US\$	DAL Ys Averted	Total Cost US\$	DAL Ys Averted	Total Cost US\$	DAL Ys Averted		Total Cost US\$	DAL Ys Averted	Total Cost US\$	DAL Ys Averted	Total Cost US\$	DAL Ys Averted		Total Cost US\$	DAL Ys Averted	Total Cost US\$	DAL Ys Averted	Total Cost US\$	DAL Ys Averted
Minor fistula surgery	Best-Case scenario	8.5	40972	4737	104007	12026	167042	19314	7.3	34405	4737	87336	12026	140266	19314	10.2	34405	3371	87336	8557	140266	13743
Moderate fistula surgery		20.8	59247	2842	150399	7215	241549	11588	17.5	49751	2842	126291	7215	202832	11588	24.6	49751	2022	126291	5134	202832	8246
Major fistula surgery		18.8	26149	1393	66380	3537	106611	5681	15.8	21958	1393	55740	3537	89522	5681	22.2	21958	991	55740	2516	89522	4042
Minor fistula surgery	Worst-Case scenario	25.6	92188	3600	234016	9139	375844	14679	21.5	77411	3600	196506	9139	315600	14679	30.2	77411	2562	196506	6503	315600	10445
Moderate fistula surgery		67.9	133308	1961	338397	4979	543486	7996	57.0	111940	1961	284156	4979	456372	7996	80.2	111940	1395	284156	3542	456372	5689
Major fistula surgery		67.0	58837	878	149356	2228	239875	3579	56.3	49406	878	125416	2228	201425	3579	79.2	49406	624	125416	1585	201425	2546
Best-case scenario: most cost-effective scenario																						
Worst-case scenario: least cost-effective scenario																						
Baseline Coverage:7%																						

Discussion

Fistula surgery offers a high health benefit considering the required investments. Cost per DALY averted was US\$13.5 for minor fistula surgery, US\$35.0 for moderate surgery, and US\$33.9 for major surgery. Total cost was US\$108 per minor fistula surgery, US\$260 per moderate surgery, and US\$345 per major surgery. According to our estimates, the cost of scaling coverage of fistula surgery up to 60% is between US\$3,758,44 and US\$1,670,42 per year for minor fistula surgery, US\$5,434,86 and US\$2,415,49 for moderate fistula surgery, and US\$2,398,75 and US\$1,066,11 for major fistula surgery.

A health economic evaluation from Uganda estimated the incremental cost-effectiveness rate for fistula surgery to be US\$54 per DALY averted (24). This is a bit higher than our results and may have several explanations. First, while the Uganda study's methodology is like ours, data collection in Uganda was done at two referral hospitals, whereas ours was done at a single specialist hospital. The Addis Ababa Fistula Hospital is perhaps the best in the world and only does fistula surgery. Therefore, care may be more efficient than in the Uganda setting. Still, the capital expenditures related to the hospital facility and land were not included in the micro costing approach of the Uganda study, which would increase the cost per DALY averted. Second, we did not apply discount rate for health benefits while the Uganda study discounted both costs and health benefits at 3%. Although a 10-implementation period is assumed, health benefits are assumed to last the whole life. Hence, discounting would reduce health benefits much more than the cost, which may explain some of the discrepancies between our study and the Uganda study.

In a study published in 2020, Watkins *et al.* reported a unit cost of US\$90 for repair of obstetric fistula in low-income settings (24). (This is lower than what we found (Table 2). However, their estimate was based on 2015 numbers, which accounting for inflation (7% in 2016, 11% in 2017, 14% in 2018 and 16% in 2019) would yield US\$256, which is consistent with our findings.

The costing of fistula surgery interventions is critical for setting priorities, mobilizing resources, advocating, and other maternal program planning and budgeting tasks. The capital costs account for 34% of the costs of conducting minor fistula surgery, 14% of the costs for moderate surgery, and 11% of the costs of major surgery. Correspondingly, personnel are substantial drivers of cost, especially for moderate (67% of costs) and major (75% of costs)

surgeries. Therefore, investing in infrastructure and training of specialists are important health policy tasks to achieve UHC of fistula surgery in Ethiopia. Still, investing in essential high-quality obstetric care is also necessary to reduce the prevalence of fistulas.

This study fills a gap in the literature on the cost of healthcare in Ethiopia. It emphasizes the difficulty of conducting a cost analysis in the absence of reliable, consistent, and precise data, which is common in many developing countries. Cost data in the health and other sectors is not part of routine statistical data collection efforts in Ethiopia, as it is in many other Sub-Saharan African nations, making it difficult to gather reliable statistical information quickly.

A limitation of this study is that we did not account for the cost of educating health workers or costs incurred by family members in accessing healthcare. Individuals, homes, and society as a whole all have cost structures that must be considered in social planning. Future research should look on the epidemiological studies and long-term effects of illness-related quality-of-life impairments.

This research was carried out in a specific institutional and epidemiological setting. Although generalizations should be made with caution, the study can still be beneficial in other low-income settings.

Conclusion

Governments, policymakers, and other stakeholders must prioritize surgical training, and build infrastructure across the country to increase access to surgical treatment, which would be a critical step toward achieving universal health coverage. The cost-effectiveness and practicality of obstetric fistula surgical repair could be improved by preventing obstetric complications. We propose task-sharing to boost capacity for timely caesarean sections by teaching doctors and midwives to do emergency caesarean sections and administer safe anesthesia, thereby improving community access to critical surgery. In low- and lower middle-income countries like Ethiopia, first-level obstetric surgical care has a huge potential for reducing maternal and newborn morbidity. Scaling up of surgical capacity in rural areas should consequently be a top priority. Given the significant scarcity of qualified obstetricians in many parts of the world, particularly in distant district hospitals, investment in general practitioners or non-physiatrists may be directed toward training. All the interventions chosen were proven to be very cost-effective. plans should be made to scale up coverage of fistula surgery.

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