Health-economics of vaccines in Ethiopia

Dagne, Abrham

DOI:
10.33612/diss.206070529

Chapter one

GENERAL INTRODUCTION

GENERAL INTRODUCTION

Ethiopia is a country located in the Horn of Africa, which is the continent's easternmost region. Ethiopia is a landlocked country bordered by Kenya to the south, Eritrea to the north, Djibouti to the northeast, Somalia to the east, and South Sudan and Sudan to the west. The country has a total area of approximately 1.1 million km^2. With a population of 114 million people (2020), Ethiopia is Africa's second-most populous country, trailing only Nigeria [1,2]. The vast majority of the population (roughly 80%) lives in rural areas, and more than half of the population is under the age of 20 [3,4]. Ethiopia is a federation that is currently divided into ten administrative regions and two chartered cities. Ethiopia has one of the fastest-growing economies in the region, aspires to be a lower-middle-income country by 2025, and is working to achieve the Sustainable Development Goals (SDGs) for health through universal health coverage by 2030 [1].

In Ethiopia, the public healthcare service is structured into a three-tier system: primary, secondary, and tertiary levels of care. Primary care hospitals, health centers, and health posts are all part of the primary care level. Secondary level services are provided by general hospitals, while tertiary level services are provided by specialized hospitals [5,6]. In 2016/17, Ethiopia's total health expenditure was estimated to be US$3.10 billion, accounting for 8.04% of total government expenditure and 4.2% of gross domestic product (GDP). Out-of-pocket health spending accounted for 31% of the total health expenditure. More than half of all health expenditures were spent on infectious and parasitic disease prevention, control, and treatment (51%). In Ethiopia, vaccine-preventable diseases (VPDs) accounted for 12% of infectious and parasitic disease health expenditures [7].

Ethiopia has implemented several policies and strategies to enhance equity and reduce poverty over the last two decades, resulting in significant improvements in citizens' health [8]. There has been a substantial expansion in access to key maternal and child health services. The percentage of women who received antenatal care from a skilled provider increased from 27% in 2000 to 74% in 2019. Institutional deliveries have increased from 5% in 2000 to 50% in 2019. In 2019, 43% of children aged 12-23 months had received all basic vaccinations, up from 14% in 2000 [9,10]. Correspondingly, the country's Universal Health Coverage (UHC) effective coverage index, which measures how well a country provides effective and essential health services, jumped to 46.5 in 2019 from 10.1 in 1990 [11]. Infant mortality dropped by 56% in the last two decades, and under-five mortality dropped by 67%. During the same

time period, maternal mortality decreased by 53%. [9,10]. Moreover, there has been a remarkable gain in HIV/AIDS, malaria, and tuberculosis control [12,13].

Despite these accomplishments, Ethiopia continues to face a triple disease burden: emerging non-communicable disease, injuries, and infectious disease [14,15]. In Ethiopia, the percentage contribution of non-communicable diseases to age-standardized years of life lost (YLL) was 41% in 2015, with injuries accounting for 9% and Communicable, Maternal, Neonatal, and Nutritional Diseases (CMNND) accounting for approximately 50%. Lower respiratory infections, diarrheal diseases, and tuberculosis were the top three leading causes of age-standardized YLL for all age groups [16]. Similarly, non-bloody diarrhea, pneumonia, acute upper respiratory infections, acute febrile illness, and infections of the skin and subcutaneous tissue accounted for 68% of causes of morbidity among under-five children in Ethiopia in 2016/17, with the majority preventable through vaccination [17]. This demonstrates a significant backlog in infectious disease prevention in Ethiopia, and VPDs remain the country's most serious public health challenge.

Vaccines effectively prevent certain infections and the associated death, disease, and disability in people of all ages. Vaccination is estimated to save 4-5 million lives each year [18]. Vaccines played a significant role in the effective eradication of certain deadly diseases such as smallpox. As a result of extensive vaccination, substantial progress has also been made in polio and measles elimination from most part of the world. In addition, other diseases which were once a major cause of death (e.g., diphtheria) become rare medical conditions, and frequent epidemics due to certain VPDs have been reduced to occasional outbreaks [19,20]. Vaccines have a broader impact than just disease control. They promote economic growth, provide peace of mind, equity, women's empowerment, combat antimicrobial resistance, and protect against bioterrorism [21].

The World Health Organization (WHO) initiated the Expanded Programme on Immunization (EPI) in 1974, intending to vaccinate every single child across the globe to ensure universal access to vaccines [22]. The EPI has significantly contributed to the improvement of global vaccination coverage. In 2016, more than 85% of the children received three doses of vaccine containing diphtheria-tetanus-pertussis (DTP3), compared to only 5% when the program first began in 1974 [23]. In accordance with the WHO recommendation, Ethiopia started its EPI in 1980 to protect children against six VPDs: tuberculosis, poliomyelitis, diphtheria, pertussis, tetanus, and measles. The country was then able to expand its immunization service by introducing several new vaccines into the EPI program, including Hepatitis B vaccine, *Haemophilus influenza*e

type b vaccine, pneumococcal vaccine, rotavirus vaccine, and human papillomavirus vaccine, thanks to funding from Gavi, the Vaccine Alliance. In 2018, the national budget for immunization services exceeded $126 million, with the government contributing 43%. In Ethiopia, vaccines recommended in the EPI are provided free of charge at the point of delivery [24–26]. The national immunization schedule is shown in Table 1.

Table 1: National immunization schedule in Ethiopia [27]

Age	Vaccine
At birth	BCG vaccine, OPV0
Six weeks	OPV1, Pentavalent* 1, PCV 1, Rotavirus vaccine 1
Ten weeks	OPV2, Pentavalent 2, PCV 2, Rotavirus vaccine 2
Fourteen weeks	OPV3, Pentavalent, PCV 3, IPV
Nine months	MCV1 first dose
Fifteen months	MCV2 second dose
Fourteen-year old (girls only)	4vHPV vaccine (followed by second dose after six months)

* A combination of Diphtheria, Tetanus, Pertussis, Hepatitis B, and Haemophilus influenzae type B vaccines.
BCG: Bacillus Calmette-Guérin vaccine; OPV: oral polio vaccine; PCV: Pneumococcal Conjugate Vaccine; IPV: Inactivated Polio Vaccine; MCV: Measles vaccine; 4vHPV: Quadrivalent human papillomavirus

A high and equitable immunization coverage should be achieved by a high-performing EPI. Ethiopia aimed to reach 90% national coverage and at least 80% in every district with all vaccines by 2020, in line with the Global Vaccine Action Plan (GVAP) endorsed by World Health Assembly in 2012 [28,29]. Data from the 2019 Ethiopian mini Demographic and Health Survey (DHS) show that the coverage remains far below the goal at 43%. However, it should be noted that the coverage has shown improvement when compared to the earlier DHS surveys: 14% in 2000, 20% in 2005, 24% in 2011, and 39% in 2016. There is also inequality in coverage between the lowest socioeconomic quintile and the highest quintile. According to the 2016 Ethiopian DHS, there is 41% gap in the full childhood vaccination coverage between the lowest and highest wealth quintile. As result of the equity gap, the most vulnerable groups who will benefit most from the immunization program are left under-served. As a result, policymakers must understand the determinants of poor vaccination coverage as well as socioeconomic inequalities in vaccination coverage to strengthen their immunization program and sustain progress.

In addition to traditional EPI vaccines, many new vaccines, such as the human papillomavirus (HPV) vaccine, are now available for use as a result of advances in vaccinology. Accordingly, many countries, including Ethiopia, are constantly updating their EPI calendar. However, these new vaccines are more expensive than the traditional

EPI vaccines. Donors and local decision-makers typically require information on the relative cost-effectiveness of vaccines in order to determine whether or not to include them in the national EPI. Cost-effectiveness analysis is a health economic evaluation method that compares the relative costs and outcomes (effects) of one intervention to another (or the status quo). It is primarily used to calculate how much extra money must be paid to obtain one unit of additional benefit[30]. Nowadays, various international organizations and policymakers, such as Gavi, the Vaccine Alliance and the United Kingdom's National Institute for Health and Clinical Excellence , routinely use health economic evaluations to support their decision on certain vaccination programs.

AIM OF THIS THESIS

The main aim of this thesis was to quantitatively determine the drivers of the change in vaccination coverage, to investigate the factors that influence childhood vaccination coverage, as well as to examine the extent and trend of socioeconomic inequalities in coverage in Ethiopia. Further, this thesis aimed to analyze the cost-effectiveness of HPV vaccines in Ethiopia.

THESIS OUTLINE

Including the introductory chapter (**Chapter 1**) this thesis contains eight chapters in total. **Chapter 2** investigates drivers of the change in full vaccination coverage among children aged 12–23 months. In **Chapter 3** factors associated with the uptake of newly introduced vaccines namely rotavirus vaccine and pneumococcal conjugate vaccine in Ethiopia was investigated. **Chapter 4** describes socioeconomic inequalities associated with the uptake of rotavirus vaccine in Ethiopia and the factors contributing to inequalities. **Chapter 5** intended to understand the trend in socioeconomic inequality of measles vaccine. **Chapter 6** argues how to maximize the benefit from human papillomavirus (HPV) vaccines. **Chapter 7** presents a cost-effectiveness analysis of quadrivalent human papillomavirus (4vHPV) and nonavalent human papillomavirus (9vHPV) vaccines in Ethiopia. Finally, **Chapter 8** discusses the main findings from the above chapters and draw conclusion. Suggestions for further research is also provided in **Chapter 8.**

REFERENCES

1. The World Bank. Ethiopia Overview. https://www.worldbank.org/en/country/ethiopia/overview. Accessed May 16, 2021.
2. The Nations Online Project. Ethiopia - Country Profile - Destination Ethiopia - Nations Online Project. https://www.nationsonline.org/oneworld/ethiopia.htm. Accessed May 16, 2021.
3. Zekaria S, Ababa A. Central Statistical Agency Population Projections for Ethiopia Population Census Commission ii. 2013.
4. The World Bank. Rural population (% of total population) - Ethiopia | Data. https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS?locations=ET. Accessed May 16, 2021.
5. Alebachew A, Waddington C. *Improving Health System Efficiency: Ethiopia- Human Resources for Health Reforms*.; 2015. https://apps.who.int/iris/bitstream/handle/10665/187240/WHO_HIS_HGF_CaseStudy_15.6_eng.pdf?sequence=1&isAllowed=y.
6. World Health Organization. *Primary Health Care Systems (PRIMASYS): Case Study from Ethiopia*. Geneva; 2017. https://www.who.int/alliance-hpsr/projects/alliancehpsr_ethiopiaprimasys.pdf?ua=1. Accessed May 16, 2021.
7. Federal Democratic Republic of Ethiopia Ministry of Health. *Ethiopia Health Accounts, 2016/17*. Addis Ababa, Ethiopia; 2019.
8. Admasu K, Balcha T, Ghebreyesus TA. Pro-poor pathway towards universal health coverage: Lessons from Ethiopia. *J Glob Health*. 2016;6(1). doi:10.7189/jogh.06.010305
9. Ethiopian Public Health Institute (EPHI) [Ethiopia] and ICF. *Mini Demographic and Health Survey 2019:Key Indicators*. Rockville, Maryland, USA; 2019.
10. CSA [Ethiopia] and ICF. *Ethiopia Demographic and Health Survey 2016*. Addis Ababa, Ethiopia, and Rockville, Maryland, USA; 2016.
11. Lozano R, Fullman N, Mumford JE, et al. Measuring universal health coverage based on an index of effective coverage of health services in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet*. 2020;396(10258):1250-1284. doi:10.1016/S0140-6736(20)30750-9
12. Murray CJL, Ortblad KF, Guinovart C, et al. Global, regional, and national incidence and mortality for HIV, tuberculosis, and malaria during 1990-2013: A systematic analysis for the Global Burden of Disease Study 2013. *Lancet*. 2014;384(9947):1005-1070. doi:10.1016/S0140-6736(14)60844-8
13. Assefa Y, Van Damme W, Williams OD, Hill PS. Successes and challenges of the millennium development goals in Ethiopia: Lessons for the sustainable development goals. *BMJ Glob Heal*. 2017;2(2):e000318. doi:10.1136/bmjgh-2017-000318
14. Kaba M. Non-communicable diseases: unwelcome in Ethiopia. *Ethiop J Heal Dev*. 2018;32.
15. Shiferaw F, Letebo M, Misganaw A, et al. Non-communicable Diseases in Ethiopia: Disease burden, gaps in health care delivery and strategic directions. *Ethiop J Heal Dev*. 2018;32.
16. Misganaw A, Haregu TN, Deribe K, et al. National mortality burden due to communicable, non-communicable, and other diseases in Ethiopia, 1990-2015: Findings from the Global Burden of Disease Study 2015. *Popul Health Metr*. 2017;15(1):1-17. doi:10.1186/s12963-017-0145-1
17. Federal Democratic Republic of Ethiopia Ministry of Health. *Health and Health Related Indicator of Ethiopia (2016/2017)*. Addis Ababa, Ethiopia; 2018.
18. World Health Organization. Immunization. https://www.who.int/news-room/facts-in-pictures/detail/immunization. Accessed May 16, 2021.
19. Greenwood B. The contribution of vaccination to global health: past, present and future. *Philos Trans R Soc Lond B Biol Sci*. 2014;369(1645). doi:10.1098/rstb.2013.0433
20. Gentile A, Bhutta Z, Bravo L, et al. Pediatric disease burden and vaccination recommendations: understanding local differences. *Int J Infect Dis*. 2010;14(8):e649-e658. doi:10.1016/j.ijid.2009.11.006
21. Andre FE, Booy R, Bock H, et al. Vaccination greatly reduces disease, disability, death and inequity worldwide. *Bull World Health Organ*. 2008;86(2):140-146. doi:10.2471/blt.07.040089
22. Keja K, Chan C, Hayden G, Henderson RH. Expanded programme on immunization. *World Heal Stat Q*. 1988;41(2):59-63. doi:10.1007/978-0-387-78665-0_5628
23. World Health Organization. Immunization coverage. https://www.who.int/news-room/fact-sheets/detail/immunization-coverage. Accessed May 16, 2021.
24. Memirie ST, Nigus M, Verguet S. Cost-effectiveness and equitable access to vaccines in Ethiopia: an overview and evidence synthesis of the published literature. *J Glob Heal Reports*. 2021:1-8. doi:10.29392/001c.19354

25. Geweniger A, Abbas KM. Childhood vaccination coverage and equity impact in Ethiopia by socioeconomic, geographic, maternal, and child characteristics. *Vaccine*. 2020;38(20):3627-3638. doi:10.1016/j.vaccine.2020.03.040
26. Belete H, Kidane T, Bisrat F, Molla M, Mounier-Jack S, Kitaw Y. Routine immunization in Ethiopia. *J Heal Dev*. 2015;1:2-7.
27. Federal Democratic Republic of Ethiopia Ministry of Health. National Routine immunisation schedule. https://www.moh.gov.et/ejcc/am/EPI. Accessed May 16, 2021.
28. Decade of Vaccine Collaboration. Global Vaccine Action Plan. *Vaccine*. 2013;31:B5-B31. doi:10.1016/j.vaccine.2013.02.015
29. Federal Democratic Republic of Ethiopia Ministry of Health. *Ethiopia National Expanded Program on Immunization, Comprehensive Multi - Year Plan 2016 – 2020.* Addis Ababa, Ethiopia.; 2015.
30. Musgrove P, Fox-Rushby J. Cost-Effectiveness Analysis for Priority Setting. In: Jamison DT, Breman JG, Measham AR, et al., eds. Disease Control Priorities in Developing Countries. 2nd edition. Washington (DC): The International Bank for Reconstruction and Development / The World Bank; 2006. https://www.ncbi.nlm.nih.gov/books/NBK11780/. Accessed May 16, 2021.