HEALTH SYSTEMS

Andhra Pradesh: Health Scenario, Health Systems Interventions and Cost-Benefit Studies

Cost-Benefit Analysis

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ANDHRA PRADESH PRIORITIES
AN INDIA CONSENSUS PRIORITIZATION PROJECT

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Andhra Pradesh Priorities
An India Consensus Prioritization Project

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Academic Abstract

Andhra Pradesh is one of the progressive states of India. Key health and programme performance indicators of the state like infant mortality rate, maternal mortality rate, and total fertility rate, and antenatal care, institutional delivery, immunization, malnutrition, and couple protection rate are better than the national average. Still, a lot needs to be done to achieve SDG targets in the next 12 years. Andhra Pradesh has been recently created as a new state and, therefore, faces several challenges in terms of reorganizing governance structures and taking appropriate decisions for allocation of funds for rapid and sustainable development. Hence, the objective of this paper is to address the health system problems and identify the best possible interventions for public health investment.

In this context, India Consensus has partnered with the State Government to undertake Cost-Benefit studies of the interventions that had been identified and prioritized through stakeholder consultations. In the health sector, these are

i). strengthening basic and surgical capacities for reducing maternal and neonatal deaths;

ii). improving emergency referral management using 108 ambulance services; and

iii). family planning interventions.

The study findings show that investment made on strengthening basic and surgical capacities for reducing maternal and neonatal deaths, improved emergency referral management using 108 ambulance services in urban and rural areas, and family planning interventions have benefit-cost ratios of 7.3, 16.8, 6.8, and 16 respectively. These analyses reveal that investment in these key health interventions is cost-effective and should help decision-making for public health interventions that maximize dividends.

Policy Abstract

The Problem

In recent times, the Indian healthcare sector has evolved both in terms of quality and quantity. It is noteworthy that the sector includes a broad range of services to address the increasing burden of non-communicable diseases, along with the still high burden of communicable diseases. This sector has a vital role in both the wellbeing of the community and the development of the nation. Public and private institutions and development partners have started shifting their focus to this sector, and the change is evident from the current health indicators. However, the overall performance of the healthcare sector in India is considerably below international benchmarks. Andhra Pradesh, an Indian state located on the southeastern coast, is not an exception. It has an estimated population of 54,238,698 in 2017, with a 68.1% rural share. Following recent geographic and administrative reforms, the Government of Andhra Pradesh started working with key stakeholders to improve the overall developmental status of the state. Healthcare was a major component of the developmental agenda. Despite visible success in this sector, many health indicators are still a concern for the state as they are far behind the Sustainable Development Goals (SDGs) targets. For example, the maternal mortality ratio (MMR) was 92 per 100,000 live births in 2011-13. In Andhra Pradesh, the female population forms virtually half of the 15-49 years age group. This population group experiences enormous suffering due to the unequal distribution of maternal and child health services. The earlier experience of unfulfilled Millennium Development Goals (MDGs) suggests we take a cautious approach towards the progress and level of healthcare indices. Hence, both public and private sector and developmental partners must be aligned to work in coordination using multisectoral and multidisciplinary approaches reaffirmed by evidence, in order to achieve the SDG targets.

Interventions based on these approaches may involve different health system components addressing maternal and child health. These interventions vary dramatically in their costs due to the difficulty in their successful planning and implementation – such as identifying the required number of ambulances in rural and tribal areas, the availability of MCH services and identification of marginal populations for family planning services. Considering the expected

benefits at the population level, policymakers should make informed choices among the evidence-based health systems interventions and implement those that are cost-effective and will provide the highest returns to investment in terms of health benefits.

Intervention 1: Strengthening basic and surgical capacity for reducing maternal and neonatal deaths

Overview

Complications during pregnancy and childbirth cause around 800 maternal deaths and 12,100 neonatal deaths per year in Andhra Pradesh. Andhra Pradesh has relatively better indicators are than other states, but it still requires significant effort to achieve related SDG targets. Coverage of basic and emergency obstetric care is a critical factor to improve maternal and child health, therefore, we are looking at improving the coverage of basic, and to some extent the emergency, surgical capacities to improve the system of care for mothers and newborns in Andhra Pradesh.

Implementation Considerations

The intervention will work in a prospective manner initially for 20 years. We assume that the benefits will be same for next 19 years as in the first year. The target of this intervention is a decrease in the Maternal Mortality Rate (MMR) by 40% compared to the pre-intervention status.

Costs and Benefits

This study adopted the economic model from Goldie et al (2010), which focused on maternal mortality (MM) of India overall plus a few selected states. In our study, the key focus was on reducing MM by strengthening the service quality of maternal health interventions. For this, we used incidence and case fatality rate of haemorrhage, obstructed labour, hypertensive disorder, sepsis, and unsafe abortion. These interventions are estimated to result in a reduction of MM by 40%, saving 319 maternal lives per year. They will also reduce neonatal mortality by 8%, saving 1,019 newborn lives per year.

The total cost of the intervention is estimated at INR3,028 crores and the total economic benefit of saving the maternal and neonatal lives is expected to be INR22,107 crores at 5% (annual) discount rate. Hence, it has a benefit-cost ratio of 7.3.

Intervention 2: Improved emergency referral management by 108 ambulance services

Overview

Ambulance services constitute a critical component of Emergency Medical Services (EMS) to transport patients to health facilities on time, which is essential to ensure timely and adequate care. In Andhra Pradesh, there is a shortage of ambulances, which results in an unintended delay in delivering timely health services. It often leads to the death of victims in a number of medical and surgical emergencies. Therefore, we aim to calculate the requirement of additional ambulances and staff, followed by calculation of total investment and benefits.

Implementation Considerations

It is challenging to ensure an adequate number of ambulances for the population of a large geographic region. Based on available literature, we identified an approximate number of ambulances that should be made available in Andhra Pradesh to serve the serve the healthcare needs of the population. The intervention considers deployment of additional ambulances, which are expected to remain operational for next 10 years. The indicator to measure the improvement in population health will be the coverage of the ambulance services.

Costs and Benefits

Costs

In this intervention, we calculated both capital and recurrent costs on various heads. The capital cost is a one-time investment for the next 10 years; in addition there will be recurrent costing such as salaries, maintenance, training etc. We estimated the total number of ambulances required as 33 per million population in the urban area and 99 per million in rural areas. Hence, the total cost to fulfil the need for ambulances in the urban and rural areas of the state comes to INR 99 crores and INR7,950 crores, respectively.

Benefits

For the calculation of benefits, we used the data of referrals for ischemic heart disease, road traffic accidents, and obstructed labour cases. The total benefit in economic terms would be INR16,837 crores in urban areas and INR7,867 crores in rural areas. It means such

interventions would have benefit-cost ratios of 16.8 and 6.0 respectively in urban and rural areas of Andhra Pradesh.

Intervention 3: Family Planning

Overview

Family planning helps women to have their desired number of children and/or ensure the spacing of pregnancies. It is achieved using contraceptive methods and the treatment of infertility. It prevents unwanted pregnancy-related health risks in women, indirectly reduces infant mortality, reduces the spread of sexually transmitted diseases, empowers people and enhances education, reduces adolescent pregnancy, helps in reducing population growth etc. Thus, adequate family planning measures promote the well-being and autonomy of women and improvement in various health indices of Andhra Pradesh.

Implementation Considerations

This intervention looked forward over the next 50 years, as our ultimate target is to reduce the number of unwanted children and decrease the prevalence of unwanted pregnancy-related abortion. Even to maintain the current birth rate, family planning plays an important role. However, it is always a tough task to identify the roughly 5% of the female population who need contraceptives, but we still assume that we will be able to reach these women.

Costs and Benefits

Costs

The cost of the intervention includes the cost of service delivery and procurement of contraceptives for the target population. The total per capita cost is about INR386 at 5% discount rate.

Benefits

The major benefits would come by way of demographic dividends but the child and maternal lives saved due to family planning methods would also be important. The total economic benefits would be about INR6,310 which is about 16 times the investment cost.

BCR Table

Table 1: Summary of Benefit-Cost Ratio

Interventions	Benefit	Cost	BCR	Quality of Evidence
Maternal and Neonatal health*	22,107	3,028	7.3	Medium
Ambulance (Urban)*	16,837	999	16.8	Limited
Ambulance (Rural)*	47,867	7,950	6.0	Limited
Family planning (per capita-years)	6,310	386	16.3	Medium

Notes: All figures assume a 5% discount rate; * Benefits and Cost values are in crores of INR except family planning which are in per capita-years

1. Introduction

1.1 India's Health Scenario

Health is the responsibility of the government as per the Constitution of India. Health is a state subject primarily, and states are responsible for providing health services, though the policy is developed by the Federal government. Health systems in India have evolved into a massive network of health institutions since their inception in 1951. The health of the people was considered as central to community development with the district as a functional and administrative unit across the country. The genesis of healthcare in India is rooted in the concept of comprehensive health care as recommended by the Health Survey and Development Committee (1946), popularly known as Bhore Committee Report. The guiding principles of comprehensive health care were to provide preventive, promotive and curative health services; healthcare being accessible and available as close as possible to the beneficiaries and available to all irrespective of their ability to pay for it; special provision of care for vulnerable sections of the population, particularly women and children; and involvement of communities and people in healthcare planning and delivery of services and maintaining a healthy environment. There are 156,231 sub-centres and 25,650 primary health centres (PHCs) at the village level that provide primary health care. Secondary level health and referral services are provided by 5,624 community health centres (CHCs) located at the block level (HMIS-MoHFW, 2017). In each district, there is a district hospital with 100 – 300 beds. The district hospitals are the main source of secondary level health care. In all, there is a total of 14,379 hospitals and 634,879 beds, with 67% in urban areas (CBHI, 2017). The private sector has a significant presence in healthcare in the country and its shares in hospitals and hospital beds are estimated at 74% and 40%, respectively. In India, private health care accounts for 74% of the country's total health care expenditure (IBEF, 2017).

India has made significant progress, not only in health infrastructure and resources but also in various health indicators. The mortality rate has declined from 27 per 1000 population to less than 7 per 1000 population, life expectancy has increased from a low of 32 years to the current 69 years. There has been a phenomenal decline in the infant mortality rate (~200/1,000 live births) and maternal mortality rate (~500/100,000 live births) to 37 per

1,000 live births and 167 per 100,000 live births (Govt. of India). The major communicable diseases have been brought under control, and smallpox and polio have been eliminated.

A key policy initiative was taken in 1983 when India announced its first formal Health Policy, which was part of a major effort to achieve the goals of primary health care post- the Alma-Ata Declaration – Health For All by 2000 AD (Singh and Singh, 2004). The policy focused on creating and expanding health infrastructure, human resource development, and equipping health facilities with the requisite equipment, essential drugs, and material. In the process of evolution, the second version of the National Health Policy was announced in the year 2002. The launch of the National Rural Health Mission (NRHM) in 2005 by the Government of India was a major breakthrough in the country's healthcare, with a focus on reducing maternal mortality and infant mortality, while also implementing management interventions to improve the efficiency and effectiveness of health systems to achieve Millennium Development Goal 3. The NRHM paid rich dividends and India almost achieved the goals of MDG 4, 5 and 6 (WHO- South-East Asia, 2008) (Ministry of Statistics and Programme Implementation, 2017).

India announced its third National Health Policy in 2017, focusing on achieving health-related Sustainable Development Goals (SDG 2015) to reduce maternal deaths to fewer than 70 per 100,000 live births, infant mortality to 12 deaths per 1'000 live births, and under-five mortality to fewer than 25 per 1000 live births (UN India, 2016). Universal Health Coverage (UHC) that aims to enhance access and availability of quality health services, and provide financial protection to the poor, is the major approach to achieve the unfinished agenda of the MDGs and realize the health goals of the SDGs.

India faces serious challenges in the implementation of policy intentions and strategies. There are gross inequities in access and availability of health services, especially for the poor and disadvantaged. Despite a vast network of public-sector healthcare institutions, a large health workforce and resource mobilization, almost 70% people use a private health facility for out-patient care. They incur about 70% of total health expenses out of pocket (Nandi *et al.*, 2017)(T *et al.*, 2015). Health systems are afflicted with low efficiency and effectiveness with poor implementation of health programmes and interventions.

Maternal, neonatal and under-5 mortality rates are still high. The major preventable causes of maternal deaths are haemorrhage during and after childbirth, puerperal sepsis, pregnancy-induced hypertension and eclampsia. Neonatal mortality accounts for 60-65% of infant deaths, together with diarrhoea, acute respiratory infections (ARI) and severe malnutrition. This is due to poor coverage of critical mother and child care services. According to NFHS 4, only 30.3% of pregnant women received full antenatal care. In rural areas, only 16.3 % of pregnant women received full antenatal care, in contrast to their urban counterparts (31.1%). Further, on average women had INR3,198 of out-of-pocket expenses in public health facilities. Almost one -fourth of women (22.9%), were undernourished, with a BMI of less than 18.5 kg/m^2. Half the pregnant women were anaemic. An even larger proportion of children – 58.5% – had anaemia. Malnutrition among children under age 5 was rampant, with 38.4% being stunted and 21.0% wasted. Full immunization coverage among children 12-24 months was only 62.0% (NFHS 4 India, 2015).

In addition, the disease burden due to tuberculosis continues to be high though the mortality rate has declined. Treatment faces a major threat from strains resistant to the usual anti-tubercular medicines. Although trends of HIV have shown a reversal, it remains a major health problem. While India struggles with these chronic diseases, there is a rise in the disease burden caused by non-communicable diseases (NCD), such as diabetes, hypertension, various forms of cancers and Chronic Obstructive Pulmonary Disease (COPD). It is projected that NCDs will account for over 70% of total disease burden by 2025 (Kontis *et al.*, 2015) ('Economics of Non-Communicable Diseases in India', 2014).

1.2 Andhra Pradesh: Health Systems, Status and Driving change

Andhra Pradesh is one of most progressive states in India and has achieved its demographic goal of reaching replacement fertility levels, with a TFR of less than 2.1 (current level 1.8). It has also almost accomplished MDGs 4, 5 and 6 (NFHS 4, 2015). It has some significant achievements in improving key health indicators in the state; namely, maternal mortality rate (92 per 100,000 live births), and Infant mortality rate (35 per 1000 live births), which are much below the national average (Govt. of India). The coverage with full immunization among children aged 12-23 months is slightly higher than the national average, at 65.3 % compared to 62.0%. About 40% of pregnant women received full antenatal care and 76.3% received at least four requisite visits during pregnancy. However, the state of nutrition

among women and children was a concern, as 52.9% of pregnant women and 58.6% of children were reported to be anaemic. Malnutrition among children under five was high, with 31.4% found to be stunted, 31,9% underweight, 17.2% wasted and 4.5% severely wasted (NFHS 4, 2015).

Andhra Pradesh's public system has a well-developed health infrastructure with 7,458 sub-centres, 1,147 PHCs and 193 CHCs (Dept. of HMFW, 2018). There are 258 hospitals in the public sector with a total of 16,658 beds (CBHI, 2017). However, despite this vast network, there are gaps in the availability of infrastructure when compared to IPHS standards. The state of Andhra Pradesh has a significant presence of private sector healthcare.

Andhra Pradesh has been transforming fast. It was the first state to formulate a State Population Policy in 1997, in order to reduce population growth rate and improve quality of life. It started the first health insurance programme 'Rajiv Arogya Shri' (Now NTR Vaidya Seva Scheme) to increase access to and availability of tertiary care (AP- Govt., 2017). The state envisages building a healthy society by developing a sustainable ecosystem to universalize quality health and nutrition services that are accountable, effective, efficient, equitable and technically appropriate. To realize the vision, the state has to close the gaps in health infrastructure, strengthen health systems and their building blocks, and implement evidence-based strategies and interventions that are cost-effective and efficient to enhance health benefits.

As documented in the published literature, key stakeholder consultations and national level surveys, in the case of health system interventions in Andhra Pradesh, the priority areas include maternal and child health (MCH), emergency medical services, and family planning.

In this paper, we discuss prospective interventions addressing these health issues through strengthening the health system in Andhra Pradesh to achieve better health outcomes and impacts. Also, we analyze the benefit-cost ratio for each intervention.

We have selected three interventions for benefit-cost studies, namely,

1. Strengthening Basic and Surgical Capacities to reduce Maternal and Neonatal deaths
2. Improving emergency referral management using 108 ambulance services
3. Family Planning

2. Strengthening basic and surgical capacity for reducing maternal and neonatal deaths

2.1 Description of intervention

The rates of maternal and neonatal deaths continue to be high in Andhra Pradesh. Most of these deaths are avertable by better care during childbirth, especially surgical care, and appropriate care during the postpartum period. Complications during pregnancy and childbirth are considered as leading causes of deaths and disabilities among women of reproductive age in developing countries. These associated risks contribute to raising the critical maternal mortality ratio indicator. However, the majority of maternal deaths are preventable if diagnosed and treated in time. About three-quarters of all maternal deaths are caused by postpartum haemorrhage, hypertensive disorders such as pre-eclampsia/eclampsia, infections, unsafe abortion and other delivery-related complications (UNICEF). In practice, however, even if a woman can access prenatal care and deliver in a health facility where skilled birth attendants are available, poor quality of care can be threatening enough for the mother and newborn. Moreover, a wide spectrum of non-communicable diseases also plays an important and growing role contributing to the deaths that occur during pregnancy, delivery, or during the postpartum period.

For the purpose of our study, we have adopted the WHO definition of maternal death. Maternal death is defined as “the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes” (WHO, 2014).

Basic Emergency Obstetric Care (BEmOC) and Comprehensive Emergency Obstetric Care (CEmOC) have been extensively promoted to improve maternal and neonatal health outcomes. However, the consensus about universal access to high-quality BEmOC and CEmOC services is facing challenges due to uncertainties about how best to implement them in specific situations (MoHFW, 2007). It is essential to ensure an adequate number of skilled staff, efficient emergency support systems, and well-equipped facilities for CEmOC to overcome barriers to maternal care predominantly in rural areas (Goldie *et al.*, 2010). In this

study, we focus on a couple of interventions which collectively play their roles in reducing the maternal mortality ratio (Shiffman and Ved, 2007).

The study by Goldie et al 2010, considered the costs, feasibility, and operational complexity of alternative interventions and estimated the clinical and population-level benefits associated with strategies to improve the safety of pregnancy and childbirth in India. They found that early intensive efforts to improve family planning and control of fertility choices and to provide safe abortion, accompanied by a paced systematic and stepwise effort to scale up capacity for integrated maternal health services over several years, is as cost-effective as childhood immunization or treatment of malaria, tuberculosis, or HIV. In just 5 years, more than 150,000 maternal deaths would be averted through increasing contraception rates to meet women's needs for spacing and limiting births; nearly US$1.5 billion would be saved by coupling safe abortion to aggressive family planning efforts; and with stepwise investments to improve access to pregnancy-related health services and to high-quality facility-based intrapartum care, more than 75% of maternal deaths could be prevented. If accomplished over the next decade, the lives of more than one million women would be saved. However, this model used projections up to 2015 but now the situation in Andhra Pradesh has changed due to improvements in infrastructure and various health indicators. The interventions used in the paper are still good ones and now we are scaling them up to target the SDGs.

2.2 Data

The data necessary for a cost-benefit analysis of BEmOC and CEmOC as interventions to reduce maternal and neonatal deaths was collected from available online sources and primary data sources like unpublished Government documents and interviews with Government officials working in the relevant agencies at the state level. Global Burden of Disease (GBD) 2016 data was used to collect information about age-specific deaths. Niti Aayog and Census data were used for various projections. Further, the cost data from the Goldie et al. paper was used on various interventions and projected based on the adjusted inflation rate. Total incentives were calculated on the number of beneficiaries and incentive per beneficiary.

2.3 Situation analysis

A study by Prakasamma M. 2009 revealed a disproportionately low focus on maternal health in peripheral hospitals resulting in the low use of these facilities for childbirth (Prakasamma, 2009). Moreover, the expansion of services offered through primary health centres was not done with adequate planning, which weakened the peripheral health system further. Also, there was little emphasis on developing a cadre of midwives who would have focused primarily on maternal and newborn health. Lastly, the low socioeconomic status of women in the state has affected timely referral and access to maternal health services for a large proportion of the population in Andhra Pradesh.

Another study by Revu et al 2018 found that a combination of critical factors like poverty, ineffective or unaffordable health services contribute to increased rates of maternal deaths in Andhra Pradesh (Revu *et al.*, 2018). Moreover, the success of JSSY is often affected by a lack of awareness among the target population. It is essential to consider these socioeconomic factors when implementing further interventions in this regard. Furthermore, findings from the Andhra Pradesh NFHS 4 report show that 60% of females among the reproductive age group (15-49 years) are anaemic (NFHS 4, 2015) and a study by Nirmala D. et al 2015 found that severe anaemia during pregnancy is associated with maternal morbidity and mortality (NirmalaDevi, Varalaxmi and Jyothirmayi, 2015). Therefore, effective preventive measures in the form of regular antenatal checkups and iron-folate supplementation are recommended to prevent complications from anaemia in pregnant women. Furthermore, delays at different stages of maternal care contribute to subsequent mortalities and morbidities. The first delay takes place in making the decision to seek health services for obstetric complications, which commonly occurs at the household and community level. The second delay occurs in transporting the patient from home to the nearest health facility. Finally, the third delay occurs in obtaining care at the desired facility which is one of the most tragic issues affecting the survival of the mother and is a direct reflection of the quality of care during major obstetric emergencies (Thaddeus ' and Maine, 1994) (Carvalho Pacagnella *et al.*, 2012).

It is evident from the above description that maternal care services in Andhra Pradesh are far behind the optimal level in terms of availability and accessibility. These critical issues in

maternal care remain a real cause for concern despite the rapid expansion of healthcare infrastructure. Moreover, the quality of services offered by healthcare facilities is often compromised due to deficiencies in the skilled workforce, other allied resources and standard operating procedures. Further initiatives should address the earlier gaps as mentioned above to develop a robust and resilient health system capable of delivering optimal maternal care in Andhra Pradesh.

2.4 Calculation of Costs and Benefits

2.4.1 Costs and Benefits

This study model is a modified version of that used by Goldie et al. This study covered maternal mortality (MM) in India along with a few state-specific rates. The key focus area is to reduce MM by strengthening the service quality of maternal health interventions. In our study, the incidence and case fatality rate (CFR) of haemorrhage, obstructed labour, hypertensive disorder, sepsis, unsafe abortion, and other causes were adapted from Goldie et al. and used after projecting them for the year 2017. We calculated the number of post-intervention preventable deaths to estimate the post-intervention MM. The outcome of these interventions is about a 40%t reduction in the rate of MM.

Table 2: Overview of Parameters for Various Causes of Maternal Mortality

	Haemorrhage	Obstructed Labor	Hypertensive disorders	Sepsis	Unsafe Abortion	Others
Incidence rate[#]	0.114	0.047	0.035	0.05	0.128	
CFR* [#]	0.023	0.019	0.021	0.028	0.009	
↓ CFR [#]	75%	95%	59%	90%	98%	
CFR calculated	0.0013	0.0002	0.0011	0.0019	0.0002	
RR post-intervention	25%	5%	41%	10%	2%	19.03%
Potential impact fraction	0.328	0.646	0.201	0.537	0.697	0.380
Deaths avoided	94	9	14	94	30	79

Source: [#]Goldie et al 2005 and authors calculation; *Adjusted value

Costs

Census 2011 data was used to identify the number of ever-married females among the 15-49 age group population. The same proportion was used to calculate the estimated number of ever-married females in 2017 among the projected population of Andhra Pradesh. GBD 2016, cause and age-specific data for different age groups between 15 and 49 were extracted. Among the other causes of MM, indirect maternal deaths, late maternal deaths and deaths aggravated by HIV/AIDS were also included. Present value (PV) of years of life lost (YLL) was calculated using the mean YLL value of individual age group. This value was estimated at 3%, 5%, and 8% discount rate.

It is not possible to reduce maternal mortality sufficiently by a single intervention. So, here we used a group of interventions like family planning for unmet need for spacing, facility births, skilled birth attendants, transport from home, availability of primary level health centres, BEmOC, and CEmOC services. According to Goldie et al, the combination of such services produces a significant reduction in the maternal mortality rate (MMR). Various updated data sources like the NFHS- 4 report, rural statistics 2017 etc. were used to verify the updated status of all these interventions and the status represents an improvement in

the situation; however, there is a gap which requires more attention and resources to fill it. Therefore, we projected our targets based on these gaps and tried to cover 95 – 100% of pregnant females in the 15 – 49 age group. Our view is to provide at least the BEmOC services to all and CEmOC services to all identified females who need it.

All the unit costs were adapted from the Goldie et al paper with present values calculated by using the adjusted inflation rate for 2007 – 2017. Costs of direct health and non-health care indicators were calculated. Direct health care cost includes the cost of induced abortion and treating abortion or pregnancy-related complication like eclampsia, haemorrhage, sepsis etc., and salaries of health-care providers including counselling, skilled birth attendants (SBA), clinicians' time etc. Costs related to prenatal care (e.g., additional prenatal visits, nutritional supplementation, treatment of anemia or other existing diseases, screening for sexually-transmitted diseases), cost of providing safe abortion or family planning options (e.g., sterilization, intrauterine device, oral contraceptives), emergency obstetric care (e.g., facilities with the capacity for transfusion, parental antibiotics, surgery, anesthesia) are also included.

Direct non-health care costs include drugs, vaccines, salaries, infrastructure by intervention and by service location or level (e.g. hospital, health centre, health post), and facility costs. They are categorized as (1) family planning; (2) antenatal care, including treatment for anemia; (3) abortion (incomplete and elective) and post-abortion complications; (4) delivery care; (5) emergency/pre-referral care; (6) assisted vaginal delivery (CEmOC treatment of obstructed labor); (7) cesarean section; (8) postpartum hemorrhage; (9) puerperal sepsis; (10) severe pre-eclampsia/eclampsia; (11) treatment of long-term complications such as PID and obstetric fistula; and (12) postpartum care.

Coverage of all 4 ANCs is used as the proxy indicator for BEmOC services which is 76.3% in Andhra Pradesh (NFHS 4, 2015) and in CEmOC services we are looking for a minimum 25% scale-up from BEmOC to CEmOC which accounts for a 23.8% improvement (95% * 25%) from the current status. So, in our calculations, the target population for BEmOC services is 'total estimated live births in 2017' * (target percent – present status) {889515 * (95%-76.3%) = 166339} and for CEmOC services 'total estimated live births in 2017' * target percent (889515 * 23.8% = 211704). In family planning services, an average cost of temporary

methods like oral contraceptives, condoms, injectables, and IUDs is used to satisfy the unmet need for spacing (3.6%) among ever-married females. For transportation-related cost, we used a per patient transportation cost of 760 INR (AP Govt., 2017). The target population for transport services costing is the percentage of females who used inconvenient modes of transport during NFHS 4 survey, such as motorcycle/scooter, cart, on foot etc. and this is about 81.35% (Table 6).

Facility expenditures were calculated by multiplying the unit cost by the required services number. Abortion-related calculations were performed at two levels; first elective abortions were calculated at 26 per 1000 live births (Stillman Melissa, Frost Jennifer J., Singh Susheela, 2014) and among them, post-abortion complication cases were calculated at an incidence rate of 0.128 (Goldie *et al.*, 2010). The total abortion cost was calculated by multiplying by the unit cost for each. For remaining causes like obstructed labour, haemorrhage, pre-eclampsia, sepsis, and other maternal mortality causes, we used the incidence rate, target population, and unit cost for total cost calculations. The CEmOC cost was not calculated for those where the beneficiaries are getting the same service at the BEmOC centre. The sum of all relevant costs is the total cost of BEmOC and CEmOC services. For financial incentives, we include the JSY incentives for both rural and urban area population.

Table 3: Cost of BEmOC and CEmOC

Intervention	Unit Cost	BEmOC	Unit cost	CEmOC
ANC	1,799.38	299,307,582		Covered in BEmOC
Anaemia	107.52	55,653,326		Covered in BEmOC
Facility expenditures	2,591.02	430,988,891	3,430	177,263,481
Incomplete/Elective abortion	1,621.76	7,013,827		Covered in BEmOC
Post-abortion complications	4,574.87	138,334		Covered in BEmOC
Obstructed labour	2,056.59	16,078,270	9,795	5,315,030
Haemorrhage	3,093.84	58,667,442	14,935	13,473,141
Pre-/Eclampsia	6,303.63	36,698,932	10,795	2,526,085
Sepsis	3,434.32	28,563,096	7,802	17,302,322
Post-partum care	526.01	71,587,067		Covered in BEmOC
		1,004,696,767		**215,880,059**

Source: Author's calculation; Cost in INR

This total cost includes investments in physical and human infrastructure (building, renovation, and equipping medical facilities; training and retaining staff; improving the referral and medical supply system) as well as demand creation, outreach, supervision, monitoring and evaluation activities. All the cost estimates are available in Table 2 and 3.

Table 4: Total cost of the intervention

Intervention	Present Status	Target	Target population	Unit Cost	Total cost
Family planning (Unmet need for spacing)	3.6%	0.0%	431289	1,012	436,558,733
Facility births	91.6%	95%	30243	1,524	46,098,819
SBA (home births)	3.7%	5%	11564	679	7,850,039
Transport from home	14.07%	81.35%	723579	760	549,920,366
Primary-level health centre	100%	100%			
BEmOC	76.3%	95%	166339		1,004,696,767
Availability and quality of CEmOC*		25% of those requiring BeMOC	211260		215,880,059
Financial incentives	91.6%	95%			52,768,856
					2,313,773,639

Source: Author's calculation; Cost in INR

Benefits

The calculation of overall benefits due to saving the life of a mother is not limited to the female only; it goes beyond that and impacts society as a whole as well. But, here we included the direct benefits related to the mother and newborn baby only. For this, we identified the reduction in death rates by scaling-up and performing all the identified interventions. With that, a total number of avoided deaths was calculated. The next step was to calculate the DALYs at 3%, 5%, and 8% discount rates with the previously calculated PV and total avoided deaths. Two approaches were used to calculate the total benefits. In the first one, DALYs were multiplied by three times GDP cost and in second the value of a statistical life year was multiplied by total avoided deaths to calculate the total benefits.

The study finds that maternal deaths would be reduced from the projected number of 801 in 2017 to 481, which means that 319 deaths or about 40% could be averted by maternal health interventions. By reducing these deaths 7,931, 5,699, and 3,864 DALYs per year could be averted at 3%, 5%, and 8% discount rates.

Benefits due to neonatal lives saved were calculated for all available causes from GBD 2016 data and the Darmstadt et al 2005 paper. Our major focus was to cover the benefits at the intra- and post-partum level because these will be indirect benefits due to providing the maternal health facilities. The reduction rate was the average value of the upper and lower limits of the reductions. The next step was to calculate the cause-specific total avoided deaths.

We estimate that 1,019 neonatal deaths per year could be averted due to this intervention. By reducing these deaths 31,509, 21,630, and 14,626 DALYs could be averted at 3%, 5%, and 8% discount rate. The net present value of these collective benefits of maternal and neonatal health outcomes will be Rs. 39,262 crores, 22,107 crores, and 11,257 crores over the 20 year period of the intervention at the 3%, 5% and 8% discount rates respectively.

Calculation of Benefit-Cost Ratio

The results are presented in Table 5. For a 3% discount rate, the BCR is 11.1; in other words, for every rupee spent, the present value of the net economic benefit is 11.1 rupees. The result differs for the 5% discount rate. In this case, every rupee spent yields an economic benefit of 7.3 rupees. The lowest return is at a discount rate of 8%, with just 6.7 NPV return for every rupee spent. Clearly, these results are highly sensitive to the discount rate used.

Table 5: BCR of the intervention in Andhra Pradesh

Discount rate	Benefits 3 x GDP per cap* (in Rs. crores)	Costs (in Rs. crores)	BCR 3 x GDP per cap
3%	39262	3546	11.1
5%	22107	3028	7.3
8%	11257	1677	6.7

Source: Authors calculations; * Includes maternal and neonatal benefits

2.5 Assessment of Quality of Evidence

The impacts of the intervention on maternal and neonatal health are from Goldie et al (2010), and Darmstadt et al (2005). The first of these studies provides evidence for the India-specific context while the second study maps overall reductions from global experiences in developing countries. The underlying data is from reliable data sources but they are not tailored to the particular state. The quality of evidence is assessed as "Medium".

3. Improved emergency referral management using 108 ambulance services

3.1 Description of Intervention

An emergency Medical Service (EMS) is defined as "a comprehensive system which provides the arrangements of personnel, facilities and equipment for the effective, coordinated and timely delivery of health and safety services to victims of sudden illness or injury" (Al-Shaqsi, 2010). An emergency medical system is expected to be effective and efficient enough to provide universal emergency health care services, which means that such services should be available for all who need it. However, this area has been neglected and did not get prioritized in the context of low and middle-income countries (LMICs). The identified reasons for this are a poor focus on care during transportation and/or at a health-care facility level, and the perception of expensive emergency care (Kobusingye *et al.*, 2005). These services cover a wide range of medical conditions including communicable and non-communicable diseases plus obstetrics and injuries, and it has been very challenging to define the burden on EMS in a given community. However, ambulance services are collectively considered as the key resources to reach victims and provide emergency care. But this system has been ineffective due to poor availability of vehicles, poor infrastructure, the lack of trained prehospital personnel, and lack of access to services (Sharma and Brandler, 2014). A major proportion of beneficiaries are either pregnant females or the victims of vehicular trauma who need immediate medical and surgical attention, and an organized EMS system can play an important role in saving lives. Many organizations provide different emergency services, among which the Emergency Management and Research Institute (EMRI) is a pioneer in India (*Emergency Management and Research Institute | GVK EMRI*). It handles medical, police and

fire emergencies through the "108 Emergency Service". It was launched on August 15, 2005, in Hyderabad and at present in Andhra Pradesh, there are 468 ambulances operational under the scope of that initiative (AP Govt., 2017). However, this far fewer than the required number of ambulances, as the suggested number is 33 per 1 million people in the urban population and about 3 times higher in rural areas (Kobusingye *et al.*, 2006). Furthermore, this number varies with the population dynamics and geographic diversities in rural and tribal areas.

So, in this intervention, we are looking to scale up the available services in terms of improved quality and quantity of ambulances. For the same objective, we estimate the benefit-cost ratio of investment in EMS and try to focus the attention of government, policymakers, and other relevant stakeholders on this sector.

3.2 Data

For the intervention, baseline data was collected from available online resources and primary data sources like interviews with government officials. Cost data for ambulances include the capital cost of the ambulance and annual recurrent costs including human resources (paramedical staff, driver), maintenance, fuel, salary, annual training etc. GBD 2016, cause and age-specific data on road traffic injuries and ischemic heart disease were extracted for all age groups whereas in obstructed labour only the 15-49 age range is considered.

3.3 Situation Analysis

In recent years, the demand for EMS, as well as ambulances, has increased rapidly, which requires efficient planning of such vital systems. Since utilization relates to the geographic and demographic distribution, it makes this factor important when planning and managing such services (Sariyer *et al.*, 2017).

It was evident from the NFHS-4 data that only 24% (Table 6) of pregnant females were transported during the study period by any (public/private) ambulance service in India. The situation in Andhra Pradesh was even worse, with a coverage of only about 14%. However, this was due to the proportionate availability of ambulances, attention to increasing the number of ambulances in line with the requirement.

Table 6: Transport used by the respondent to go to a health facility for delivery

	Andhra Pradesh		India
	Valid Percent	Cumulative Percent	Cumulative Percent
Government Ambulance	11.8	11.88	21.9
Other Ambulance	2.19	14.07	24.0
Jeep/Car	4.58	18.65	57.4
Motorcycle/Scooter	4.10	22.76	64.7
Bus/Train	9.97	32.73	68.1
Tempo/Auto/Tractor	65.08	97.81	93.6
Cart	0.29	98.09	94.4
On Foot	1.77	99.86	97.8
Other	0.14	100.0	100.0
Total	100.0		

Source: NFHS-4 data

The performance indicators of ambulance services in Andhra Pradesh are above the benchmark (AP Govt., 2017). But, with increasing service utilization, the EMS must improve its quality and quantity, so that the community can benefit more.

3.4 Calculation of Costs and Benefits

3.4.1 Costs

Cost of the intervention includes capital and recurrent costs. The capital cost is 20 lacs per ambulance which is a one-time investment for the next 10 years, as per the official data. Further, we calculated the total cost based on the required number of ambulances in urban and rural areas. The optimal number of ambulances in an urban area is 33 per million population and in a rural area, it is 99 per million population (Kobusingye et al., 2006). However, the requirement in a rural area may vary based on the population living in that locality or other relevant conditions. In Andhra Pradesh, currently, 468 ambulances are providing services, of which about 42% are deployed in urban areas. This provides the estimated number of ambulances for both areas. The recurrent cost includes the cost of supervision, paramedical staff and driver's salary, maintenance expenditure and cost of training. We calculated the required number of supervisors by using the estimates of one supervisor for 3 ambulances (Kobusingye et al., 2006). The contractual salary rate for them

was taken from the service-providing agencies' site – about 1.8 lac per annum. To scale-up available ambulance services, we considered increasing the additional requirement of ambulances and paramedical staff. We estimate five additional paramedics per ambulance and calculated total salaries for them at 1.8 lac per annum per head contractual salary. The training cost for all the available and new staff is added based on DCP3 Chapter 14 (Thind et al. 2017) which suggests that $50 per trainee is required for two years' refresher training programme. A gross amount (1.3 lac per ambulance) was suggested by officials for remaining expenditures like human resources (paramedical staff and driver), maintenance, fuel etc. Therefore, we estimate a total capital cost of 745,941,555 and 6,773,437,605; the total recurrent cost of 581,834,413 and 5,283,281,332 for urban and rural areas respectively. Assuming that this recurrent cost will be the same for the next 9 years, we calculated the net present value at 3%, 5%, and 8% discount rate, which we use for the calculation of BCR.

3.4.2 Benefits

Calculations of overall benefits for any health intervention is relatively difficult due to multiple streams of benefits from diversified ends. However, limiting the benefits to a key focus area might result in an underestimation of benefits. To mitigate this issue, we include benefits derived from the victims of vehicular accidents, ischemic heart disease, and obstructed labour as they contribute a major proportion of the need for emergency transport services for subsequent treatment. From the GBD report, we estimate about 85,279, 10,581, and 22 deaths due to ischemic heart disease, vehicular trauma, and obstructed labour respectively during 2016. We apportion them into urban and rural populations using the population distribution. Age-specific distribution for all three causes and age-group specific values of years of life lost (YLL) from life tables are used to calculate the present value (PV) of YLL at 3%, 5%, and 8% discount rates. We assume 0.33, 0.18, and 0.5 times reduction in deaths from vehicular trauma, ischemic heart disease, and obstructed labour respectively by providing EMS (Kobusingye et al., 2006). It used to calculate the relative risk, which is 0.67, 0.82, and 0.5 respectively. This is used to calculate the potential impact fraction for urban (0.24, 0.13, 0.40) and rural (0.31, 0.17. 0.48) areas. A total of 4,236 and 12,076 deaths in urban and rural areas are avoided due to all three causes and 59,909 and 170,172 DALYs averted at 3%, 48,731 and 138,541 at 5%, and 37,712 and 107,308 at 8% discount rates in urban and rural areas respectively. Two approaches are used to calculate the total benefits.

In the first, DALYs are multiplied by 3 times GDP cost and in the second, the value of a statistical life year is multiplied by total avoided deaths to calculate the total benefits. A similar approach is used to calculate the benefits for subsequent years.

Calculation of Benefit-Cost Ratio

The results are presented in Table 7, with the assumption that the required number of ambulances will remain same for the next 10 years. For a 3% discount rate, the BCR will be 21.2 and 7.6 in urban and rural areas respectively; in other words, for every rupee spent, the present value of the net economic benefit is 21.2 rupees in urban and 7.6 rupees in rural areas. The result differs if the discount rate is 5%. In this case, every rupee spent yields an economic benefit of 16.8 and 6.0 rupees. The lowest return is at a discount rate of 8%, with just 12.5 and 4.5 NPV return for every rupee spent. Clearly, these results are highly sensitive to the discount rate used, both because of the long period of 10 years over which the intervention is assessed.

Table 7: BCR for Ambulance network intervention

Scenario 1: Urban Ambulance Network						
	Benefits 3 x GDP per cap	Cost	BCR	Benefits VSL	Cost	BCR VSL
3%	228,801,576,201	10,768,661,322	21.2	388,260,818,645	10,768,661,322	36.1
5%	168,370,109,019	9,994,907,769	16.8	351,255,131,742	9,994,907,769	35.1
8%	113,019,600,810	9,012,800,907	12.5	304,672,532,357	9,012,800,907	33.8

Scenario 2: Rural Ambulance Network						
	Benefits 3 x GDP per cap	Costs	BCR	Benefits VSL	Cost	BCR
3%	649,908,501,973	85,593,979,297	7.6	1,106,908,862,217	85,593,979,297	12.9
5%	478,674,230,515	79,509,036,731	6.0	1,001,407,815,452	79,509,036,731	12.6
8%	321,590,767,923	71,785,564,793	4.5	868,603,551,903	71,785,564,793	12.1

Source: Authors calculations

3.5 Assessment of Quality of Evidence and Sensitivity Analysis

The available literature and online material were used to assess the situation. These sources are reliable, but we consider the quality of evidence as "limited" because very few studies are available that are conducted in Andhra Pradesh. The sensitivity analysis using 3%, 5%, and 8% discount rates was performed to see the effect of changing the required number of ambulances in both contexts and findings were relatively same in both the contexts.

4. Family Planning

4.1 Description of intervention

Family planning helps women have their desired number of children and/or determine the spacing of pregnancies, in addition to improving the health of both women and children. The main strategy involves promotion and use of various contraceptives and sterilization for men and women, together with information and communication for behaviour change. Contraception prevents pregnancy-related health risks in women, reduces infant mortality, prevents the transmission of sexually transmitted diseases, empowers people and enhances education, minimizes adolescent pregnancy and reduces population growth etc. (WHO, 2018). Moreover, using family planning methods, women can make informed choices about pregnancy and subsequent spacing, which directly influences her health outcomes and overall well-being. Thus, they can prevent unintended pregnancies and can limit the size of their families. Indirectly it reduces the need for unsafe abortions and the risk of neonatal/infant mortality.

In 1952, India launched the world's first National Programme for Family Planning. This initiative gradually led to the National Population Policy (NPP) in 2000 to reduce fertility rates (MoHFW, 2016). Now, this programme has expanded to include sub-centres in rural areas with the pace of technological advances and improved quality. Results of this programme include a fall in the Crude Birth Rate (CBR), Total Fertility Rate (TFR) and growth rate (MoHA, 2011).

Globally, the prevalence of unmet need for contraception is still high. There are several reasons which prevent the target population receiving and using family planning methods, which include:

- limited choice of methods;
- limited access to contraception, particularly among young people, poorer segments of populations, or unmarried people;
- fear or experience of side-effects;
- cultural or religious opposition;
- poor quality of available services;
- users' and providers' bias
- gender-based barriers.

Considering the potential health impacts and gaps in the current scenario, efforts are being made to providing improved family planning services and interventions in the community to limit family sizes and improve the health of women and children.

4.2 Data

For the intervention, we collected the baseline data from available online resources source like NFHS 4, Census 2011, GBD 2016, Niti Aayog sites. References from relevant studies will also be used as needed. Also, we collected the projected unit cost of family planning methods from the study of Goldie et al 2005.

4.3 Literature Review

The National Population Policy (NPP) of India was adopted in 2000 to achieve a total fertility rate (TFR) of 2.1 by 2010 from 2.7 of 2005/2006. However, in 2017, it is still about 2.3, although in 17 states the TFR has reached below 2.1, and Andhra Pradesh is among them, with a TFR of 1.8. Along with this, the total unmet need for contraception stands at 4.7% (NFHS 4, 2015) and this indicates there is a demand for family planning measures as well. To maintain the birth rate, the demand for contraception should be met and demographic dynamics of the next birth cohorts should be considered in facilitating and promoting such activities.

4.4 Calculation of Costs and Benefits

The price of the contraceptive methods was USD 23.03 (Goldie *et al.*, 2010), which is converted into INR according to the 2017 exchange rate. Here, the average value of temporary (oral contraceptives, injectables, condoms, intrauterine devices) and permanent (female and male sterilization) contraceptive methods for the current year are used. The estimate of service delivery cost is referenced from K. Sarah et al. 2017 paper, which is $0.3 per head (19.24 INR). The total annual cost will be the sum of the cost of family planning and cost of service delivery for the target population. To estimate the total number of the target population, we use women of the childbearing age group (15-49 years), which we calculate by using the age group proportions of the 2011 Census population, and a total unmet contraception need of 4.7% (NFHS 4, 2015). This helps us to identify the target population with unmet needs.

The second step is to identify the number of females planning birth spacing, which we calculate by 'total births per year' * 'unmet need for spacing'. Of these, we assume that 75% will successfully space the birth by using family planning methods. We use the percent births less than 2 years apart and 2-3 years apart, which is 29% and 34.7% respectively (Rutstein, 2011). The rest {1- (29% + 34.7%)} – 36.3% – is an estimate of the percentage of births more than 3 years apart. We estimate the under-5-mortality rate for < 2, 2, 3, and 4 years between birth respectively 97, 54, 40, and 40 per 1000 live births (Guttmacher Institute, 2002). So, the implied under-5-mortality rate is 61, which is the sum product of annual percent births apart and the annual estimates of under-5-mortality rate. With these estimates, we adjusted the gradient of child deaths by birth spacing to reflect state-specific U5 mortality rate. For example in < 2 years calculation, 'actual under-5-mortality'* 'under-5-mortality rate for < 2 years between birth' / 'implied under-5-mortality' (41*97/61 = 65). We decided to apply a 50% discount to avoided under-5-mortality to approximately account for correlation (instead of causation) in the relationship between mortality and spacing.

The number of <2-year spaced births avoided due to family planning will be 'number of successfully spaced births' * 'percent births less than 2 years apart (29 percent)'/ 'percent births less than 2 years apart (29%)' + 'percent births 2-3 years apart (29 + 34.7%) = 10934. Along with this, the child lives saved due to family planning will be 'the number of <2-year

spaced births avoided due to family planning'*Discount rate (50%) * (under-5-mortality rate per < 2 years (65) – under-5-mortality rate at 2 years between birth (33))/ 1000 = 208. So, the per-user child death averted will be 0.000292 for births less than 2 years apart. Similarly, for 2-3 years apart, it will be 0.000086 per user. So, the total child deaths avoided per user is 0.000378. We assume that we will save an average of 69 DALYs per child life saved. These DALYs are discounted at 3%, 5% and 8% rates, and followed by calculation of total DALYs.

To estimate avoided maternal deaths, we use 'the MMR of Andhra Pradesh 92 per 100,000 live' births * 'number of births avoided due to family planning intervention' = 1.98'. We calculate the number of avoided abortions among the avoided live births by assuming that it will be half of the avoided live births. With this, we calculate maternal deaths averted per user of family planning service among the target population (1.98 + 23)/ 2,273,188 = 0.0000042. So, here we will save 3 maternal and 269 child lives per year. Now, we assume that we will save an average of 40 DALYs per life saved. These DALYs are discounted at 3%, 5%t and 8% rates, and followed by calculation of total DALYs.

To estimate the effects of fertility reduction on economic growth, we follow Ashraf, Weil, and Wilde (2013). That paper identifies multiple mechanisms under which a reduction in fertility can lead to increased economic growth such as reduced dependency, capital shallowing, reduced costs of childcare and schooling and more. Through these channels, the authors develop a model which estimates that a 0.5 point reduction in total fertility rate increases GDP per capita by 5.6% over 20 years and 11.9% over 50 years. We apply this broad relationship to the estimated fertility reduction in Andhra Pradesh, following Stenberg et al (2017).

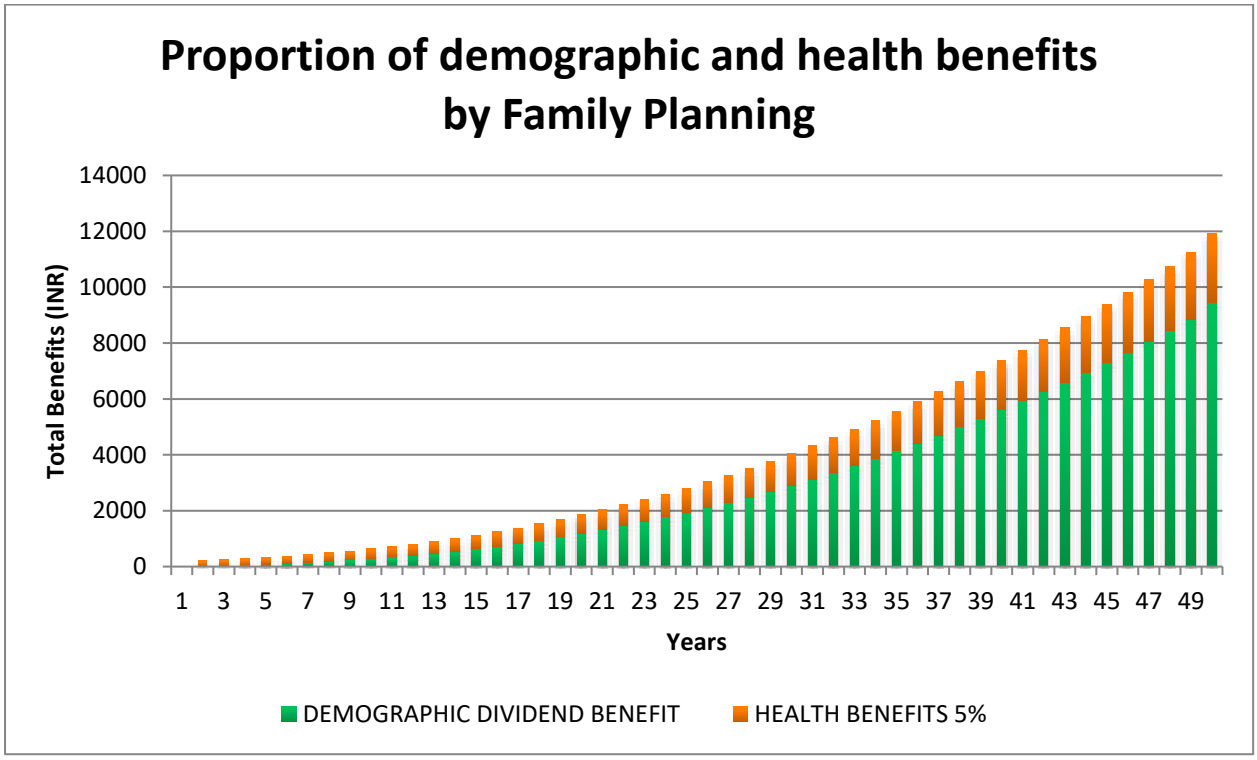
The calculation approach is approximate, and several dynamic elements of the population and income growth have not been fully accounted for. However, it is likely this still provides a reasonable order of magnitude of the demographic dividend benefit.

In Andhra Pradesh, the current TFR is 1.8. The unmet need for family planning for fertility reduction is only 1.6%. We use the unmet need for fertility reduction only, and not for spacing because avoided population growth is the primary mechanism by which economic growth benefits occur. The study by Joshi and Schultz (2007) in Bangladesh shows that

provision of family planning reduces TFR by 15%. So, the estimated TFR reduction from this intervention is 1.8 * 1.6% * 15% = 0.004 of births.

Applying the Ashraf et al (2013) effect to this fertility reduction in Andhra Pradesh, we can estimate that in 20 years' time GSDP per capita will be 0.05% higher than in the baseline scenario and in 50 years' time 0.10% higher. In between years, we have assumed a linear interpolation between these figures. These small per capita effects are large in absolute terms when expanded across the entire population. We estimate the population with the intervention by applying a constant reduction of 1% in the crude birth rate of 16.4 per 1000. This is admittedly approximate but seems to generate reasonable figures.

Using the new profile of the population, we multiply the GDP per capita increases above to estimate the welfare gain from family planning via a demographic dividend. The benefits are substantial and dominate the benefits from avoided deaths. In the first year, the benefit is 17 crores. By 2066 these benefits are 9,450 crores. The demographic dividend represents around 75% of the undiscounted benefits from the intervention.



Source: Authors calculations

4.5 Calculation of Benefit-Cost Ratio

To calculate the BCR of the family planning intervention, we calculate the per capita cost and benefits at 3%, 5% and 8% discount rates. This is important because family planning is different from other welfare calculations. With fewer people, the economy actually shrinks, though each person in the economy is better off. So here we are not doing the calculation in absolute terms.

The results are presented in Table 8, with the assumption that the growth rate will continuously increase at the same rate due to the intervention. For a 3% discount rate, the BCR is 24; in other words, for every rupee spent, the present value of the net economic benefit is 24 rupees. The result differs with a discount rate of 5%. In this case, every rupee spent yields an economic benefit of 16 rupees. The lowest return is at a discount rate of 8%, with just 10 NPV return for every rupee spent. Clearly, these results are highly sensitive to the discount rate used, because of the over long period of 50 years.

Table 8: BCR of Family Planning Intervention

	Benefits* per capita	Costs* per capita	BCR
3%	13,530	556	24
5%	6,310	386	16
8%	2,440	253	10

Source: Authors calculations, * in crores INR

4.6 Assessment of Quality of Evidence

The available literature and online materials are helpful to assess the situation. Although these sources are reliable, the quality of evidence was between limited to medium because of the limited availability of studies that consider fertility preferences in the context of Andhra Pradesh.

5. Conclusion

Based on the challenges and priorities in the health system assessed by the state government, evidence generated by the research team on the initiatives in the state and in

similar contexts was used as the base for analyzing the return on investment in all the three interventions. Our estimation showed that on providing relevant health services to the target populations, the investment would provide wide ranging benefits owing to the size of population coverage; directly and indirectly impacting the target population. The largest returns could be achieved in family planning interventions, followed by the emergency ambulance services, and strengthening basic and then surgical capacity intervention. Since the interventions targeted different population groups, the findings should be used more as complementary rather than competitive for priority setting.

Strengthening basic and surgical capacity was estimated to avert maternal deaths of pregnant women and neonates, by 319 and 1,019 cases, respectively per year. Using an expanded ambulance service, we found that 4,236 deaths in urban areas and 12,076 deaths in rural areas could be avoided per year among victims of ischemic heart disease, road traffic accidents, and obstructed labour. Providing family planning services could avert an estimated 272 maternal and child deaths, as well as additional benefits arising from reducing population growth rate.

The basic and surgical capacity intervention included a group of small interventions, which were not mutually exclusive. These interventions made a critical contribution at different levels and none of them alone would address the overall reduction in maternal and neonatal deaths. Hence, the returns are greater than the investments made in this sector.

Providing an ambulance service in rural areas is very important, however, the BCR in an urban area is 16.8 at 5% discount rate, which was almost three times greater than the rural area (6.0). The key possible reason behind this is the wider distribution of a rural population, which cause delays in service delivery. However, there are various other reasons as well. The return on investment in family planning service is relatively high due to a large proportion of benefits come from the demographic dividend and a decrease in population growth rate.

There may be several limitations of this study. The data on the target population, intervention effects and intervention costs were collected from different sources, and efforts had been made to keep them comparable. Costs of interventions data were used from online data sources, personal interviews with officials, and research studies. Where recent updates were not available, we projected existing figures using the rate of inflation. In estimating the

benefits, we considered the current year data from GBD 2016 and other official sites. Therefore, the projections made in our study may vary. We also could not capture the economic loss in terms of years lost due to disability (YLD) because of the lack of available relevant data. Thus, the return on investment is a conservative estimate.

Table 9: Summary of BCR

Interventions	Discount	Benefit	Cost	BCR	Quality of Evidence
Maternal and neonatal health	3%	39,262	3,546	11.1	Medium
	5%	22,107	3,028	7.3	
	8%	11,257	1,677	6.7	
Ambulance network (Urban)	3%	22,880	1,077	21.2	Limited
	5%	16,837	999	16.8	
	8%	11,302	901	12.5	
Ambulance network (Rural)	3%	64,991	8,559	7.6	Limited
	5%	47,867	7,951	6.0	
	8%	32,159	7,179	4.5	
Family planning* (per capita-years)	3%	13,530	556	24.3	Medium
	5%	6,310	386	16.3	
	8%	2,440	253	9.7	

Source: Author's calculations; * Cost and benefits are in Crores, except family planning which are in per capita-years

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As a new state, Andhra Pradesh faces a bright future, but it is still experiencing many acute social and economic development challenges. It has made great strides in creating a positive environment for business, and was recently ranked 2nd in India for ease of doing business. Yet, progress needs to be much faster if it is to achieve its ambitions of becoming the leading state in India in terms of social development and economic growth. With limited resources and time, it is crucial that focus is informed by what will do the most good for each rupee spent. The Andhra Pradesh Priorities project as part of the larger India Consensus – a partnership between Tata Trusts and the Copenhagen Consensus Center, will work with stakeholders across the state to identify, analyze, rank and disseminate the best solutions for the state. We will engage people and institutions from all parts of society, through newspapers, radio and TV, along with NGOs, decision makers, sector experts and businesses to propose the most relevant solutions to these challenges. We will commission some of the best economists in India, Andhra Pradesh, and the world to calculate the social, environmental and economic costs and benefits of these proposals

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