BACKGROUND

- Negative association between malaria morbidity and the growth rate of Gross Domestic Product (GDP) per capita (McCarthy, 2000).
- A number of countries that managed to eliminate malaria have had more rapid economic growth than their neighbours (Gallup, 2001).
- In the absence of malaria in Africa economic growth would have been 1.25% higher than observed (Artaz, 2003).
- Reduced malaria case rates and mortality are likely to have implications on government expenditure that can inform resource allocation and budgeting decisions.

OBJECTIVES

- To assess lifetime economic returns from investing in malaria vaccination programs from the government and societal perspectives.
- To explore the economic consequences of reduced malaria case rates and mortality and its future labour productivity and government social transfers (e.g., healthcare spending, education, pensions).

METHODS

- A prototype microeconomic health investment model was developed for estimating economic returns from malaria vaccination programs from the government and societal perspectives.
- The model was evaluated using published efficacy rates for a pre-erythrocytic vaccine and the following equation (Connolly, 2008):

\[
K = \frac{R_t}{1 + \gamma}
\]

Where:

- \(K\) = vaccine price
- \(R_t\) = Sum of all economic benefits accruing to society or future taxes in government budgeting decisions
- \(\gamma\) = discount rate for future benefits

- The net fiscal balance of vaccinated and unvaccinated cohorts at any point in time is estimated as the difference between the discounted sum of all economic components at any given age. Specifically, the net present value (NPV) for both cohorts is defined as discounted sum of all revenues to government at all ages minus social expenditures, including vaccine price, at all ages defined using the following equation (Connolly, 2008):

\[
NPV = \sum \left( \frac{R_t - E_t - F_t}{(1 + \gamma)^t} \right)
\]

Where:

- \(R_t\) = economic return to vaccination (benefits minus costs) for year \(t\)
- \(E_t\) = economic costs of malaria for year \(t\)
- \(F_t\) = future vaccine price

- Model considers different malaria health states including clinical malaria, severe malaria, neurological sequelae, anaemia, and death.

- For each malaria health state we estimated direct medical costs (e.g., clinic visits, treatments and hospitalisation) and indirect costs (e.g., lost productivity of parents caring for children with malaria and lifetime lost earnings).\n
- Wages are an important component of the health investment model as they define economic benefits associated with changes in malaria mortality and morbidity between the vaccinated and unvaccinated cohorts. In the health investment model we used age-adjusted wages that were inflated for improved education with adjusted malaria rates (Lucas, 2005).

RESULTS

Government perspective

- Costs to government in the first 5 years of the model were comparable for vaccinated and unvaccinated cohorts. This finding was dependent on the price of the vaccine and delivery costs included in the model.

- The differential NPV between vaccinated and unvaccinated cohorts was cost-saving with the first 4 years because of reduced healthcare spending in the vaccinated cohort.

- In the first two decades of life the net balance for the government is negative for both vaccinated and unvaccinated cohorts because of direct government transfers for education, health, and allowances. Over time the balance shifts in favour of government as the cohort ages, enters employment and starts to pay taxes.

- Achieving a positive fiscal balance with government occurs earlier in the vaccinated cohort.

- The average age at which a child reaches the break even point (age at which a child has paid back for his own costs of vaccination in addition to all previous government transfers) is 32 years (vaccinated) and 34 years (unvaccinated). Break even ages are consistent with previously published data (see, e.g., Bejon et al., 2010).

- The model is cost effective in the non-vaccinated cohort compared with the vaccinated cohort even after factoring in the vaccine cost. This is because of reduced malaria case rates and healthcare costs consumed in the vaccinated cohort.

- After 50 years the profitability index measures as the discounted lifetime net benefits as the initial vaccine costs is 5 times the initial malaria vaccine investment.

- The lifetime tax contributions in the vaccinated cohort were greater than those in the non-vaccinated cohort because of changes in malaria morbidity and mortality (area between curves).

Societal perspective

- In the societal perspective model the economic benefits are much greater compared with the more limited government perspective model.

- The overall economic benefits of malaria vaccination were the same in both the vaccinated and non-vaccinated cohorts at age 17. This suggests the vaccine investment costs are minimal in the context of life time societal benefits.

- After 50 years the profitability index measured as the lifetime societal benefits was 37 times the initial malaria vaccine investment.

DISCUSSION

- With a judicious mix of data sources, it is possible to develop a malaria health economic modelrapid economic growth than their neighbours (Gallup, 2001) using data from Ghana. However, future versions of the ‘government perspective’ model will consider the economic value to malaria reduction in less developed countries that often lack structured national tax collection.

- The health investment approach addresses fundamentally different questions from that of cost-effectiveness or budget impact analyses often used by stakeholders for making resource allocation decisions regarding malaria.

- The choice of methodologies for evaluating malaria reduction strategies may have implications. While these methodologies are used to inform resource allocation decisions.

- The health investment modelling approach can help national and international stakeholders address the return on investment in malaria vaccine investment strategies as discussed within the Malaria Vaccine Decision-Making Framework (MVDF).

- Early investment may accelerate early benefits such as better school programs, improved health care programs – a snowball effect – easy of getting out of poverty.

Model Limitations

- It is important to note that the health investment framework undervalues benefits attributed to malaria vaccination as it only values human life in economic terms to establish the economic value to malaria reduction in less developed countries that often lack structured national tax collection.

- It only focuses on one disease area and one approach. Therefore, the framework does not take into consideration the intangible benefits that people assign to being healthy and reducing malaria burden.

- Priority setting compared with other health programmes overall is not adequately addressed by the model.

- Broader macroeconomic changes in the economy are not considered, therefore the framework will fail to assess the true economic value of reduced malaria related morbidity and mortality.

- Assumptions about the following model variables were made: collabotibility of taxes across levels of government, discounting of benefits (e.g., health), and underestima of various epidemiological settings, malaria case progression of treatment, translation of health outcomes into economic terms, and public health outcome and therefore impact on malaria disease.

CONCLUSIONS

- Unique framework

- Considers future tax revenue from government and social transfers in Ghana.

- It is part of a comprehensive malaria health economic plan that will address questions of cost-effectiveness and affordability.

- Exploring how future malaria morbidity and mortality influences future labour productivity and government social transfers (e.g., healthcare, education, pensions).

- Complementary approach

- Addresses different questions from cost-effectiveness and budget impact analyses (e.g., what happens after vaccination).

- Looks at return on investment at various points in time (e.g., 25 years, 50 years, 75 years, 100 years after vaccination).

- Future model considers framework that assigns economic value to malaria reduction in developed countries with less structured national tax collection systems.

REFERENCES