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Fiscal consequences of changes in morbidity and mortality attributed to rotavirus immunisation

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ABSTRACT

Changes in population health status are known to influence government fiscal transfers both in terms of lost tax revenue and increased expenditure for health and social services. To estimate the fiscal impact of changes in morbidity and mortality attributed to rotavirus immunisation, we developed a government perspective model to estimate discounted net tax revenue for Ghana and Vietnam. The model derived the impact of rotavirus morbidity and mortality on lifetime productive capacity and related tax transfers, and demand for government transfers in relation to education and healthcare in immunised and non-immunised cohorts. The discounted age-specific net tax revenue was derived by deducting transfers from gross taxes and discounting for time preference. In Ghana, taking into account immunisation costs, tax and transfers, the estimated net discounted tax for the immunised cohort was estimated to generate $2.6 billion in net taxes up to age 65. In Vietnam, the net revenue attributed to the immunised cohort reached $55.17 billion suggesting an incremental benefit of approximately $29 million. We posit that the government perspective fiscal framework described here is a valid approach for estimating how governments benefit from investments in immunisation that can be considered supplementary to conventional cost-effectiveness approaches for defining value.

1. Introduction

In 2009 the WHO released the WHO Guide to Identify the Economic Consequences of Disease and Injury [1]. Within the WHO guide the impact of population health on government spending and expenditures was described. Specifically, the report acknowledged that poor health can impact governments' fiscal accounts both in terms of lost tax revenue and increased transfers costs [1]. Despite acknowledging that population health influences fiscal consequences for governments, the report provided few examples of the ways in which population health impacts government revenues and transfers. In the context of low and middle income countries this is an important relationship to consider because the ability of governments to raise revenue through taxation is an integral part of development [2].

The conventional approach for evaluating healthcare expenditure is often performed at the programme level, using cost-effectiveness analysis to achieve technical efficiency. Such an analysis is normally performed by focusing on health service costs and often ignoring the downstream indirect costs of changes in health status that improve our understanding of the broader economics of healthcare. This is particularly salient for immunisation where the benefits accrue over many generations. Consequently, applying a longer time perspective could provide a more complete picture of the value of vaccines [3].

In fiscal terms, transfers between citizens and state in relation to health status changes have been mostly ignored in cost-effectiveness analysis on the belief there is no welfare gain or loss associated with transfers and taxes according to welfare economics [4]. While this may be true from the welfare economic perspective, from a government perspective this approach is flawed because lost taxes and transfers represent real cost for government. For example, an analysis conducted in the UK on the costs of ill-health in working aged adults reported that approximately 90% of the costs were attributed to increased transfer payments for time off work and lost tax revenue [5].

The relationship between health and economic growth is one of the cornerstones of development economics [1,6]. More

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specifically, health status is a determinant of productivity which can be shown to influence economic growth [7]. In fiscal terms, if one considers the relationships between health, productivity and economic growth, and the established relationship between economic growth and government tax revenue [8], a rationale can be put forward for exploring the 'government perspective' associated with investments in health. The underlying premise of such analyses is that changes in health status in current and future working populations will have fiscal implications for government. Therefore, population health status changes linked to specific programme investments can be shown to influence government tax revenue – in much the same way that investments in education have been shown to translate into future government taxes [9]. The burden of rotavirus in low and middle income countries (LMIs) is often immense. In 2008 the WHO estimated 453,000 deaths attributed to rotavirus with the majority of these occurring in LMI countries [10]. Additionally, rotavirus poses significant direct costs for families and healthcare services resulting in clinic visits, diagnostics, medicines and hospitalisations [11,12]. Furthermore, it has also been shown that the costs attributed to lost productivity are often higher than the direct medical costs of rotavirus [13].

To understand the relationship between investments in rotavirus immunisation and resulting changes in morbidity and mortality with corresponding consequences for government accounts, we apply a government perspective framework to adult immunisation costs to determine the return on investment in future discounted net tax revenue. The aim is to estimate to what extent the fiscal benefits associated with vaccinating children against rotavirus will exceed the costs of immunisation. It is thought that understanding the relationship between health and future tax revenue linked to mortality changes can contribute to demonstrate the fiscal sustainability linked to public investments in immunisation programmes.

2. Materials and methods

A government perspective fiscal accounting model was developed to evaluate changes in rotavirus attributed morbidity and mortality in Ghana and Vietnam, based on a previously described framework [14]. The model employed a modified generational accounting framework typically used by Treasury and other international organisations for modelling the intertemporal consequences of fiscal policy and changes in population dynamics [15]. The metrics evaluated were the discounted net tax revenue (NPV) and discounted gross tax receipts attributed to changes in population health status and labour force participation. Labour force participation was defined mainly in terms of survival and labour supplied. Moreover, the corresponding labour loss for families that will care for the non-immunised sick subjects was also considered.

The survival of an average cohort was simulated based on the current life-tables in each country. For simplicity we did not change any long-term demographic changes. Rotavirus immunisation efficacy for Ghana and Vietnam was obtained from previous economic studies performed in each country [16,17]. Both Ghana and Vietnam were deemed as appropriate for such an analysis due to their growing economies, the existence of an organised tax and social insurance system as well as the epidemiology of rotavirus infections. Vaccine coverage rates and costs of treating rotavirus cases were obtained from previous cost-effectiveness models [16,17]. The average cost of rotavirus immunisation was estimated from publicly available prices applied to the immunisation schedule for the two vaccines [18].

To reflect the government perspective we quantified direct transfers from Ghana and Vietnam governments to immunised and non-immunised cohorts. Consistent with the generational accounting framework, transfer costs were inflated at the expected rates of 4% and 5.1%, for Ghana and Vietnam, respectively [19,20]. The model accounted for rotavirus specific health costs and age-specific per capita expenditure over the lifetime of the model. The rotavirus specific health costs accounted for different severity health states reported in cost-effectiveness studies for each country [16,17]. For both models the age-specific per-capita health cost was derived from average expenditure reported by the Ministry of Health. Enrolment rates for each education level were derived from national statistics and subsequently, age-specific education costs were estimated for both countries [21–23].

Transfers from citizens to state in the form of taxes and social contributions were integral to the model for assessing the fiscal impact of health investments. Consequently, future labour force contributions of immunised and non-immunised cohorts were employed. Data on average wages, age-specific unemployment and economic activity originated from the household surveys for each country [21,23]. Because the average wage is derived from a cross section of the community it is not necessary to adjust for variations in socioeconomic status.

In both models economic activity was adjusted for age-specific unemployment and labour force participation applied to immunised and unimmunised cohorts. In addition, an age-specific earnings pattern was calibrated for each country to reflect the effect of experience in per-capita earnings. In the model taxes were derived from the age-specific earnings using a disaggregated approach to account for direct and indirect taxes and social contributions that are collected in a similar fashion to taxes. In Ghana both the value added tax (VAT) levied at 10.5% and the National Health Insurance Levy of 2.5% were applied to disposable income [24]. In Vietnam the 10% value added tax was applied to disposable income expenditure. An average income tax burden of 7.5% based on the two lowest tax bands was applied to wages which corresponded with the average salary for Vietnam [25]. Additionally, mandatory unemployment insurance of 1%, and health insurance of 1.5% was applied to wages. To account for unreported economic activity an adjustment was applied to tax revenues based on reported estimates of the shadow economy for each country [26]. Specifically, the scale of shadow economy was set at 45% and 16% for Ghana and Vietnam, respectively.

Net taxes represent the difference between lifetime taxes paid after deducting lifetime direct transfers received. In the model all taxes and transfers are age-specific to represent the fiscal life course and the point of time at which fiscal transactions occur. In summary, in early ages of life the immunised and unimmunised cohorts are net recipients of government transfers in the form of healthcare and education. As the cohorts age and reach working age the cumulative gross taxes increase and government transfers are minimal. The model horizon was set at 65 years from birth. This age cut-off point was used since there was limited data on average earnings, pensions and consumption in later ages. The costs of rotavirus immunisation are treated as an investment that appears in the transfer costs for these cohorts. Therefore, to reflect the present value of investing in rotavirus vaccination, we estimate the net present value (NPV) and the downstream lifetime taxes and transfers of the immunised cohort as follows:

$$\mathrm{NPV} = \frac{\Sigma^{T}(R_t - E_t)}{(1+r)^{t} - K_0(t)}$$

R_t = sum of gross taxes paid

E_t = sum of age-specific direct government expenditure per cohort over lifetime (e.g., education, healthcare)

r = rate of discount

T = current life expectancy

K_0 = vaccine purchasing costs.