Global economic consequences of selected surgical diseases: a modelling study

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Summary

Background The surgical burden of disease is substantial, but little is known about the associated economic consequences. We estimate the global macroeconomic impact of the surgical burden of disease due to injury, neoplasm, digestive diseases, and maternal and neonatal disorders from two distinct economic perspectives.

Methods We obtained mortality rate estimates for each disease for the years 2000 and 2010 from the Institute of Health Metrics and Evaluation Global Burden of Disease 2010 study, and estimates of the proportion of the burden of the selected diseases that is surgical from a paper by Shrime and colleagues. We first used the value of lost output (VLO) approach, based on the WHO's Projecting the Economic Cost of Ill-Health (EPIC) model, to project annual market economy losses due to these surgical diseases during 2015–30. EPIC attempts to model how disease affects a country's projected labour force and capital stock, which in turn are related to losses in economic output, or gross domestic product (GDP). We then used the value of lost welfare (VLW) approach, which is conceptually based on the value of a statistical life and is inclusive of non-market losses, to estimate the present value of long-run welfare losses resulting from mortality and short-run welfare losses resulting from morbidity incurred during 2010. Sensitivity analyses were performed for both approaches.

Findings During 2015–30, the VLO approach projected that surgical conditions would result in losses of 1·25% of potential GDP, or $20·7 trillion (2010 US$, purchasing power parity) in the 128 countries with data available. When expressed as a proportion of potential GDP, annual GDP losses were greatest in low-income and middle-income countries, with up to a 2·5% loss in output by 2030. When total welfare losses are assessed (VLW), the present value of economic losses is estimated to be equivalent to 17% of 2010 GDP, or $14·5 trillion in the 175 countries assessed with this approach. Neoplasm and injury account for greater than 95% of total economic losses with each approach, but maternal, digestive, and neonatal disorders, which represent only 4% of losses in high-income countries with the VLW approach, contribute to 26% of losses in low-income countries.

Interpretation The macroeconomic impact of surgical disease is substantial and inequitably distributed. When paired with the growing number of favourable cost-effectiveness analyses of surgical interventions in low-income and middle-income countries, our results suggest that building surgical capacity should be a global health priority.

Funding US National Institutes of Health/National Cancer Institute.

Lancet Glob Health 2015; 3 (S2): S21–27

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Introduction

The global burden of surgical disease has only recently been defined and subsequently estimated. Whereas original estimates suggested that up to 11% of global morbidity and mortality is secondary to surgical disease,[1] more recent efforts have suggested that that number is a vast underestimate and that up to 33% of the global burden of disease is surgical.[2]

Although an understanding of surgical morbidity and mortality is of paramount concern to researchers and policy makers alike, the downstream consequences of this burden are also of importance. One way to contextualise the impact of disease is to estimate the economic consequences it imposes. Although there is continued debate in the economic literature regarding how health and income are connected,[3] there is strong evidence that improved population health contributes positively to aggregate economic growth.[4–10] Broadly speaking, the effect of poor health can be examined at the microeconomic level, in which individuals, households, firms, or other specified economic agents are studied, or at the macroeconomic level, in which the broader effects on society as a whole are assessed.[11]

Some studies have investigated the economic impact of specific surgical diseases at regional and global levels,[12–14] but little is known about the global economic impact of a more comprehensive set of surgical conditions. Using two distinct macroeconomic approaches, we sought to estimate: (1) the effect of surgical disease mortality on annual global economic output during 2015–30, and (2) the effect of surgical disease during a single year, 2010, on a more broadly defined measure of economic welfare which incorporates a combination of long-run effects of mortality and short-run effects of morbidity.

Methods

Surgical burden of disease for selected conditions

We examined five major surgical disease categories: neoplasm, injury, maternal disorders, neonatal disorders,

and digestive disorders. We assumed that only a portion of the burden of each disease category is surgical. To this end, we used results from a survey instrument by Shrime and colleagues,[2] which asked respondents, "What proportion of patients with the following conditions would, in an ideal world, require a surgeon for management?" for each of the 21 categories in the Institute for Health Metrics and Evaluation's (IHME) Global Burden of Disease.[15,16]

We selected the disease groups listed above because they have been repeatedly acknowledged to contribute to a large burden of surgical disease;[1,17] under Shrime's survey instrument, they contribute to more than 85% of all surgical deaths.[2] Table 1 provides the mean responses from the survey; the specific diseases contained within each IHME category are listed in the appendix.[18] Table 1 also gives an estimate of the global burden of the surgical proportions of the included conditions for 2010 using IHME estimates.[15,16] The survey instrument and the definition of surgical disease are discussed further in the appendix.

See Online for appendix

Macroeconomic approaches

This study uses two approaches to describe the macroeconomic consequences of surgical disease. These approaches were chosen because both allow for global economic modelling in the face of limited data, and each provides different information. The first approach is based on a model supplied by the WHO known as EPIC (Projecting the Economic Cost of Ill-health). We use the EPIC model to project annual market economy losses due to surgical disease during 2015–30, and, to be consistent with others who have used it,[19] we term this approach the value of lost output (VLO). The second approach estimates the value of lost economic welfare (VLW) resulting from surgical disease in 2010. The counterfactual in both approaches is absence of disease. Estimates from both approaches are gross estimates, since they are not net of the cost of treatment.

The two approaches differ in two important ways: the definition of economic loss, and the time period over which the loss is calculated. The VLO approach relates disease mortality to the labour supply and capital accumulation of a country over time. Changes in these factors result in decreased output of marketed goods and services, as measured in forgone gross domestic product (GDP). The EPIC model does not incorporate disease morbidity, which also affects GDP. In this study, the VLO approach estimates the effects of mortality on output in a given year during 2015–30. It is therefore a short-run measure, although the annual estimates can be summed to calculate cumulative effects.

The VLW approach, also termed the full-income approach,[20] relies on a concept known as the value of a statistical life, which incorporates non-market losses such as forgone leisure, non-health consumption, and the value of good health in and of itself. Consistent with previous studies of a similar scope to this one,[19,21,22] we use the value of a statistical life approach to value disability-adjusted life years (DALYs), which capture both mortality and morbidity due to a disease in one metric. Owing to the manner in which DALYs are calculated,[16] the VLW approach estimates the long-run effects of life-years lost secondary to mortality, which is measured from an incidence perspective. Mortality estimates therefore include the effects in 2010 plus the present value of future effects. Morbidity, however, is measured from a prevalence perspective, and therefore DALYs only capture the effects of poor health in 2010. Although a case of non-fatal surgical disease that occurred in 2010 could have persistent health effects, future morbidity effects of incident cases in 2010 are not what the current global burden of disease approach measures; rather, the prevalence of the disease of interest is estimated for 2010, and consequently this approach includes morbidity from diseases that were diagnosed before 2010.[18] Since the VLW estimates include non-market welfare losses due to mortality and morbidity, and, in the context of mortality represent long-run losses, they can be expected to be many times larger than the VLO estimates, which account only for market losses due to mortality (not morbidity) in the short term.

Results are presented in 2010 US$ and adjusted for purchasing power parity.[23] The purchasing power parity method compares the price levels of a fixed basket of goods between countries to establish a currency conversion rate, such that the price of the basket of goods is the same in both countries when stated in the reference currency, usually US$. For each approach, countries were evaluated by IHME region and their respective 2010 World Bank income classification.[18,23]

The appendix provides the mathematical details, assumptions, and data sources for each approach.

	Proportion of patients	Deaths (thousands)	YLLs (thousands)	YLDs (thousands)
Digestive disorders	30·3%	337	8246	1658
Injury	60·8%	3085	141 283	30 144
Maternal disorders	36·7%	93	5251	657
Neonatal disorders	27·3%	611	52 594	2586
Neoplasm	62·0%	4943	113 995	2777

Data are mean estimates from Shrime et al.[2] DALY=disability-adjusted life year. YLL=non-discounted years of life lost (mortality) using Institute for Health Metrics and Evaluation standardised life-expectancy.[15,16] YLD=years lost to disability (morbidity).

Table 1: **Proportion of patients requiring a surgeon for management and implied burden of disease in 2010**

Sensitivity analyses

For each approach, we accounted for uncertainty in the estimation of the burden of disease by using the uncertainty intervals given by the IHME[18] in addition to a lower and upper bound estimate of the proportion of