# Analyzing the technical efficiency of health systems in Asian countries: What Myanmar can learn from Bangladesh and Sri Lanka.

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**Research article**

# Abstract

Background: Advancements in medicine leads, among other things, to increasing life expectancy and quality of life. However, at the same time, health care costs are increasing, and this may not be sustainable in the future. Governments and health care organizations need to implement efficiency measures in order to maximize health outcomes within available resources. This study aims to compare the technical efficiency of health systems in middle-income Asian countries, and to identify "efficient peers" for each "inefficient country": in particular for Myanmar.

Methods: A data envelopment analysis (DEA) variable returns to scale output-oriented model was used to evaluate technical efficiency in middle-income Asian countries. The input variables were current health expenditure per capita, the density of doctors, and the density of nurses and midwifery personnel. The output variables were health adjusted life expectancy (HALE) and the infant mortality rate (IMR). Myanmar may learn how to improve efficiency of its health care system through studying its efficient peers from DEA results. A review of relevant English language literature was used as a basis for informing a comparative analysis of the health systems of Myanmar and its efficient peers: Bangladesh and Sri Lanka.

Results: Among the twenty-eight middle-income Asian countries studied, 39.3% of countries were technically efficient. Myanmar is one of the inefficient countries, and it should look at the health systems of its efficient peers, Bangladesh and Sri Lanka, to make its health system technically more efficient.

Conclusions: The results of this study suggested that countries with inefficient health systems can improve their health outcomes without increasing their health care resources. As DEA measures efficiency only, future studies should take into account equity to assess comprehensive health system performance.

# Background

Advancements in medicine help people live better as well as longer. Life expectancy and quality of life are increasing. According to the Global Burden of Disease study 2017, life expectancy at birth increased by 7.4 years, from 65.6 years in 1990 to 73 years in 2017 globally. Similarly, health adjusted life expectancy (HALE) which quantifies the number of years of life expected to be lived in good health also increased by 6.3 years, from 57 years in 1990 to 63.3 years in 2017 (1). However, at the same time, health care is becoming more expensive. Between 2000 and 2016, health expenditure per capita rose from US$ 15 to 33 in low-income countries, from US$ 22 to 79 in lower middle- income countries, from US$ 103 to 455 in upper middle-income countries, and from US$ 2430 to 5180 in high-income countries (2). As such, increasing health care costs is a major challenge for almost every country in the world.

The significant amounts of health care spending are wasted worldwide. The World Health Organization (WHO) estimates that globally 20%-40% of total health spending, equivalent to a current monetary value around 1.5 trillion, is being wasted every year due to health system inefficiency (3). Inefficient health

systems negatively impact on population health, which in turn affects productivity, education, and human welfare (4,5). According to 2010 estimates from the Organization for Economic Cooperation and Development (OECD), life expectancy at birth would increase by more than two years without increasing health care spending, if the health care systems of all OECD countries performed at their maximum levels (6). These issues highlight the need for greater efficiency in health system.

In general, countries that spend more on health have higher life expectancies (7). For example, an average life expectancy at birth for high-income countries was 80.6 years whereas 62.9 years for low-income countries in 2016 (8). However, countries that spend most on their health care do not necessarily have best health outcomes, best exemplified by the United States (7). Interestingly, countries with differing proportions of health care expenditure can have similar health outcomes. For instance, life expectancy in Uruguay and that in Paraguay are the same (75 year), but Uruguay's health expenditure per capita is four times higher than Paraguay's (6,9,10). Even though there are other determinants of health, there clearly is scope to improve the effectiveness of health care spending within countries (6).

Efficiency in the health sector means achieving maximum health within available resources or using minimum resources for the given level of outputs. This is "technical efficiency" in economic terms (3,11). Health care efficiency can be measured at micro level to compare performance in diagnostic and therapeutic procedures between departments and hospitals etc., (11,12) at meso-level to evaluate organizational efficiency (13), and at macro level to assess health systems between countries (4,14,15). Cross-country comparisons of health system efficiency can provide opportunities to identify whether countries' health systems are performing efficiently, and to take appropriate actions to improve efficiencies in under-performing countries (16).

In terms of health care spending, Asian countries spend much less than OECD countries. Current health expenditure (CHE), expressed as percentage of gross domestic product (GDP), for East Asia and the Pacific Region was 6.6% and that in the South Asia Region was 3.6% in 2016. In contrast, 2016 CHE for OECD countries was 12.6% (17). In addition, out-of-pocket payments (OOPs) as a percentage of CHE are very high in some Asian countries; OOPs were more than 70% of CHE in Armenia, Azerbaijan, Bangladesh, Myanmar and Turkmenistan in 2016 (18). High OOPs are strongly correlated with catastrophic health expenditure and impoverishment and can exacerbate poverty (19,20). Moreover, South East Asian region countries are now facing a triple burden of diseases: communicable diseases, non-communicable diseases, and injuries (21). All these factors demand efficient use of health care resources, especially in resource limited Asian countries, in order to improve health of their populations.

Some previous studies have analysed health system efficiency in OECD countries (4,14,22), but few have compared health system efficiency in Asian countries (15). To our knowledge, no studies have as yet undertaken comparative analysis of the health systems of inefficient Asian countries with the purpose of benchmarking so that inefficient countries might adopt best practices with regard to improving efficiency.

This study includes twenty-eight middle-income Asian countries. The West Bank and Gaza and Iraq were excluded from the study due to missing data of selected variables. The aim is to compare the technical

efficiency of health systems in Asian countries and to identify "efficient peers" for each of the "inefficient" countries.

# Methods

*Data Envelopment Analysis (DEA)*

DEA is one of the most widely used methods to measure the technical efficiency of operating units (called decision making units, DMU). It is a non-parametric, linear programming technique that measures the relative technical efficiency of several decision-making units by calculating the ratio of the weighted sum of outputs to the weighted sum of inputs. Stating it in algebraic terms, given $n$ outputs and $m$ inputs:

$$E_0 = \frac{\sum_{r=1}^{n} u_r * y_{ro}}{\sum_{i=1}^{m} v_i * x_{io}}$$

where $u_r$ = weight attached to output $r$, $y_{r0}$ = quantity of output $r$ produced by unit $o$; $v_i$ = weight attached to input $i$; $x_{i0}$ = quantity of input $i$ produced by unit $o$; $E_0$= technical efficiency of unit $o$ (23).

The efficiency frontier is plotted based on the combinations of inputs and outputs of the best performing DMUs and the efficiency of each other unit can be measured by comparing it with an identified frontier of efficiency. The efficiency ratio ranges from zero to one, with the efficiency frontier being scored 1 (100%) and the inefficient units falling below the frontier scored less than 1 (0-99%). DMUs located on the frontier are known as "benchmarks or peers". These are the best practice examples which allow comparison with less efficient DMUs. DEA is also considered as a powerful benchmarking technique (24).

The DEA method was originally introduced by Charnes, Cooper, and Rhodes in 1978 assuming constant returns to scale (CRS). It should be used when all DMUs are operating at an optimal scale. In 1984, Banker, Charnes, and Cooper developed a second DEA model assuming variable returns to scale (VRS). This is appropriate when DMUs are not operating at an optimal scale, i.e. DMUs facing imperfect competition, government regulations, etc. Increasing returns to scale (or economies of scale) is a situation where changes in input of 1% results in greater than 1% changes in output. Conversely, decreasing returns to scale (or diseconomies of scale) refers to a situation where changes in input of 1% results in less than 1% changes in output. The DEA model can be input or output oriented. An output-oriented DEA model maximizes output for a given level of input, whereas, an input-oriented DEA minimizes input for a given level of output (24). Figure 1 shows both the CRS and VRS efficient frontiers on the same graph.

To measure health system efficiency of middle-income Asian countries, we use DEA because it can deal with multiple inputs and outputs that are measured in different units and their relative values are unknown. It is especially useful to measure efficiency of complex systems like health care systems. This study uses variable returns to scale, an output-oriented model. Variable returns to scale are used because

the selected variables are ratios and the health care systems in the studied Asian countries (DMUs) differ in terms of health financing policies and socio-economic characteristics (23,24). An output-oriented model is used as most of the health system objectives refer to maximizing health outcomes by using available resources as efficient as possible. Moreover, inputs such as health expenditure and health care professionals are already assigned, so that it would be inappropriate to advise to reduce health care inputs by using an input-oriented model.

*Data and Variables*

Data were collected for the year 2016 from WHO Global Health Expenditure Database and WHO Global Health Observatory Data Repository (18,25–28). Where 2016 data were not available, the closest year data were used. WHO data are comparable across countries which is crucial for DEA. The WHO uses the System of Health Accounts (SHA 2011) framework to provide comparable national health expenditure statistics internationally (18,29).

For the analysis, it is important that the selected health resource inputs have significant impact on the selected outputs. Three selected input variables are current health expenditure per capita in international dollars (Int$), density of doctors, and density of nursing and midwifery personnel for twenty-eight Asian countries (18,25,26). The output variables, HALE and infant mortality rate (IMR) were used in the analysis (27,28). The IMR was converted to the infant survival rate (ISR) for consistency with the DEA assumption that more output is better. The ISR is 1-IMR/1000 (30). The selection of three inputs and two outputs meets the DEA model requirement in that the number of decision- making units or countries (n=28) exceeds three times the number of input and output variables (24).

*Statistical Analysis*

STATA 16.o was used to perform the DEA. The data set included input and output variables for selected Asian countries. First, the countries were named "dmu"- decision making units. The DEA program was run by entering input and output variables. For the analysis reported in this paper, variable returns to scale- rts(vrs) and output-oriented model-ort(out)- options were chosen.

*Comparative Analysis*

Information on the health systems in Myanmar and its benchmark countries, Bangladesh and Sri Lanka, was extracted from the published scientific literature in online databases, PubMed and Google Scholar etc. Search terms are "health system in Bangladesh", "health system in Myanmar", "health system in Sri Lanka" and "health system changes in Asia".

# Results

DEA Results

The descriptive statistics of the input and output variables for twenty-eight Asian countries are shown in Table 1. Bangladesh has the minimum value of CHE per capita (Int$89.00), Cambodia has the lowest number of doctors (1.93) and Jordan has the lowest nursing and midwifery personnel (2.08). On the other hand, Iran spend the highest CHE per capita (Int$ 1712.00) and the maximum number of doctors (59.97) and nursing and midwifery (112.80) are found in Georgia and Uzbekistan respectively. The HALE (57.7) and ISR (0.9395) are the lowest in Pakistan, while Maldives has the highest HALE (69.8) and Lebanon and Malaysia have the highest ISR (0.9932). The average CHE per capita, density of doctors, density of nursing and midwifery personnel, HALE and ISR are Int$640.79, 16.94, 31.39, 63.63 and 0.9788 respectively.

The selected countries in this study have similar geographical backgrounds, however, their economic circumstances vary with GDP per capita in 2016 ranging from Int$ 3,648 to Int$ 27,731. Moreover, CHE per capita as percentage of GDP varies between 2% and 10%. Out-of-pocket expenditure (OOPs) as percentage of CHE is also ranging from 9% to 82% (18).

Table 2 illustrates the DEA results. Eleven out of twenty-eight countries - Bangladesh, Cambodia, China, Jordan, Kyrgyzstan, Lebanon, Malaysia, Maldives, Sri Lanka, Thailand and Vietnam- demonstrated pure technical efficiency. Pakistan was the least efficient country with VRS efficiency score of 0.9636, meaning that Pakistan could increase output by 3.64% with existing inputs if they perform at the maximum efficiency. The VRS efficiency scores for the other inefficient countries varied from 0.9648 to 0.9984, indicating that 0.16% to 3.52% of increased output can be achieved without using more inputs.

The last column shows inefficient countries and their peers (composite members) with reference weight given. For each inefficient DMU, the DEA identifies the comparable, closest efficient DMU peers as the best practice examples to improve the performance of inefficient DMUs (12). Reference weight given to each peer corresponds to its relative importance for each peer among composite members.  For example, Myanmar's composite countries were formed by Bangladesh (weight 0.44), Cambodia (0.13) and Sri Lanka (0.40). The country should look at best practice of peers associated with the highest weight value so that the role models for Myanmar will be Bangladesh and Sri Lanka for improvement in its health outputs.

*Sensitivity Analysis*

Sensitivity analysis was performed to determine the stability or robustness of the efficiency scores obtained by data envelopment analysis. In this study, we conducted sensitivity analysis by changing a single variable of efficient DMUs while data of other inefficient DMUs remain unchanged. We gradually increased the proportion (10%, 15%, 20% and 25% increase) of input data (CHE per capita, density of doctors and density of nursing and midwifery personnel) one at a time until efficiency frontier DMUs change. For CHE, efficient DMUs frontier unchanged until 25% increase where Indonesia (the least inefficient country in original data set) turned out to be efficient. Similarly, gradual increase in proportion of number of nursing and midwifery personnel did not change until 25% increase where efficiency frontier was made up of Indonesia together with other original efficient DMUs. However, number of doctors is the

most sensitive variable and only 15% increase would cause Indonesia to become an efficient country together with other original efficient countries.

# Discussion

## *Discussions of DEA results, strengths and weakness*

The findings of this analysis demonstrated that eleven (39.3%) out of twenty-eight countries were technically efficient and the remaining seventeen inefficient countries could improve 1.28% (compared to efficient countries in this study) without using more resources. Being the least efficient country, Pakistan had the lowest HALE and the highest IMR. Countries with the highest HALE, Maldives, and lowest IMR, Lebanon and Malaysia, were among the efficient countries and as expected, majority of efficient countries had higher than average HALE and ISR. Although Bangladesh and Cambodia had slightly lower than average HALE and ISR, they were on efficiency frontier because of their very low inputs. This suggests that these countries made good use of their scarce resources to produce good health outcomes.

The findings from a previous study that includes all low-, middle- and high-income Asian countries showed that Bangladesh was the only efficient country belonged to lower middle-income countries and majority of efficient countries; Singapore, Japan and Cyprus, belonged to the high-income countries (15). In our study Bangladesh was also one of the efficient countries, but results were not completely comparable because of the differences in number of countries, inputs and outputs involved.

The DEA's identification of peers provides an important and useful policy information for inefficient countries to reform their health systems. The selected sample in this paper included Asian countries only. Geographic proximity makes it easier for country to relate within their region. An inefficient country could focus more on peer countries with higher reference weights as they are likely to be better role models to emulate their health care policies and practices.

Although DEA is very useful, it has its own limitations. The method cannot measure true efficiency and results can change depending on the number and nature of DMUs selected in the sample. The inefficiency results tend to be underestimated as it is calculated in relation to the efficiency frontier of the sample. For instance, Myanmar's efficiency score 0.9794 does not mean that it could improve only by 2.06%. It means that Myanmar could improve 2.06% compared to the most efficient country in the sample selected.

In this analysis, only CHE per capita, doctor density and nursing and midwifery personnel density were used as inputs. Although other factors outside of health system like education, social class, lifestyle, environmental factors and country policy etc. play an important role in health outcomes, these factors were not taken into account in this study.

## *Comparative analysis of health systems of Myanmar, Bangladesh and Sri Lanka*

Myanmar should learn successful strategies of health systems from its benchmark countries, Bangladesh and Sri Lanka, to improve efficiency. "A system framework for analysing the efficiency of health care resource use" indicates that health system efficiency can be influenced by a set of policy instruments: financing, provider payment methods, organization and regulation (10). The policy makers should target these instruments to reform their health system to be more efficient. In the following sections, the health systems of three countries are compared and analysed in terms of policy instruments. However, provider payment methods are not used owing to a lack of comparable data.

*Financing*

Table 3 describes health financing of Myanmar, Bangladesh and Sri Lanka. Myanmar's current health expenditure is around 5% of GDP. The majority of CHE comes from OOPs (77%) and domestic general government health expenditure is only 14% (18). Health insurance scheme called 'Social Security Scheme (SSS)" for employees is regulated through the Ministry of Labour, Employment and Social Security, but its contribution is negligible (31).

In Bangladesh, current health expenditure is only 2% of GDP. CHE is mainly made up of OOPs (73%) and only 16% are contributed by domestic general government health expenditure (18). In recent years, some non-governmental organizations (NGOs) have piloted health insurance schemes, however, there is no successful health insurance in Bangladesh yet (32).

The CHE of Sri Lanka is around 4% of GDP. Government health expenditure is the highest (43% of CHE) and OOPs is the lowest (50% of CHE) among three countries (18). Even though national health insurance scheme has not yet developed, there are a contributory health insurance scheme that covers some public-sector employees, a growing private health insurance industry that covers mostly private sector employees and publicly-financed school health insurance scheme that covers all students, with caps on claims (33). Sri Lanka has introduced tax on sugar sweetened beverages to tackle risk factors for non-communicable diseases (NCD) (34).

*Organization*

Myanmar's health care system has evolved with changing political situation and growing demand from people. Although both public and private sectors are involved in health care financing and provision, the Ministry of Health (MOH) remains the major provider of comprehensive health care services providing all aspects of health care. The MOH supervises both administrative and technical functions of state/region health departments, district health departments and township health departments (35). The private, for profit, sector has expanded rapidly especially in major cities and it is estimated to provide 75%-80% of ambulatory care (31).

International aid agencies used to have difficulty in engaging Myanmar Government under the isolated military regime, but this is changing under the quasi-civilian government (36). At present, community-based organizations, local and international non-governmental organizations are increasingly involved to

deliver health care services across the country. However, one review article about 'Healthcare in Myanmar' suggests donors to discuss the health care systems more openly to reduce overlapping functions and to avoid duplicated donations (31).

The Bangladesh health system is made up of five-layers. The lowest level is village health facility with community clinics, the second layer is Union health and Family Welfare Centre, the next level is the Upazila Health Complex and the fourth level is the district hospital with theatre facilities. Medical colleges and post-graduate institutes offering a wide range of health services are at the top of the health system (37).

The government of Bangladesh accommodates many stakeholders and explicitly works together with the private sectors, local and international non-governmental organizations (NGOs) and informal providers. Extensive community programs are very successful in reaching all households in community and implementing health programs such as maternal and child health and family planning programs etc. Pro-women development programs in economy, education as well as health sectors shown to improve health of the population (38).

Sri Lanka's mixed health care system consists of a tax-funded public sector and a fee-for-service private sector. The public sector provides 95% of inpatient care and approximately 50% of outpatient care. The central Ministry is responsible for providing technical guidance and policy making, medical education, research and development, management of national facilities and purchasing and distribution of drugs and medical supply. The nine Provincial Directors of Health are responsible for the management and implementation of health services in the provinces (33,39).

Systematic investment and a firm foundation of primary health care have resulted in the country's many health achievements like reaching most of the targets of Millennium Development Goals (MDGs), reducing maternal and neonatal mortality and eradicating communicable diseases such as malaria, tetanus and filariasis etc. Therefore, country's primary health care system has been recognized internationally as a low-cost high-impact system (34,40). Sri Lanka's MOH cooperate with other government agencies, development partners, academia and non-governmental organizations in implementing its activities, so that a multitude of partners are active in the health sector in Sri Lanka (34).

*Regulation*

In terms of regulations and policy, Myanmar has regulations for licensing medical professionals, the national essential medicine policy, the food and drug administration regulations and national health plan every five years but there are few resources and limited capacity to implement them (41).

The government of Bangladesh has established professional regulatory and statutory bodies such as the Bangladesh Medical and Dental Council and Pharmacy council, etc. The National Drug Policy was updated in 2016 to ensure the access to the essential medicines. The Health Care Financing Strategy

2012-2032 was developed aiming to increase funding to reduce personal expenditure on healthcare services and to protect financial risk (37).

Sri Lanka has regulations for essential drugs and drug development, medical doctors and nurses to benefit people. Health master plan 2007-2016 was set out to rationalize primary health-care delivery structure. The national policy and strategic framework for prevention and control of non-communicable diseases was finalized in 2010 to highlight the strategy on health delivery organization change. National health policy 2016-2025 was guided by principles of people-centered care, equity, quality of services and financial protection (33,40).

### *What Myanmar can learn from Bangladesh and Sri Lanka*

*From Bangladesh*

Bangladesh has been recognized as an example of "good health at low cost" and praised for exceptional health achievements (42).

First thing that Myanmar should learn from Bangladesh is its extensive community-based health service delivery system. It reached almost all the households in rural areas and achieved high coverage. For decades, both government and NGOs use large-scale community-based health workers to address the shortage of human resources in health sectors. One successful tuberculosis (TB) community program (more than 90% cure rate) was already adopted by South Africa for treatment of TB and Human Immunodeficiency Virus (HIV) (43).

Another thing to learn is Bangladesh government's willingness to create an environment for pluralistic health system. Government of Bangladesh has partnered with NGOs, private sectors, informal providers and international donors etc., to address limitation of health care resources in government in order to improve health outcomes of population (43).

Last but not the least, Myanmar should look at how women empowerment in education, economic as well as in health sectors make impressive achievement in Bangladesh's health system. Bangladesh's education policy that favours girls reduced gender inequality and helped achieve almost universal primary education for aged 6-10 years. Grameen's microcredit for poor rural population, especially for women, was well known innovation in economy and was awarded Nobel Peace Prize in 2006 (38). This microcredit program, together with improvement in education, helped increase women empowerment. This, in turn, has positive effect on women decision making power within and beyond their own family including decision making for health of their family members. In health sector itself, women are employed as frontline workers for most community-based programs, and have exceptional achievements (44).

*From Sri Lanka*

Among low- or middle-income countries, Sri Lanka health care system has been recognized to achieve good health outcomes, financial protection and low cost. Many countries are praised for achieving two out of three, while few can claim to have done so well as Sri Lanka on all three (45). One important thing Myanmar can learn from Sri Lanka is its firm foundation of primary health care system that accounts for the country's achievements. The public health care system comprises two streams of primary care services: preventive and curative sectors (33,40).

Preventive health sector covers the entire country systematically and have already achieved impressive results in maternal and child health and communicable disease control activities. Preventive service delivery is decentralized to the provincial departments of health led by medical officer of health who is a general practitioner with public health training. Each medical officer of health is supported by a public health team consisting of assistant medical officer of health, public health inspectors, public health nurses and public health midwives. On the other hand, Sri Lanka's government has now been reforming the curative health sector- which is not well organized as preventive one - focusing on the primary care level to address the increasing burden of non-communicable diseases (33,40).

*Myanmar*

Myanmar health care system is still weak in above mentioned practices. Therefore, it will be very useful for Myanmar to adopt these approaches: strengthening primary care services, training community-based health workers in rural area, cooperating with donors and restructuring health financing system, in order to reform its health system.

First of all, Myanmar's primary health care system should be strengthened. As a lower middle-income country (LMIC) where there are limited health care resources, strengthening primary health care is the most efficient way to provide good health care at low cost. In fact, investing in primary care which provides prevention, promotion as well as treatment, will achieve good value for money. According to WHO policy note, putting primary care second place to hospital services is one of the challenges for Myanmar health system to achieve universal health coverage (46). Myanmar health system review also mentioned that allocating a majority of budget to secondary and tertiary hospital care services at the expense of primary health care could cause detrimental effect on equity (41). This is the evidence of how primary health care is important in a LMIC like Myanmar. Allocating more budget to primary care as well as increasing overall government's financial investment in health will be necessary to strengthen and upgrade primary health care. Moreover, medical officer or general practitioner who run the primary health care should have proper training that Myanmar still lacks.

Myanmar has an inadequate number and uneven distribution of skillful health workers between urban and rural area (31,46). To address this issue, government should work together with NGOs to train and retain local people in order to have sufficient community-based health workers for underserved rural population. In particular, for maternal and child health, women health workers should be prioritized as women are more comfortable to talk about their health issues to women health workers. In addition, women employment can also increase women empowerment from their own income.

As a LMIC, Myanmar government's health expenditure (US$ 8 per capita for 2016) is far lower than proposed target (more than 5% of GDP and more than US$86 per capita) to achieve universal health coverage (47). This means that Myanmar will need help from international aid agencies to address the shortage of health care resources in government. To use the donor's health care resources efficiently and to reduce overlapping donations, Myanmar government should cooperate and discuss openly with international aid agencies and NGOs.

In terms of health financing, neither of these three countries has established health insurance. However, they recognize the need of financial protection and they are now piloting and trying to reorganize their financing strategy. In addition to the practices mentioned above that already proved efficient in Bangladesh and Sri Lanka, Myanmar should now consider financing reform in parallel with its efficient countries. At present, Myanmar government do not have sufficient resources, so that government cannot, realistically, provide health insurance for all citizens. A combination of different insurance models will be the only option that could provide financial protection for the whole population.

Current health insurance scheme, the social security scheme (SSS), providing health insurance for formal workers covers only 1% of the population. The health care services provided by the SSS do not satisfy the customers for poor health facilities and long reimbursement process. Firstly, that social security scheme should be scaled up and strengthened to cover all formal workers with contributions from both employees and employers. As formal sector employees and their families pay for (as contributions to SSS) the free public health services they currently consume, there will be more free public resources left to the poor.

To cover elderly, poor and vulnerable population, tax-based health insurance should be arranged through direct and indirect tax. One option to be consider for increasing government tax revenue is 'excise tax' - a kind of tax imposed on products that have a negative impact on health like sugar-sweetened beverages, tobacco, alcohol and fossil fuels (48). Such tax can be earmarked to finance health system only. Imposing excise tax can result in healthier population as well as can generate additional revenues.

For the population who are not eligible for SSS and tax-based insurance scheme, community-based health insurance should be set up. As weak management, technical and financial difficulties are the common problems of community-based health insurance scheme, government and NGOs should provide subsidies, technical and management advice as appropriate to successfully implement community-based insurance scheme.

## Conclusions

Health system efficiency is crucial to improve health outcomes of populations especially in the current situation of increasing health care costs resulting from aging populations and expensive medical care. Knowing the efficiency of a country's health system provides the opportunity to analyse health systems and to take appropriate actions to improve performance. Our cross-country comparison of health system performance by using DEA provides empirical evidence of the technical efficiency of health systems in

middle-income Asian countries. The findings suggest that countries with inefficient health systems can improve their health outcomes without increasing health care resources. Moreover, DEA identifies most comparable benchmark countries for every inefficient country so that inefficient countries can potentially emulate policies and practices of their role models. It will be very beneficial for Myanmar to learn useful practical approaches and policies of its peers, Bangladesh and Sri Lanka, from our comparative analysis of health systems of these countries.

However, efficiency alone is not enough to meet the needs of increasing demand especially in resource-constrained countries. The amount of resources governments spend on health care is also important to provide basic health care that their citizens need. One paper argues that government health expenditure should be more than 5% of GDP and more than US$86 per capita in the pursuit of universal health coverage (47). In addition, DEA cannot measure equity of health care. According to the economic theory, a situation where there is pareto efficiency; allocation of resources in which no individual can be made better off without making another individual worse off; there may be no equity (10). Some studies suggest that instead of health gain and health equity as two separate outcomes, combination of these two should be the one combined goal of the health system that we should try to achieve as efficient as possible (49). Another suggestion that is based on the phenomenon called relative income hypothesis is that income inequality is inversely related to health outcomes, meaning that individual living in a more equal income society will have better health status (50). Therefore, targeting at reducing income inequality together with improving health outcomes of a society efficiently will be a way to achieve both efficiency and equity. Future research should be aimed at developing methodologies to measure efficiency and equity together to assess the comprehensive health system performance.

## Abbreviations

CHE: Current Health Expenditure; CRS: Constant Returns to Scale; DEA: Data Envelopment Analysis; DMU: Decision Making Units; GDP: Gross Domestic Product; HALE: Health Adjusted Life Expectancy; HIV: Human Immunodeficiency Virus; IMR: Infant Mortality Rate; Int$: International Dollars; ISR: Infant Survival Rate; LMIC: Lower Middle-Income Country; MDG: Millennium Development Goals; MMR: Maternal Mortality Rate; MOH: Ministry of Health; NCD: Non Communicable Diseases; NGO: Non-Governmental Organization; OECD: Organization for Economic C0-operation and Development; OOPs: Out of Pocket Payments; SSS: Social Security Scheme; TB: Tuberculosis; US$: United States Dollars; VRS: Variable Returns to Scale; WHO: World Health Organization.

## Declarations

### Ethics approval and consent to participate

Not applicable

### Consent for publication

Not applicable

## Availability of data and materials

The datasets used and analyzed during the current study are publicly available from World Health Organization (WHO) and World Bank.

## Competing Interest

The authors declare that they have no competing interests.

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## Authors' contributions

ZMW analyzed the data and drafted the manuscript. CL reviewed the manuscript and provided feedback. All authors have read and approved the final manuscript.

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# Tables

Table 1. Input and output variables of middle-income Asian countries

| | Countries | CHE per capita in international dollar | Doctors per 10,000 population | Nursing and midwifery personnel per 10,000 population | Health adjusted life years | IMR per 1000 live births | ISR= 1-IMR/1000 |
|---|---|---|---|---|---|---|---|
| 1 | Armenia | 880.00 | 29.14 | 49.54 | 66.30 | 12.20 | 0.9878 |
| 2 | Azerbaijan | 1155.00 | 34.46 | 64.34 | 64.90 | 21.80 | 0.9782 |
| 3 | Bangladesh | 89.00 | 4.97 | 2.64 | 63.30 | 28.00 | 0.9720 |
| 4 | Bhutan | 293.00 | 4.06 | 15.33 | 60.70 | 26.50 | 0.9735 |
| 5 | Cambodia | 229.00 | 1.93 | 7.20 | 60.80 | 26.20 | 0.9738 |
| 6 | China | 763.00 | 22.94 | 24.67 | 68.70 | 8.50 | 0.9915 |
| 7 | Georgia | 799.00 | 59.97 | 40.00 | 64.90 | 9.10 | 0.9909 |
| 8 | India | 233.00 | 7.59 | 14.95 | 59.30 | 33.20 | 0.9668 |
| 9 | Indonesia | 363.00 | 2.74 | 12.99 | 61.70 | 22.60 | 0.9774 |
| 10 | Iran | 1712.00 | 11.53 | 18.91 | 65.40 | 13.30 | 0.9867 |
| 11 | Jordan | 658.00 | 13.95 | 2.08 | 66.40 | 14.80 | 0.9852 |
| 12 | Kazakhstan | 860.00 | 39.80 | 72.94 | 63.40 | 9.80 | 0.9902 |
| 13 | Kyrgyzstan | 234.00 | 22.13 | 59.45 | 63.50 | 18.90 | 0.9811 |
| 14 | Laos | 155.00 | 4.95 | 10.30 | 57.90 | 40.40 | 0.9596 |
| 15 | Lebanon | 1106.00 | 20.12 | 15.72 | 66.10 | 6.80 | 0.9932 |
| 16 | Malaysia | 1038.00 | 15.36 | 33.97 | 66.60 | 6.80 | 0.9932 |
| 17 | Maldives | 1594.00 | 28.86 | 65.73 | 69.80 | 8.10 | 0.9919 |
| 18 | Mongolia | 542.00 | 28.59 | 40.80 | 61.90 | 15.20 | 0.9848 |
| 19 | Myanmar | 273.00 | 6.20 | 10.34 | 58.40 | 39.30 | 0.9607 |
| 20 | Pakistan | 150.00 | 9.62 | 4.87 | 57.70 | 60.50 | 0.9395 |
| 21 | Philippines | 344.00 | 12.72 | 52.74 | 61.70 | 23.40 | 0.9766 |
| 22 | Sri Lanka | 490.00 | 8.93 | 19.48 | 66.80 | 7.00 | 0.9930 |
| 23 | Thailand | 639.00 | 4.45 | 27.72 | 66.80 | 8.60 | 0.9914 |
| 24 | Timor-Leste | 317.00 | 6.95 | 14.82 | 59.20 | 42.00 | 0.9580 |
| 25 | Turkey | 1133.00 | 18.14 | 25.73 | 66.00 | 10.30 | 0.9897 |
| 26 | Turkmenistan | 1119.00 | 22.25 | 44.27 | 61.40 | 41.80 | 0.9582 |
| 27 | Uzbekistan | 417.00 | 23.74 | 112.80 | 64.50 | 21.50 | 0.9785 |
| 28 | Vietnam | 357.00 | 8.28 | 14.46 | 67.50 | 17.20 | 0.9828 |
| | | | | | | | |
| | Mean | 640.79 | 16.94 | 31.39 | 63.63 | 21.21 | 0.9788 |
| | Minimum | 89.00 | 1.93 | 2.08 | 57.70 | 6.80 | 0.9395 |
| | Maximum | 1712.00 | 59.97 | 112.80 | 69.80 | 60.50 | 0.9932 |

CHE= current health expenditure, IMR=infant mortality rate, ISR= infant survival rate

Table 2. Variable returns to scale, output-oriented DEA results with composite members

| | DMUs | Rank | VRS TE | % improvement in output | Composite members with reference weight |
|---|---|---|---|---|---|
| 1 | Armenia | 16 | 0.9946 | 0.5379 | 16(0.71), 22(0.29) |
| 2 | Azerbaijan | 23 | 0.9849 | 1.5103 | 15(0.98) |
| 3 | Bangladesh | 1 | 1 | 0 | - |
| 4 | Bhutan | 17 | 0.9944 | 0.5646 | 3(0.06), 5(0.66), 22(0.28) |
| 5 | Cambodia | 1 | 1 | 0 | - |
| 6 | China | 1 | 1 | 0 | - |
| 7 | Georgia | 13 | 0.9978 | 0.2228 | 16(0.56), 22(0.44) |
| 8 | India | 22 | 0.9869 | 1.3123 | 3(0.58), 13(0.08), 22(0.33) |
| 9 | Indonesia | 12 | 0.9984 | 0.1557 | 5(0.71), 22(0.02), 23(0.27) |
| 10 | Iran | 18 | 0.9936 | 0.6392 | 15(0.22), 16(0.02), 22(0.75) |
| 11 | Jordan | 1 | 1 | 0 | - |
| 12 | Kazakhstan | 14 | 0.9970 | 0.2955 | 16(0.67), 22(0.32) |
| 13 | Kyrgyzstan | 1 | 1 | 0 | - |
| 14 | Laos | 24 | 0.9846 | 1.5404 | 3(0.72), 5(0.15), 22(0.11) |
| 15 | Lebanon | 1 | 1 | 0 | - |
| 16 | Malaysia | 1 | 1 | 0 | - |
| 17 | Maldives | 1 | 1 | 0 | - |
| 18 | Mongolia | 19 | 0.9917 | 0.8277 | 16(0.09), 22(0.90) |
| 19 | Myanmar | 25 | 0.9794 | 2.0589 | 3(0.44), 5(0.13), 22(0.40) |
| 20 | Pakistan | 28 | 0.9636 | 3.6383 | 3(0.82), 11(0.01), 22(0.13) |
| 21 | Philippines | 20 | 0.9906 | 0.9388 | 3(0.15), 13(0.33), 22(0.52) |
| 22 | Sri Lanka | 1 | 1 | 0 | - |
| 23 | Thailand | 1 | 1 | 0 | - |
| 24 | Timor-Leste | 26 | 0.9740 | 2.6024 | 3(0.38), 5(0.06), 22(0.53) |
| 25 | Turkey | 15 | 0.9965 | 0.3524 | 15(0.45), 16(0.55) |
| 26 | Turkmenistan | 27 | 0.9648 | 3.5240 | 15(0.96) |
| 27 | Uzbekistan | 21 | 0.9888 | 1.1223 | 13(0.28), 22(0.71) |
| 28 | Vietnam | 1 | 1 | 0 | - |
| | Mean values of inefficient countries | | 0.9872 | 1.2849 | |

DMUs= decision making units, VRS TE= variable returns to scale technical efficiency, Composite members= a group of comparable, closest efficient peers, Reference weight= weight given to each peer according to its importance among peer group

Table 3. Health care financing in Myanmar, Bangladesh and Sri Lanka

|  | Myanmar | Bangladesh | Sri Lanka |
|---|---|---|---|
| CHE as % of GDP | 5% | 2% | 4% |
| Government health expenditure as % of CHE | 14% | 16% | 43% |
| OOPs as % of CHE | 77% | 73% | 50% |
| Other private health expenditure as % of CHE | - | 3% | 6% |
| External health expenditure as % of CHE | 9% | 8% | 1% |
| Government health expenditure in Int$ | 39 | 15 | 211 |
| OOPs in Int$ | 209 | 65 | 246 |

CHE= current health expenditure, GDP= gross domestic product, OOPs= out of pocket payment, Int$= international dollars