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Adjusting for Inflation and Currency Changes Within Health Economic Studies

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ABSTRACT

Objectives: Within health economic studies, it is often necessary to adjust costs obtained from different time periods for inflation. Nevertheless, many studies do not report the methods used for this in sufficient detail. In this article, we outline the principal methods used to adjust for inflation, with a focus on studies relating to healthcare interventions in low- and middle-income countries. We also discuss issues relating to converting local currencies to international dollars and US$ and adjusting cost data collected from other countries or previous studies.

Methods: We outlined the 3 main methods used to adjust for inflation for studies in these settings: exchanging the local currency to US$ or international dollars and then inflating using US inflation rates (method 1); inflating the local currency using local inflation rates and then exchanging to US$ or international dollars (method 2); splitting the costs into tradable and nontradable resources and using method 1 on the tradable resources and method 2 on the nontradable resources (method 3).

Results: In a hypothetical example of adjusting a cost of US$100 incurred in Vietnam from 2006 to 2016 prices, the adjusted cost from the 3 methods were US$116.84, US$172.09, and US$161.04, respectively.

Conclusions: The different methods for adjusting for inflation can yield substantially different results. We make recommendations regarding the most appropriate method for various scenarios. Moving forward, it is vital that studies report the methodology they use to adjust for inflation more transparently.

Keywords: currency changes, global health, health economics, inflation, international dollars.

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Introduction

For economic evaluations in healthcare, it is often necessary to use cost data that have been collected at different time points. However, because of inflation, the purchasing power of a currency can change (usually decreasing) over time; therefore it can cost progressively more to provide the same quantity of goods and services. Within this article, we focus on "inflation," defined as when the same nominal quantity of currency buys less in terms of a fixed basket of goods and services (Box 1). We do not describe the causes of inflation or discuss in detail its measurement,[1-5] but focus rather on the approaches to adjust for it within health economic evaluations and their implications.

As costs measured (or estimated) in different years are not directly comparable, within health economic studies it is often necessary to adjust costs obtained from different time periods to express them in a single base or reference year (Box 1). Without making such an adjustment, it can be difficult to tell whether a change in the cost of an intervention over time is due to a change in the real value of the resources being used or to a change in the value of the currency used to purchase them.[6] Adjusting for inflation captures changes in the value of the currency. This can be particularly important for the following:

1. Using cost data relating to an intervention that is incurred over multiple years.[6]

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2. Comparing costs and cost-effectiveness data from different analyses that are performed in different years.[6] This is needed when:
   - performing systematic literature reviews, parameterizing cost assumptions within economic evaluations, or making cost databases;
   - comparing economic evaluations conducted in different countries; and
   - comparing incremental cost-effectiveness ratios of studies conducted in the past to a new cost-effectiveness threshold that relates to a different year.

Costs that have been adjusted for inflation are typically referred to as constant or real costs, whereas costs that are unadjusted are referred to as nominal or current costs.[6] It is important to clarify that although discounting (Box 1) and adjusting for inflation are mathematically similar (and sometimes confused), in economic terms they are different. Adjusting for inflation accounts for how the purchasing power of a fixed nominal quantity of currency has changed over time, whereas discounting future costs accounts mainly for the opportunity cost of spending the money now rather than in the future (Box 1).

Unfortunately, many studies have not reported in sufficient detail the methods used to adjust for inflation. Nevertheless, it is important to know these methods because different approaches can have a significant impact on the adjusted costs. Inconsistency in methods of adjustment and a lack of transparency concerning them can lead to unexplained variation in cost estimates. The choice of method used to adjust for inflation is critical for all economic evaluations, but becomes even more relevant for comparing cost estimates from studies in low- and middle-income countries because of the absence of local costing data, high rates of inflation and fluctuating market exchange rates. It is also typical to report the adjusted costs in US$ or international dollars in these settings (Box 1), causing further challenges and methodological variation regarding currency conversion. None of the currently available guidelines issued by low- and middle-income countries for conducting health economic evaluations provide detailed methodological guidance on how to adjust for inflation when using information from different healthcare settings.[7]

BOX 1. Key health economic terms.

Base or reference year: The year in which a fixed quantity of currency can buy a fixed basket of goods and services. In practice, the most recent year for which reliable price data for the basket are available is used as the base year.[6]
Basket of goods and services: A list of goods and services matched with the proportions in which the individual items enter into the reference set.
A fixed basket of goods and services: A basket of goods and services in which not only the items on the list and their proportions have been determined but also their quantities.
Discounting: Healthcare interventions typically incur costs and generate health outcomes and other benefits over a period of time. Nevertheless, when the economy is growing, there is an opportunity cost to spending money now (ie, "consuming") when instead it could be invested (ie, "saving") so as to generate a return in the future. We do not discuss discounting in detail, but in passing note that the discount rate is generally held by economists to be composed of 4 distinct terms.[19-22] There are 3 (usually nonnegative) terms that enter positively in the expression for the discount rate: one accounting for *impatience* (the desire to consume sooner rather than later), one reflecting expected *growth* (the opportunity cost of consuming now rather than in the future when resources are usually cheaper because of long-term growth in incomes), and one expressing the *relative risk* of the investment (which, if riskier than average, might well lower future consumption and favors consuming now); finally, there is one that enters negatively, expressing the *aggregate risk* of all investments (which favors setting aside precautionary saving, the more, the riskier the overall environment). To account for these factors, economic evaluations need to weigh costs and benefits occurring in the future differently to those occurring in the current period. Discounting is the process used to convert costs or benefits occurring in the future into a "present value," that is, into the equivalent (consumption) value those costs or benefits would have now.[23-25] Discounting (for positive discount rates) makes costs and benefits accruing in the future worth less than those in the present period. Similarly to adjusting for inflation, although taking into account different factors, discounting allows for the comparison of costs and benefits accruing at different time periods on a like-to-like basis.
Real interest rates: The rate of return of an investment after adjusting for inflation. Real interest rates are often used as estimates of the discount rate.
Tradable versus nontradable resources: Tradable resources are those that can be sold in a different country from that in which they were produced; that is, they can be exported or imported. Tradable resources typically include items such as laboratory equipment and drugs. Nontradable resources are those that cannot be exported or imported. Nontradable resources include many types of services, which typically must be consumed locally (eg, labor inputs). In economic terms, tradable resources have a uniform cost worldwide, whereas the cost of nontradable resources generally differs by country because of differences in local prices.
Market exchange rate: A market exchange rate determines a currency's value in relation to other currencies.
Purchasing power parity (PPP) exchange rate: See International dollars (I$).
International dollars (I$): The international dollar is a hypothetical currency unit that is designed to capture differences in relative prices across different settings. As with discounting and inflation, differences in relative prices also differentially affect the purchasing power of a currency unit, but international dollars are used to adjust for variations in location rather than in time.[8,10,15] That is, what US$1 can buy in the United States is not generally the same as what it buys (converted at exchange rates) in, say, Ghana. Nevertheless, the international dollar is defined such that it would buy in the country of interest a comparable amount of goods and services as that which US$1 can buy in the reference country, that is, in the United States. As with discounting and inflation adjustment, international dollars are used as a means of comparing the cost of goods and services in different countries (locations) on a like-to-like basis.[10] To convert a currency unit to international dollars, a purchasing power parity (PPP) exchange rate is used. The PPP exchange rate represents the number of units of a country's currency required to buy the equivalent quantity of goods and services as that which US$1 can buy in the United States.[10,15] PPP exchange rates are available from the International Monetary Fund: World Economic Outlook[12] and the World Bank.[26]

Ultimately, the most appropriate methodology will depend on the context and aim of the study.[6,8] Moving forward, it is important that studies more clearly describe and justify their approach while considering its advantages and limitations for the given context. The aim of this article is to describe various methods for adjusting for inflation for studies relating to healthcare interventions in low- and middle-income countries, providing numerical examples and assessing the implications and potential biases of each method. We make recommendations regarding the most appropriate method for various scenarios.

Adjusting for Inflation

There are different methods that can be used to adjust for inflation and convert costs to a single base year.[6,9] In studies relating to healthcare interventions where most of the resources have relatively stable local prices and have been purchased using the local currency, it is typical to use the local inflation rates and report the adjusted costs in the local currency (as outlined in Box 2). This is most likely to occur for studies based in high-income or upper-middle–income countries. In contrast, in studies relating to healthcare interventions where most of the resources have fluctuating local prices or are imported and purchased in foreign currencies, a variety of methods have been used to adjust for inflation. This is most likely to occur for studies based in low- and some middle-income countries. In these cases, it is typical to report the adjusted costs in US$ or international dollars (Box 1).

In studies relating to healthcare interventions in low- and middle-income countries, the main factors to consider when adjusting for inflation are the measure of inflation, the output currency, and the adjustment method.

Choice of the Measure of Inflation

There are several different measures of inflation.[10] The 2 main ones used within health economic studies are the following:

1. The Gross Domestic Product (GDP) implicit price deflator: This reflects the price changes of all goods that contribute to a country's gross domestic product (GDP), that is, all locally produced goods.[11,12] It is the most general measure of the overall price level, and the GDP deflator for a given period reflects the average annual rate of inflation in the economy as a whole during that period.[6,10] An outline of how to use GDP implicit price deflators is provided in Box 2. GDP implicit price deflators are available from the International Monetary Fund: World Economic Outlook[12] and the World Bank.[11]
2. The consumer price index (CPI): This reflects changes in the cost of a fixed basket of goods and services that households typically consume.[11,12] CPI should be interpreted with a degree of caution as

BOX 2. Using the GDP implicit price deflators or the CPI.

To adjust for inflation using GDP implicit price deflators or CPI, you multiply the cost by the ratio of the relevant metric from the year you want to adjust the costs to and the year they are currently in. In the examples below the costs are being adjusted from 2009 to 2016 prices:

$$\textbf{Adjusted cost}\ (2016\ \textbf{prices}) = \textbf{Cost}\ (2009\ \textbf{prices}) \times \frac{\textbf{GDP deflator or CPI for}\ 2016}{\textbf{GDP deflator or CPI for}\ 2009}$$

GDP implicit price deflator

Country	2008	2009	2010	2011	2012	2013	2014	2015	2016
Ghana	142	***164***	191	218	251	290	338	393	***464***
USA	99	***100***	101	103	105	107	109	110	***111***
Vietnam	84	***89***	100	121	135	141	146	146	***147***

CPI

Country	2008	2009	2010	2011	2012	2013	2014	2015	2016
Ghana	76	***90***	100	109	116	130	150	176	***207***
USA	99	***98***	100	103	105	107	109	109	***110***
Vietnam	86	***92***	100	119	129	138	145	146	***151***

Examples:
GDP implicit price deflator:
Ghana: GHS100 (2009 prices) × (464/164) = GHS283 (2016 prices)
USA: US$100 (2009 prices) × (111/100) = US$111 (2016 prices)
Vietnam: VND100 (2009 prices) × (147/89) = VND176 (2016 prices)
CPI:
Ghana: GHS100 (2009 prices) × (207/90) = GHS229 (2016 prices)
USA: US$100 (2009 prices) × (110/98) = US$112 (2016 prices)
Vietnam: VND100 (2009 prices) × (151/92) = VND164 (2016 prices)
The values used within the examples are highlighted in bold italics.

Table 1. Advantages and disadvantages of the different output currencies and adjustment methods.

	Advantages	Disadvantages
Output currency		
US$	Widely understood. The medium of exchange for many international transactions.	Can poorly reflect the relative cost of resources across different countries. Market-based US$ exchange rates can vary significantly, even over short periods of time.
I$	Allows a better comparison of the relative cost of resources across different countries. PPP exchange rates are relatively stable over time.	Many are less familiar with international dollars. PPP exchange rates are harder to measure and estimate than market-based US$ exchange rates.
Adjustment method		
Method 1: Exchanging the local currency to US$ or international dollars and then inflating using US inflation rates	US inflation rates more accurately reflect the price changes of tradable resources (which are often globally purchased and priced) compared with local inflation rates.	US inflation rates may not be reflective of the price changes for local nontradable resources. As US inflation rates are typically lower than local inflation rates, this method can underestimate the adjusted costs related to the nontradable resources.
Method 2: Inflating the local currency using local inflation rates and then exchanging to US$ or international dollars	Local inflation rates more accurately reflect the price changes for local nontradable resources compared with US inflation rates.	Local inflation rates may not be reflective of the price changes for tradable resources. As local inflation rates are typically higher than US inflation rates, this method can overestimate the adjusted cost related to the tradable resources.
Method 3: A mixed approach	Can be more accurate than other methods.	Can be difficult to stratify resources into tradable and nontradable. Can be difficult to implement on previously published data.

the sample of the survey and the defined fixed basket of goods and services it references can vary widely across different countries,[12,13] resulting in inappropriate comparisons. It is questionable whether the CPI is reflective of the changes in the cost of healthcare resources across settings because the prices of the goods and services in the fixed basket are not necessarily related to healthcare.[6,10] CPIs are available from the International Monetary Fund: World Economic Outlook[12] and the World Bank.[13] Some countries also monitor and report their own CPIs. The source of the CPIs used should be clearly referenced.

These are not the only measures of inflation, and some countries have an index of inflation specifically for goods produced and consumed in the healthcare sector.[14] Nevertheless, in practice, this measure cannot be used broadly because it is not widely available across different countries.[6,10] In some cases, the specific rate of inflation for wages is available, although this measure is typically too narrow to be used as the index of inflation for healthcare interventions as a whole.[10]

The most appropriate measure of inflation to use for adjusting costs is the one that most closely reflects the general price level of the resources used by the healthcare intervention.[6] The dissimilarity between the different measures of inflation will depend on the local setting and time period. In 2003, the WHO-CHOICE guide to cost-effectiveness analysis recommended using GDP implicit price deflators (with the CPI measure being the next best alternative).[10]

Choice of the Output Currency: US$ Versus International Dollars

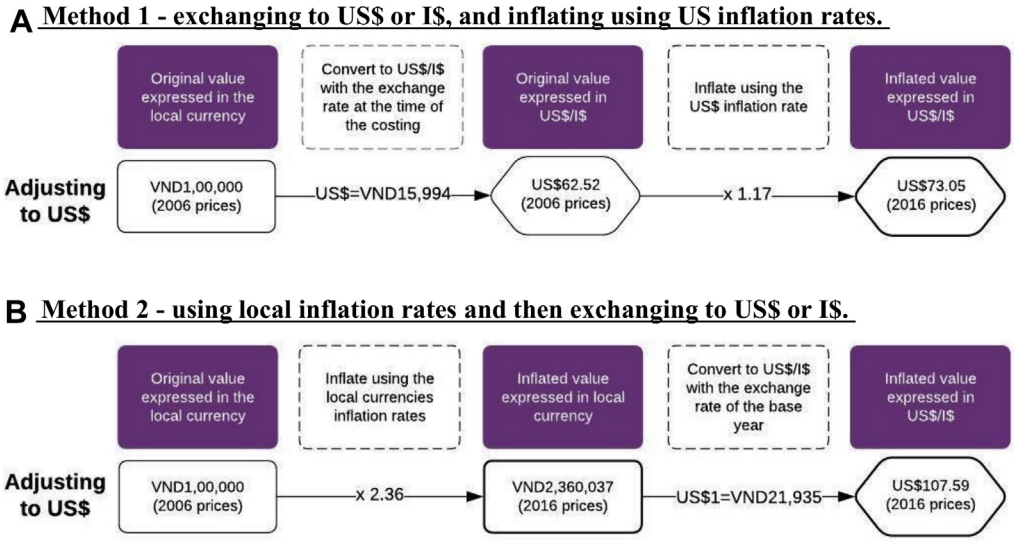
Adjusted costs are typically reported in US$ or international dollars. The international dollar is a hypothetical currency unit that is designed to capture the differences in relative prices across different settings[8,10,15] (Box 1). For example, I$1 would buy, in the country of interest, a comparable amount of goods and services as US$1 in the United States.

An important advantage of international dollars (over US$) is that they provide a better comparison of the relative cost of resources across different countries[8] (Table 1). Therefore, they are very useful when reporting costs from different countries. In addition, the PPP exchange rates (which are used to convert a currency to international dollars) are typically relatively stable over time[8] (Box 1). In contrast, a disadvantage of using US$ is that many market exchange rates can vary significantly, even over short periods of time. This can be very extreme when a currency is floated (Table 1). For example, in 2011 the market exchange rate for Myanmar was US$1 to MMK5.44, whereas in 2012 it changed to US$1 to MMK640.65.[16] In these situations, currencies may be converted using black market exchange rates, making the choice of the appropriate US$ exchange rate increasingly difficult.

Nevertheless, an important disadvantage is that many individuals, including policy makers and clinicians, are less familiar with international dollars compared with US$[8] (Table 1). In addition, PPP exchange rates are harder to measure and estimate than market-based exchange rates.[8] They are estimated by the International Comparisons Program using surveys conducted at infrequent intervals, and in between surveys, rates have to be projected.[8,15,17]

The choice of whether to present costs in US$ or international dollars will depend on the aim of the study and its setting(s) (Table 1). These options are not mutually exclusive, and both can be reported within the same study. It can be useful to report the costs in the local currency as well. Within a cost-effectiveness analysis, the choice will likely be influenced by the currency that the decision maker's budget or process is denominated in.

Figure 1. Overview of methods 1 and 2 for adjusting for inflation in studies relating to healthcare interventions in low- and middle-income countries. In these hypothetical examples, the year of the costing is 2006 and the base year of the analysis is 2016. In the example, US$ are being used, but the same approach would be applicable to international dollars.



Choice of the Adjustment Method

The following are the 3 main inflation adjustment methods used in studies relating to studies in low- and middle-income countries (Figs. 1 and 2).

Adjustment Method 1: Exchanging the Local Currency to US$ or International Dollars and Then Inflating Using US Inflation Rates

Within this method, the costs are first converted from the local currency to US$ or international dollars, using the exchange rate relating to the time period during which the cost data were collected. The values are then inflated using US inflation rates to the base year of the analysis (Fig. 1A). The World Bank can be a useful source of exchange rates.[16]

A limitation of this approach is that the US inflation rates may not be reflective of the price changes that have occurred within many low- and middle-income countries, particularly for local nontradable resources, such as personnel (Box 1). When the inflation rate for the local currency is higher than the US inflation rate, this method can underestimate the adjusted cost related to these nontradable resources.

Figure 2. Overview of the mixed method (method 3) for adjusting for inflation in studies relating to healthcare interventions in low- and middle-income countries. In this hypothetical example, the year of the costing is 2006, the base year of the analysis is 2016, and 20% of the resources used were "tradable." In the example, US$ are being used, but the same approach would be applicable to international dollars.

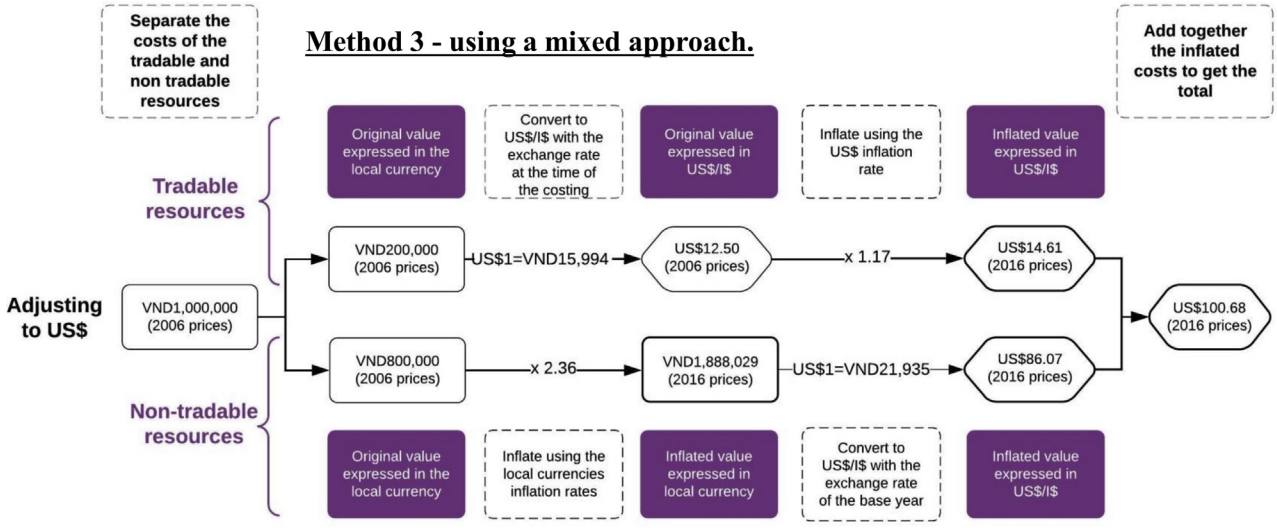
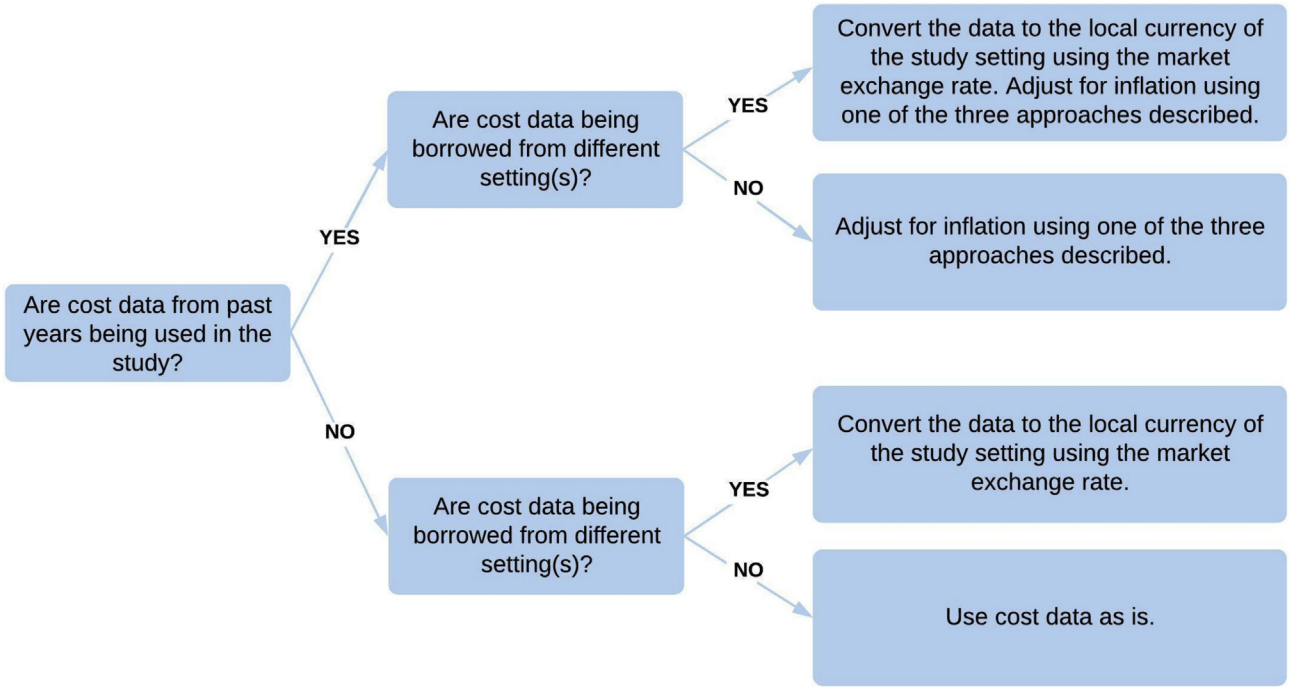


Figure 3. Overview of the process of using data from other settings and adjusting for inflation.



Adjustment Method 2: Inflating the Local Currency Using Local Inflation Rates and Then Exchanging to US$ or International Dollars

Within this method, the costs are first inflated using the local currency's inflation rates and are then converted to US$ or international dollars using the exchange rate relating to the base year of the analysis (Fig. 1B).

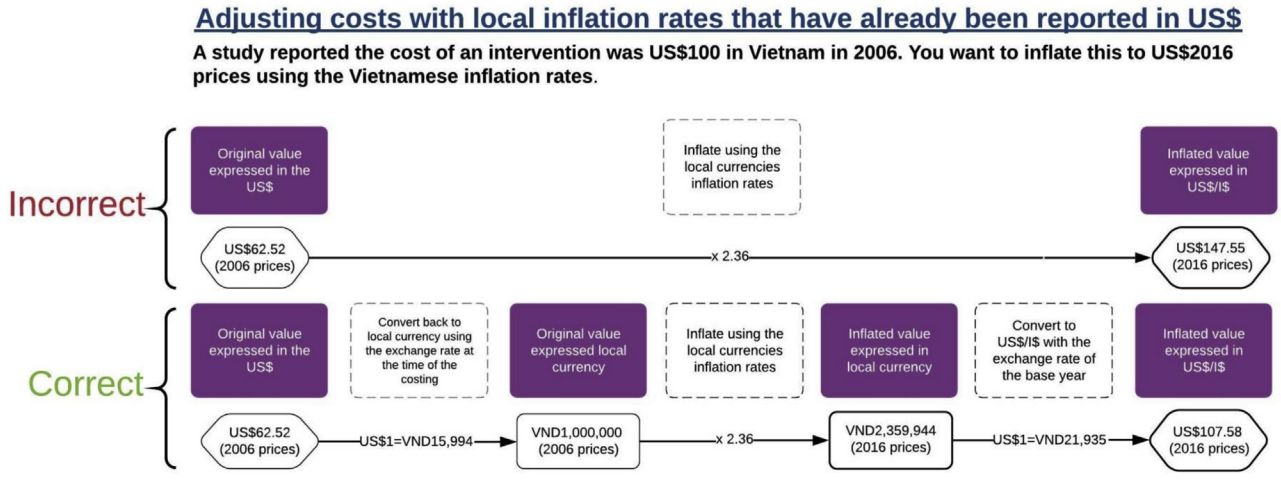
Nevertheless, in practice, many healthcare interventions use imported commodities/goods, known as tradable resources (such as laboratory equipment and many drugs; see Box 1). A limitation of this method is that local inflation rates may not accurately reflect changes in the prices of these tradable goods that are often globally purchased and priced. When the inflation rate for the local currency is higher than the US inflation rate, this method can overestimate the adjusted cost related to these tradable resources.

Kumaranayake[6] recommended using this method unless the healthcare intervention uses a relatively high proportion of imported commodities (ie, tradable resources) or rapid inflation (eg, rates >15-20%) has occurred, in which case it was recommended that working in US$ (ie, method 1) would be more appropriate.

Adjustment Method 3: A Mixed Approach

For costing studies that have used the ingredients-based approach (ie, microcosting),[10] a more detailed estimate of the inflated cost can be obtained. Within this method, the costs of the healthcare intervention are stratified into tradable and nontradable resources (Box 1). The costs of

Figure 4. Adjusting costs with local inflation rates that have already been reported in US$.



the tradable resources are then converted into US$ or international dollars using the exchange rate relating to the time period the cost data were collected and then inflated using US inflation rates (or when possible commodity-specific price change rates) (Fig. 2). The costs of the nontradable local resources are inflated using the local currency's inflation rates and then converted to US$ or international dollars (Fig. 2).

A key advantage of this approach is that it is more accurate than the other methods (Fig. 1). Nevertheless, it can be difficult to implement on previously published data as the results of costing studies are not always reported in sufficient detail. In addition, in practice, it can be difficult to separate resources in this way. For example, many goods may only be partially tradable because of trade barriers or a lack of transportation infrastructure. Because of this, whether or not a resource is tradable will depend on the specific study setting. A practical method of separating resources in this way for studies in low- and middle-income countries can be to treat the resources that were imported as tradable and treat all other resources as nontradable.

Recently, the Global Health Costing Consortium stated that this is the preferred method within their reference case for estimating the costs of global health services and interventions.[18]

A summary of the advantages and disadvantages of the different output currencies and adjustment methods is presented in Table 1. Ultimately, the difference in the adjusted costs from these methods will depend on the specific country's inflation and exchange rates compared with the United States, and will therefore vary for different countries. The differences can be very significant when the local inflation rates are higher than the US inflation rates. The proportion of the total cost that is related to tradable resources will also affect the difference between the methods and influence which is most appropriate for a given study.

Using Data from Other Settings or Previous Studies

These approaches for adjusting for inflation are also often required when using cost data collected from a different study setting or country. This is a very common necessity for studies relating to settings with limited local cost data available. An overview of this is presented in Figure 3.

The results of costing studies relating to low- and middle-income countries are often expressed in US$ or international dollars. When adjusting these previously published costs for inflation using local inflation rates, that is, method 2 (Fig. 1B), it is vital that the costs are first converted back to the local currency using the exchange rate relating to the time period the cost data were collected. The costs can then be inflated and converted back to US$ or international dollars using the exchange rate of the base year of the analysis (Fig. 4). This is important because the exchange rates will change over time, and not accounting for this could result in the costs being notably overadjusted (Fig. 4).

Conclusions

Crucially, the most appropriate methodology for adjusting for inflation will depend on the context of the study and the available data.[6,8] Generally, in studies related to healthcare interventions in low- and middle-income countries, we would recommend using method 3 when it is possible to stratify the resources into tradable and nontradable. This should be possible during primary costing studies but may not be when using previously published data (such as analyses based on systematic literature reviews or cost databases). In the cases when this is not possible, method 1 should be used when there is high use of tradable resources and method 2 when there is high use of nontradable resources. The results should be reported in US$ and/or international dollars, as well as the local currency. As highlighted by Kumaranayake,[6] what is most important is that the methodology is transparently reported and specified. Specifically, we recommend clear methodological reporting and justification regarding (1) the choice of the measure of inflation, (2) the choice of the output currency, and (3) the choice of the adjustment method, and, if applicable, (4) the approach used for adjusting cost data from other settings.

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