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A Systematic Review of Methods for Estimating Productivity Losses due to Illness or Caregiving in Low- and Middle-Income Countries

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Abstract

Background Productivity losses are often included in costing studies and economic evaluations to provide a comprehensive understanding of the economic burden of disease. Global guidance on estimating productivity losses is sparse, especially for low- and middle-income countries (LMICs) where informal and unpaid work remains dominant. This study aims to describe current practices for valuing productivity losses in LMICs.

Methods We performed a systematic review of studies published before April 2022 using three databases, including PubMed, Cochrane Library and Web of Science Core Collection. We included any costing or economic evaluation study conducted in a LMIC that provided methodological details on how the monetary value for productivity losses was estimated. Two reviewers independently screened articles for inclusion, extracted data and assessed the quality of the studies.

Results A total of 281 articles were included. While most studies did not specify the overall approach used to measure and value productivity losses (58%), the human capital approach was the most frequently used approach to measure productivity losses when this was clearly stated (39%). The most common methods to estimate a monetary value for productivity losses were market wages (51%), self-reported wages (28%) and macroeconomic measures (15%).

Conclusion Reporting standards for productivity losses in LMIC settings have room for improvement. While market wages were the most frequently used method to estimate the monetary value of productivity losses, this relies on context-specific data availability. Until a consensus is reached on if, when and how to include productivity losses in costing and economic evaluation studies, future studies could include a sensitivity analysis to explore the impact of different methods for estimating the monetary value of productivity losses.

1 Introduction

In any health economic evaluation, the choice of study perspective is critical to guide the identification, measurement and valuation of costs [1]. Study perspectives can include the individual patient or household; a specific institution, such as a healthcare provider or health insurance agency as a payer; or the societal perspective, which considers all costs regardless of who pays for the services [2]. The societal perspective includes productivity losses, which are the opportunity costs of an individual's lost time due to illness and seeking treatment [3].

A recent review assessing the inclusion of productivity losses in economic evaluation guidelines in 46 countries found that two-thirds recommended that productivity losses be excluded from the base case analysis [3]. The review cited a number of reasons for not including productivity losses in economic evaluations: policymakers may be more interested

in the costs incurred within the healthcare system, the uncertainty around assumptions needed for the inclusion of productivity losses reduces the credibility of the results, reductions in the productivity of an individual may not translate to a decrease in productivity at the societal level, their inclusion may result in double counting as changes in health-related quality of life captures the impact of reduced productivity in individuals (e.g., ability to perform usual activities) and it may be unethical as the inclusion may favour interventions for those who are well paid while neglecting those who are not in paid work (e.g., children) [3]. The guidelines identified by the review that recommended taking the societal perspective argued that it was preferable to provide more information to policymakers through the wider perspective, reducing the biases that can arise from a more narrow perspective [3]. Indeed, a program or intervention that is not cost-effective from one (often narrow) perspective might become cost-effective when a different (often broader) perspective is considered [3, 4].

Key Points for Decision Makers

The human capital and friction cost methods are commonly used to measure and value productivity losses. However, global guidance on how to estimate productivity losses is sparse, especially for low-and middle-income countries (LMICs) where informal and unpaid workers remain dominant.

The choice of method used for assigning a monetary value to productivity losses will impact the total cost results, potentially impacting the cost-effectiveness of an intervention. Thus, the identification of when and how to value productivity losses in costing and economic evaluation studies where a large proportion of the population is in unpaid or informal work is critically needed.

This systematic review provides an overview of methods used to date for estimating productivity losses in LMICs, including for those who are not in paid employment. Future studies could include a sensitivity analysis to explore the impact of different methods for estimating the monetary value of productivity losses. New methods and guidelines may need to be developed to overcome the practical and ethical challenges.

When including productivity losses, the human capital and friction cost approaches are commonly used for their measurement (quantifying time lost) and valuation (converting time losses into a monetary value) [5, 6]. The human capital approach puts a value on an individual's earnings by considering the entire period of absence from work due to illness or receipt of an intervention [7]. In contrast, a friction cost approach only includes the period until another worker from the unemployment pool is hired, called the friction period [3, 8, 9]. While the human capital approach is recommended in most guidelines, some have argued that this approach is unrealistic and may lead to overestimation since it does not consider that the work of the affected individuals could be replaced by others in a labour market [3]. A limitation of the friction cost approach is that not all countries have a measure of the friction period, hindering implementation [10].

One of the key issues when estimating productivity losses is identifying whose time losses matter. Traditional approaches tend to focus on time losses for paid work, defined as any activity compensated as financial gain or reward [11]. This can be as an employee (formal work) or informal worker [11]. Informal workers are those who are not subject to national labour legislation or certain other

employment benefits, and therefore are not entitled to regular payments, often due to their self-employment [12]. In high-income countries, unpaid work has been excluded from economic evaluations due to the lack of standardised methods for valuing this labour [1]. Unpaid work is an important aspect of economic activity that is more common in LMICs, contributing to the wellbeing of the patient and their household [13]. For example, approximately one-third of the adult labour force in Indonesia is unpaid or family work [14]. Since women are far more likely to be in unpaid care work, the exclusion of unpaid populations when estimating productivity losses could further exacerbate gender-based inequalities [13]. While some approaches also include unpaid work, such as household tasks, taking care of children, and volunteer work in recognition of the benefits to society [7, 15], unpaid work is often left out of the policy agenda because of the challenges in estimating its cost and a perception that it is less relevant for policymaking [13].

For both the human capital and friction cost approaches, a method must be chosen for assigning a monetary value to the time losses, which determines how much the individual who lost time would have been monetized for that time. In high-income countries, common approaches used to assign a monetary value to these time losses include applying each individual's daily wage or using market wages, such as the average wage for the country or region within that country [16, 17]. A number of issues make it more challenging to assign a monetary value to productivity losses in low-and middle-income countries (LMICs). While the majority of economic evaluations that recommend including productivity losses suggest using market wages to estimate the monetary value [3], the greater income inequality found in LMICs may mean that market wages are less representative of the value of lost income [18, 19]. Furthermore, since the majority of the population in LMICs work in the informal sector [12], where their income may fluctuate over time, it can be difficult to estimate what each individual's daily wage would be [20, 21].

The methodological decisions about when and how to measure, value and assign a monetary value to productivity losses will impact the total cost estimates [7]. This, in turn, will impact the incremental cost of an intervention, and therefore the results of the cost-effectiveness analysis [22]. While an increasing number of economic evaluations are including productivity losses, a consensus has yet to be reached on best practices for how to estimate these costs when included [23]. A recent review provided a comprehensive list of instruments that can be used to measure time losses owing to illness across all settings; however, it did not describe the valuation method chosen, nor the method for assigning a monetary value [15]. A recent review of economic evaluation guidelines in LMICs found that while 38%

(5/13) of guidelines stated that productivity losses should be included, only 40% (2/5) provided explicit methods on how these should be estimated [24]. Given the particular challenges in LMICs, this study aims to systematically review the methods used for valuing productivity losses due to illness in published economic evaluation and cost studies in LMIC settings, with a focus on methods used to assign a monetary value.

2 Methods

2.1 Study Design

The review was conducted following guidelines from the Joanna Briggs Institute [25] and reported using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines [26]. The protocol for this study was registered with the international prospective register of systematic reviews (PROSPERO) (#CRD4202265952).

2.2 Search Strategy and Selection Criteria

Three key concepts were combined in the search strategy: ‘productivity losses’, ‘economic evaluation’ and ‘low- and middle-income countries’. For low- and middle-income countries, we used the Cochrane filter (<https://epoc.cochrane.org/lmic-filters>), adapted from the 2019–2020 World Bank classification [27]. All keywords were combined using Boolean operators and mapped with Medical Subject Headings (MeSH) to capture any missing synonyms and relevant abbreviations, creating the search strings in Supplementary Material 1. The following electronic databases were searched: PubMed, Cochrane Library and Web of Science Core Collection. The search was performed in April 2022 without restriction on the date of publication to include the most relevant papers and minimise the risk of missing critical older studies.

Any costing or economic evaluation study conducted in an LMIC that included an estimation of productivity losses was included in this review. No diseases or interventions were specified since this systematic review aimed to assess the methodological variation in estimating productivity losses. All publication dates were checked to ensure that the country’s status was classified as an LMIC according to the World Bank classification when the study was conducted [27]. Studies that considered multiple countries, including high-income countries, were included but only if data from LMICs could be extracted.

Studies that included patient (or caregiver) productivity or time costs were considered for inclusion, while studies that did not include these costs were excluded. If studies stated that they performed a valuation of productivity losses but did

not clearly specify how they estimated the monetary value of time losses, they were excluded in the full-text screening. In addition, studies were excluded if written in a language other than English. Editorials, commentaries, reviews, opinions, posters, and historical articles were also excluded.

Records retrieved during the searches were imported to Endnote before duplicate records were removed [28]. The records were then exported into Covidence for title and abstract screening by two independent reviewers (ES and SCS) [29]. Disagreements were resolved by discussion until a consensus was reached. Next, full-text articles were reviewed to determine whether they should be included. This stage was conducted by the same two reviewers, with a third reviewer (AD) consulted for a final decision on any disagreements. To identify additional eligible studies for full-text review, a citation search was performed on the included studies that had cited original papers on productivity loss valuation that had not been included in the previous search results [30].

2.3 Data Extraction and Analysis

A qualitative synthesis was performed by systematically summarising the information extracted from the included studies. One reviewer (ES) extracted data from the included studies into prepared tables in Covidence, and a second reviewer (SCS) validated all the extracted data to assure accuracy. The data extraction was then exported to Excel for further data management and synthesis. Data extracted included the country, year of publication, study perspective, type of study (cost-of-illness or economic evaluation) and type of productivity loss (absenteeism, presenteeism or premature mortality). Absenteeism is when an individual needs to take time off from work (or other usual activities) due to illness. In contrast, presenteeism refers to when an individual goes to work while ill and, therefore, is less able to perform work duties [6].

Identified methodological aspects for estimating productivity loss included approaches used to measure and value the productivity losses, and methods of assigning a monetary value to the productivity losses. Methods for assigning a monetary value to productivity losses indicate the way that productivity losses were monetized (e.g. self-reported income or market wages). In this review, market wages include the use of a minimum, median or mean wage found in either national or local sources. We also extracted information on whose productivity losses were considered (patient, caregiver or both), patient age group (children, adults or retirees) and category of income status (paid work, unpaid work, students or retirees).

2.4 Quality Assessment of Included Studies

A quality assessment checklist was adapted from a previous systematic review that focused on cost-of-illness and cost-effectiveness studies and included the estimation of productivity losses [31]. This checklist included whether the study's scope, data analysis methods and results were reported (Supplementary Material 2). In the data analysis criteria, we assessed whether studies provided appropriate details on the cost data sources, perspective, cost year, sensitivity analysis and discounting [32]. The results criteria considered whether lost time was reported separately from the associated monetary value and whether studies reported the total costs of the productivity losses as well as the cost of productivity losses per person. The first reviewer performed the quality assessment, and the second reviewer verified the accuracy of all data afterwards. The quality assessment results were summarised as the percentage of studies that fulfilled the criteria.

3 Results

The search identified 4298 studies and covered publications from 1 March 1990 to 11 April 2022. After title and abstract and full-text screening, 281 publications were included for data extraction (Fig. 1). The most common exclusion criterion was the study omitting a clear explanation of methods used to estimate productivity losses (27%, 43/160). A complete list of the included studies and their characteristics can be found in Supplementary Material 3. Most studies were from Asia (45%, 125/281) and Africa (32%, 89/281) (Table 1). The number of eligible studies increased over time, with only one study from before 1991 [33], while 83% (232/281) of included studies were published after 2010. The majority were cost-of-illness studies (80%, 225/281), while the rest were economic evaluations (20%, 56/281).

Many studies clearly stated the use of the societal perspective (49%, 138/281). A further one-fifth of the studies were assumed to be from a societal perspective despite not explicitly stating so, given their inclusion of both provider (or payer) and patient (or household) perspectives (20%, 56/281). In addition, 10% (28/281) of studies used a patient perspective with another 12% (33/281) of studies taking the household perspective, including lost productivity for caregivers. Overall, 26 studies (9%) presented results using more than one perspective (e.g. societal and provider perspective).

3.1 Assessment of the Quality of Included Studies

All included studies satisfied the quality assessment criteria for study scope by clearly stating the research question, target population, study design, and where the data came from (Table 2). In total, 85% (239/281) of the included studies performed primary cost data collection, 10% (28/281) cited cost values from other studies and 5% (14/281) used a mix of primary data collection and citation of previous studies.

Some studies did not fulfil the quality assessment criteria for data analysis and results. For example, only 48% (134/281) stated the total time losses in the result section. Most studies (96%, 269/281) clearly specified the year for which the costs were reported. In addition, 94% (265/281) of studies explicitly mentioned the total cost of productivity losses in the results, and 72% (202/281) provided the mean or median cost value of productivity losses. There were 61 studies that considered interventions or costs over multiple years, of which 80% (49/61) reported applying a discount rate to the results. Moreover, 8 out of those 61 studies were economic evaluation studies; all of these stated that discounting was applied in the analysis.

Overall, only half (51%, 143/281) of studies performed at least one type of sensitivity analysis. In total, 39% of the cost-of-illness studies (88/225), and almost all economic evaluation studies (98%, 55/56) completed a sensitivity analysis to assess the uncertainty of parameters or models to the result. Among the economic evaluation studies, 11% (6/56) evaluated whether the use of a different study perspective and the inclusion of productivity losses impacted the incremental cost-effectiveness ratio. All six of those studies found that the inclusion of productivity losses resulted in a higher probability of the intervention being cost-effective [34–39]. We generally found that the quality of conduct and reporting increased over time for the data analysis criteria while decreasing or stagnated over time for the results criteria (Table 2).

3.2 Methods for Measuring and Valuing Productivity Losses

Half of the studies estimated only the productivity losses of patients (141/281), while 13% (37/281) reported caregiver losses and 37% (103/281) reported both patient and caregiver losses (Table 3). The majority of papers reported productivity losses in adults (230/281) with a further 8% (21/281) of papers reporting productivity losses for retirees. All studies that included retirees reported their time losses owing to illness. Among the 30 studies (11%) focused on diseases in children, only 23% (7/30) reported the time losses of children, while the rest

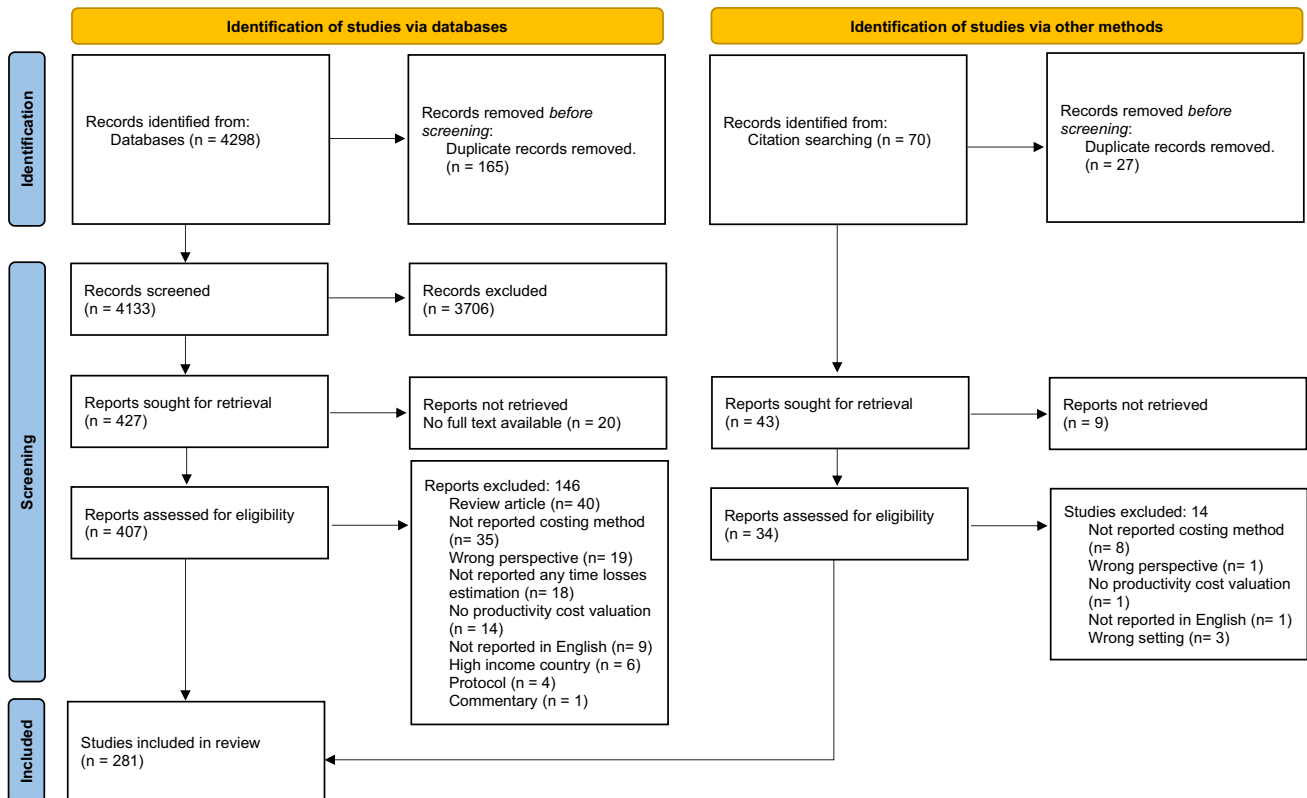


Fig. 1 PRISMA flow diagram

Table 1 General characteristics of the included studies (N = 281)

Characteristic	n	%
Region		
Africa	89	32%
Asia	125	45%
Europe	7	2%
Multi-country	23	8%
North and Central America	7	2%
Oceania	1	0.4%
South America	29	10%
Date of publication		
Before 1991	1	0.4%
1991–2000	11	4%
2001–2010	37	13%
2011–April 2022	232	83%
Type of study		
Cost-of-illness	225	80%
Economic evaluation	56	20%
Analysis perspective		
Household	33	12%
Patient	28	10%
Societal	138	49%
Societal, not explicitly mentioned	56	20%
More than one perspective included	26	9%

only reported the time losses of caregivers. No studies looked at productivity losses across all age groups.

The most reported type of productivity loss was absenteeism (67%, 187/281). Three studies (1%, 3/281) reported only presenteeism, 24 studies (9%) reported both absenteeism and presenteeism, and 15 studies (5%) reported only long-term disability (premature death or permanent disability). Only 16% (46/281) of studies included both temporary and long-term disability to consider the dual impact of the disease on morbidity and premature mortality.

Over half (58%, 164/281) of the studies did not explicitly mention what overall approach was used to estimate productivity losses (Table 3). With slightly more than one-third (39%, 109/281) of studies using the human capital approach, it was the most frequently used approach of those that were specified. Other methods less frequently employed were friction cost (1%, 3/281), willingness to pay (1%, 3/281), and the application of both human capital and friction cost approaches (0.7%, 2/281).

3.3 Methods for Assigning a Monetary Value to Productivity Losses

Table 4 reports methods used to assign a monetary value, including how these methods varied across the following

Table 2 Assessment of the quality of included studies overall and over time

Criteria	2000 and before		2001–2010		2011–2022		Overall	
	n/N	%	n/N	%	n/N	%	n/N	%
Scope								
The research question is clearly stated	12/12	100%	37/37	100%	232/232	100%	281/281	100%
The population of the study is clearly defined	12/12	100%	37/37	100%	232/232	100%	281/281	100%
Data analysis								
The source of cost data is specified	12/12	100%	37/37	100%	232/232	100%	281/281	100%
Primary data collection	11/12	92%	30/37	81%	198/232	85%	239/281	85%
Cited other studies	0/12	0%	4/37	11%	24/232	10%	28/281	10%
Mixed	1/12	8%	3/37	8%	10/232	4%	14/281	5%
The study perspective is specified	7/12	58%	29/37	78%	189/232	81%	225/281	80%
The cost year for reported results is specified	9/12	75%	36/37	97%	224/232	97%	269/281	96%
The sensitivity analysis results are reported	2/12	18%	20/37	54%	121/232	52%	143/281	51%
Discounting is applied when appropriate ^a	4/7	57%	8/8	100%	37/46	80%	49/61	80%
Results								
The number of days lost or time off is specified	7/12	58%	20/37	54%	107/232	46%	134/281	48%
The total cost of productivity losses for the entire study population is specified	10/12	83%	36/37	97%	213/232	92%	265/281	94%
The mean or median per person cost of productivity losses is specified	7/12	58%	29/37	78%	166/232	72%	202/281	72%

^aApplied when the time horizon was longer than 1 year ($N = 61$ studies overall)

populations: formal workers, informal workers, unpaid workers, school-aged children, and retirees. The methods used by each study to assign a monetary value can be found in Supplementary Material 3. Since some of the included studies used more than one method to assign a monetary value given the different population categories, there were more methods of assigning a monetary value than there were studies ($N = 312$). Only one cost of illness study completed a sensitivity analysis with more than one method for estimating the monetary value by applying minimum market wages, median market wages and GDP per capita [40].

While a range of methods were applied to assign a monetary value to productivity losses, half of the included studies used market wages (157/312). Of these, local market wages were applied in 4% of studies (13/312) as a way of accounting for different wage rates across provinces or districts within a country. Among those countries that used local market wages, 54% (7/13) were from Africa, while the rest were from Asia. Other methods used to assign a monetary value to productivity losses included self-reported income (28%, 86/312), macroeconomic measures (15%, 48/312), daily production value (2%, 6/312), willingness to pay for work replacement (1%, 3/312), proportion of the market wages for formal workers (3%, 9/312), conversion from annual tuition cost per student into a daily rate (1%,

2/312) and conversion from pension income into a daily rate (0.3%, 1/312).

Two approaches were used for self-reported income (28%, 86/312), including the estimated last income (27%, 84/312) and income changes (1%, 2/312). The self-reported last income asks what the payment amount was for the last period of income, while the self-reported income changes focused on the changes in cash earnings before and after the disease episode.

Macroeconomic measures included applying either the gross domestic product (GDP) or the gross national income (GNI) per capita per day to the reported time losses. While the GDP is a standard measure to capture a country's economic activity during a particular year, the GNI is calculated by adding a country's GDP to its residents' income from abroad [41–43]. While GDP per capita per day was used in 11% (34/312) of studies, GNI per capita per day was applied in 4% (14/312) of studies.

In the six studies (2%) using daily production value, overall household income was estimated, including the monetary value of a previous harvest and sales of any products or services over a certain period of time [35, 43–45]. For example, for farmers, the amount of sales in a year or in a month was converted into a daily value in alignment with their time lost due to illness [46].

Table 3 Methods for estimating productivity losses in the included studies ($N = 281$)

	<i>n</i>	%
Subject of productivity losses valuation		
Patient	141	50%
Caregiver	37	13%
Patient and caregiver	103	37%
Patient age group		
Adult	230	82%
Children	30	11%
Retiree	21	7%
Time unit for the measurement of productivity losses		
Daily	169	60%
Monthly	4	2%
Yearly (including lifetime loss)	62	22%
More than one time-unit (i.e., daily and lifetime loss)	46	16%
Type of lost productivity		
Absenteeism	187	67%
Presenteeism	3	1%
Temporary disability ^a	24	9%
Long-term disability ^b	15	5%
Temporary and long-term disability	46	16%
Not specified	6	2%
Approaches used to measure and value productivity losses		
Human capital approach	109	39%
Friction cost approach	3	1%
Willingness to pay	3	1%
Human capital and friction cost approach	2	0.7%
Not specified	164	58%

^aTemporary disability refers to absenteeism and presenteeism

^bLong-term disability refers to either premature mortality or permanent disability

For the three studies (1%) that used the willingness to pay approach, the patient or caregiver provided the maximum daily amount of money that they would be willing to pay to hire a substitute worker to replace the sick household member [43, 47, 48].

Among 30 studies that included school-aged children, the majority did not value their time losses (77%, 23/30), even though they reported the total time losses due to illness. In those studies, only caregivers' time was valued. The remaining studies divided the annual student tuition cost by the number of school days to calculate a daily value (7%, 2/30) or by using a proportion of the market wages of formal workers (16%, 5/30). The proportion of market wages of formal workers method was used in 16% (5/30) of studies that focused on children and 10% (2/21) of studies focused on retirees. In these studies, it was assumed that individuals received a specified percentage

of national market wages (e.g. 50% of minimum wage) [40, 49]. Similarly, most studies that included retirees (76%, 16/21) reported their time losses but only valued caregivers' time. For the studies which estimated the productivity losses for retirees, the monetary value was estimated through self-reported last income (10%, 2/21), a proportion of the market wages of formal workers (10%, 2/21), and by dividing the pension income into a daily value (4%, 1/21).

Different methods were used to assign a monetary value for formal and informal workers in 21 studies (7%, 21/281). One additional study assigned a monetary value for informal workers only (Table 4). While the self-reported income method was used in the majority of studies with formal workers (71%, 15/21) it was applied to only two of the studies with informal workers (9%). The market wage method was used in the remaining 29% of studies with formal workers (6/21), and most studies with informal workers also used this method (67%, 14/22). The rest of the studies including informal workers used either the daily production value (5%, 1/21), the willingness to pay for work replacement (5%, 1/21) or a proportion of the market wages of formal workers (9%, 2/22).

4 Discussion

This review identified 281 studies that reported productivity losses in LMIC settings. The majority of studies reported productivity losses for adults only, focusing on absenteeism. While half of the studies reported productivity losses for patients only, just over one-third reported time losses for patients and caregivers. Most studies in our review did not specify which overall approach was used to measure and value productivity losses (e.g. friction cost approach), indicating opportunities for improvement in reporting standards for productivity losses. Of the studies that reported this, the human capital approach was most frequently used. For assigning a monetary value to productivity losses, the market wage method, self-reported wages and macroeconomic measures were the most frequently used.

A quality assessment of the included studies found that although all studies clearly specified their research question and study design, only 42% of studies described the overall approach used to measure and value productivity losses (e.g. friction cost). Additionally, whilst the total cost value of productivity losses was shown in 94% of studies, only 48% of those specified the total time losses due to illness and 72% specified the mean or median per person cost of productivity losses. Without the specification of total time losses, it is challenging to determine what monetary value was assigned

Table 4 Methods used to assign a monetary value of productivity losses due to illness for all studies ($N = 312$) and for a subset of the included studies that reported methods for specific category ($n = 90$)

Monetary valuation method	Overall methods used		Studies that stated valuation method by category of income status ($n = 90$) ^a									
	$(N = 312)$		Formal workers ($n = 21$)		Informal workers ($n = 22$)		Unpaid work ($n = 18$)		School-aged children ($n = 30$)		Retirees ($n = 21$)	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Market wage	157	50%	6	29%	14	67%	16	89%	0	0%	0	0%
National market wage	144	46%	6	27%	11	53%	15	83%	0	0%	0	0%
Local market wage	13	4%	0	0%	3	14%	1	6%	0	0%	0	0%
Self-reported income	86	28%	15	71%	2	9%	0	0%	0	0%	2	10%
Self-reported estimated last income	84	27%	15	71%	2	10%	0	0%	0	0%	2	10%
Self-reported income changes	2	1%	0	0%	0	0%	0	0%	0	0%	0	0%
Macroeconomic measures	48	15%	0	0%	1	5%	1	6%	0	0%	0	0%
GDP per capita per day	34	11%	0	0%	1	5%	1	6%	0	0%	0	0%
GNI per capita per day	14	4%	0	0%	0	0%	0	0%	0	0%	0	0%
Willingness to pay for work replacement	3	1%	0	0%	1	5%	1	6%	0	0%	0	0%
Daily production value	6	2%	0	0%	1	5%	0	0%	0	0%	0	0%
Proportion of the market wages of formal workers^b	9	3%	0	0%	2	9%	0	0%	5	16%	2	10%
Conversion from annual tuition cost per student into a daily rate	2	1%	0	0%	0	0%	0	0%	2	7%	0	0%
Conversion from pension income into a daily rate	1	0.3%	0	0%	0	0%	0	0%	0	0%	1	4%
Not valued	n/a	n/a	0	0%	0	0%	0	0%	23	77%	16	76%

The overall number of methods used is greater than the 218 included studies because some studies used more than one method of assigning a monetary value

GDP gross domestic product, GNI gross national income, n/a not applicable

^aThe other 191 studies carried out the valuation of productivity losses but did not specify the population category

^bIt was assumed that subjects received a specified percentage of the national market wages (e.g., 50–80% of minimum wages)

for the productivity loss per person (or episode), particularly if the mean or median per person cost is not specified.

While market wages were used to assign a monetary value to productivity losses in half of the studies, this choice relies on the availability of data on minimum or average wages at the country or local level for the study setting. When a single value is applied to the paid or entire population, this ensures that the costs of time losses are considered equal. By sidestepping questions about income, data collection is limited to time losses. High-income country settings are more likely to have well-established data infrastructure that can provide market wage estimates. For instance, in the United States, the Bureau of Labor Statistics routinely releases average gender- and age-specific wages [50], the German Federal Statistical Office provides the average hourly wage rate by age group [51], and the United Kingdom Office of National Statistics presents average weekly earnings by sector [52]. When market wages are not available by gender, these can be reduced for women to reflect the gender pay gap. For example, one study included in our review from

Iran assumed that women in paid employment made 70% of men's market wages with a further reduction to 30% for women who did not work outside of the home [53]. While accounting for characteristics, such as gender, when using market wages will result in a more accurate financial value of the time losses, it may result in a less equal distribution of health resources [13]. Three studies in our review were able to apply market wage values by sector [54–56]. In addition to income statistics by sector, Indonesia includes a salary range for informal workers [14]. We also found 13 studies from Africa and Asia that were able to go beyond national market wages and apply local market wages at the provincial or district level, accounting for geographical variation in economic status [57, 58].

Self-reported income was the second most used method in our review (28%), enabling the results to directly reflect the patient population, including differences by gender, location or sector. This was the most commonly used method for formal workers (71%). In studies that explicitly examined productivity losses in informal workers, we found that only

9% used self-reported income; the majority of these studies chose market wages instead (67%). This likely reflects the challenges of collecting self-reported income in informal workers who may have more than one source of income or daily income fluctuations [59]. While 98% of studies using self-reported income used the estimated last income, only two used self-reported income changes. A consideration when deciding whether to use self-reported income changes is that this method may require a longer study period for data collection than for estimated last income. For example, a post-discharge interview to capture the total income lost during the treatment or illness will need to be included [60, 61]. Self-reported income is likely to be easier to implement in high-income countries where the proportion of informal workers is considerably lower, at around 18% compared with 70% in LMICs [12]. If self-reported income is chosen, it is possible that resources will be allocated more favourably to those who are in well-paid employment and that this impact will be more profound in LMIC settings due to the higher proportion of the population in unpaid or informal work.

The final method in our review that was commonly used was macroeconomic measures (15%), such as daily GDP or GNI per capita. The use of these measures likely reflects the certainty and ease of obtaining data. Macroeconomic measures can be particularly useful for ensuring consistency when comparing across countries. Macroeconomic measures, however, were not designed for this use and do not reflect living standards, which will vary across countries [62]. Another key issue is that these measures do not include the contributions of informal or unpaid workers, which are more common in LMICs [62]. Despite this limitation, macroeconomic measures provide a measure that is easy to apply to the entire population, including informal and unpaid workers.

As noted in the review by Jiang et al., most economic evaluation guidelines did not recommend the inclusion of productivity losses for unpaid work, in part because it is challenging to assign a monetary value to these time losses [3]. Our review found that the majority of studies that included productivity losses for unpaid work used the market wage method. Most studies that included school-aged children and retirees did not value these time losses. The inclusion of productivity losses only for paid work in economic evaluations has the potential to favour interventions that improve health outcomes for paid populations as opposed to those who are unable to work, including children and retirees [3], exacerbating gender-based and socio-economic inequalities [13]. Accordingly, future methodological research could focus on if, when and how to include productivity losses for unpaid populations to ensure equity. Given the challenges, new methods may need to be developed.

We found that most studies that included productivity losses were cost-of-illness studies (80%). For the 56

economic evaluations that were included, only six (11%) performed a sensitivity analysis on the impact of including productivity losses on the results. These six studies consistently found that the inclusion of productivity losses resulted in a higher probability that the intervention would be cost-effective [34–39]. This finding suggests that the inclusion of productivity losses will likely improve the cost-effectiveness result, highlighting the importance of consistent guidance on how to measure, value and assign a monetary value to productivity losses to improve comparability across studies, particularly when a large proportion of the population is in unpaid or informal work.

This review may help inform decisions about which methods for estimating the monetary value of productivity losses should be used in future costing and economic evaluation studies in LMIC settings. The first key consideration is around whether time losses should be included for all types of populations, including those who are in unpaid or informal work. While the exclusion of costs for unpaid populations will better reflect the financial impact of illness, this may exacerbate inequities. This decision should reflect what is valued by society. For example, a subsistence farmer who is not paid performs work that is crucial to the livelihood of that household. Does society value that person's ability to provide food for their family less than someone who uses paid employment to feed their family? The second key consideration is around data availability and what is practical to implement. This involves determining whether market wages are available, and, if so, whether these are deemed appropriate for the patient population. It also involves deciding whether it is feasible to collect self-reported income, including the consideration of whether there may be issues with recall bias, whether it is culturally acceptable to ask about income and whether the population is likely to respond truthfully to questions about income. Furthermore, if the population has a high proportion of informal workers, questions tailored to capture their income will need to be included, increasing the complexity of the survey. If the patient population includes those who are not in paid work, a decision will need to be made about if and how the monetary value will be estimated for their time losses. If the market wage and self-reported income methods are not feasible, then the willingness to pay method or macroeconomic measures may need to be used.

Given the complexity of deciding which methods for estimating the monetary value of productivity losses is best, future research could include a sensitivity analysis to explore the impact of multiple methods on the results [63]. While only one paper in our review compared results across different methods [40], this recommendation echoes a review on methods for valuing caregiving in economic evaluations [64]. The cost of illness study

identified in our review that applied different methods for estimating the monetary value found that the median market wage and GDP per capita methods were 3.7 and 8.6 times higher, respectively, than the minimum market wage in Mexico [40]. The sensitivity analyses could be taken further to look at the impact of including paid workers as compared with excluding them, explaining the impact these methodological differences have on the results and, where possible, on equity.

Our review has a number of limitations. While we searched three major medical databases, some studies from the wider economics literature may have been missed. Additionally, ten studies that were not published in English were excluded. Our review did not extract data on measurement tools used to measure time losses. Our review complements a recent systematic review by Hubens et al. that focused on instruments used to measure time losses, finding 49 tools [15]. The authors provide a comprehensive list of instruments, finding that the most frequently used tool was the work productivity and activity impairment questionnaire [15]. The work productivity and activity impairment questionnaire is a patient-reported quantitative assessment of the amount of absenteeism, presenteeism and daily activity impaired by either general or specific health problems [65]. Finally, we did not assess variation of valuation method by disease type or specific health problem, as it was assumed that this would reflect the patient population rather than the disease.

5 Conclusions

Although many cost-of-illness and economic evaluation studies conducted in LMICs applied the societal perspective and included productivity losses in their analyses, most studies did not clearly specify details on the overall approach used or total time losses due to illness, demonstrating the need for improvement in reporting standards for productivity losses. Future studies should consider the inclusion of a sensitivity analysis to explore the impact of different methods for estimating the monetary value of productivity losses on the overall costs. New methods and guidelines may need to be developed to overcome the practical and ethical challenges of including productivity losses in populations with a large proportion of the population in informal or unpaid work.

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Declarations

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Ethics approval The study activity has been found to meet the criteria and requirements for a NEGLIGIBLE RISK activity as outlined in the NHMRC National Statement on Ethical Conduct in Human Research (2007). The Chair of the Human Research Ethics Committee (HREC) has advised that a full ethical review by a HREC is not required under the file reference Ery Setiawan 05.04.22.

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Author contributions AD developed the study concept and design; ES and SCS performed data acquisition; ES, SCS and AD performed data analysis and interpretation; ES, SCS, KT and AD drafted the manuscript; AD, NC, KT and SCS critically revised the paper for important intellectual content; AD and KT obtained funding; AD, NC and KT performed study supervision.

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