



Multiplier Effects and Compensation Mechanisms for Inclusion in Health Economic Evaluation: A Systematic Review

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Accepted: 15 July 2023 / Published online: 17 August 2023
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Abstract

Background Compensation mechanisms and multiplier effects may affect productivity losses due to illness, disability, or premature death of individuals. Hence, they are important in estimating productivity losses and productivity costs in the context of economic evaluations of health interventions. This paper presents a systematic literature review of papers focusing on compensation mechanisms and multiplier effects, as well as whether and how they are included in health economic evaluations.

Methods The systematic literature search was performed covering EconLit and PubMed. A data-extraction form was developed focusing on compensation mechanisms and multiplier effects.

Results A total of 26 studies were included. Of these, 15 were empirical studies, three studies were methodological studies, two studies combined methodological research with empirical research, four were critical reviews, one study was a critical review combined with methodological research, and one study was a cost–benefit analysis. No uniform definition of compensation mechanisms and multiplier effects was identified. The terminology used to describe compensation mechanisms and multiplier effects varied as well. While the included studies suggest that both multipliers as well as compensation mechanisms substantially impact productivity cost estimates, the available evidence is scarce. Moreover, the generalizability as well as validity of assumptions underlying the calculations are unclear. Available measurement methods for compensation mechanisms and multiplier effects differ in approaches and are hardly validated.

Conclusion While our review suggests that compensation mechanisms and multiplier effects may have a significant impact on productivity losses and costs, much remains unclear about their features, valid measurement, and correct valuation. This hampers their current inclusion in economic evaluation, and therefore, more research into both phenomena remains warranted.

1 Introduction

Rising healthcare expenditures pose an important challenge to policymakers. Faced with limited healthcare budgets, ageing populations, increased demand for healthcare, and increasing treatment possibilities, decisions need to be made about which interventions can be funded or reimbursed in

collectively financed health systems [1–4]. Hence, there is a growing interest in health economic evaluation as a tool supporting such difficult decisions. Health economic evaluation is defined as a comparative analysis of alternative interventions in terms of their costs and benefits and, essentially, provides insights into the cost-effectiveness or value an intervention offers compared to a relevant comparator [3, 5]. The most common type of health economic evaluation is cost-utility analysis (CUA), in which health outcomes are expressed in quality-adjusted life-years. The exact operationalization of CUA varies across jurisdictions and typically strongly depends on national guidelines for health economic evaluations [6]. An important difference between such guidelines is which perspective is prescribed to be taken in the evaluation. Often, either a healthcare (or public payer) perspective or a societal perspective is prescribed. When a health economic evaluation is performed from a healthcare perspective, broadly speaking, only costs

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Key Points for Decision Makers

The systematic review highlights the importance of considering compensation mechanisms and multiplier effects in health economic evaluations. Both factors have been found to significantly impact productivity cost estimates. Decision makers should recognize the potential influence of these factors on productivity losses and costs.

Despite recognizing the importance of compensation mechanisms and multiplier effects, the review points out unresolved methodological issues in their estimation. The evidence currently available showed a wide range of estimated impacts with varying assumptions and contextual factors. Decision makers should be cautious when interpreting these factors in economic evaluations due to the lack of clear understanding and consistent evidence.

The review highlights the need for further research and methodological development to address the limitations and uncertainties associated with the impact of compensation mechanisms and multiplier effects. Decision makers should prioritize supporting research efforts aimed at clarifying the definitions, identification, measurement, and valuation of these factors. This may include qualitative research to understand the dynamics of absenteeism, presenteeism, and productivity in different contexts, as well as the development of standardized measurement instruments and methodologies for accurate estimation. Improved methodologies will enable valid inclusion of compensation mechanisms and multiplier effects in economic evaluations, leading to better-informed health policy decisions.

falling on the healthcare budget are taken into account and only health effects are seen as relevant benefits. The underlying goal of the policymaker is then assumed to be to maximize health benefits from a given healthcare budget. When a health economic evaluation is performed from the societal perspective, all relevant societal costs and benefits are taken into account, regardless of who pays the costs and who receives the benefits [7–9]. The underlying goal of the policymaker is then assumed to be to ultimately maximize social welfare through allocation decisions. The societal perspective may be seen as conforming more closely with the welfare economic roots of economic evaluation, although it may still be operationalized in line with extra-welfarism [10, 11]. Given the aim of health economic evaluations to

inform actual healthcare decisions, it is important that their methodology is clear and justified.

An important example of such a methodological issue is that of the measurement and valuation of productivity costs. Productivity costs are defined as costs related to a person's productivity loss of paid and unpaid work due to disease resulting from illness, disability, or premature death of productive individuals [12]. When taking a societal perspective, these productivity costs should be included in a health economic evaluation whenever productivity is expected to be relevantly affected by the intervention. Productivity costs have been shown to be a significant part of total costs in many economic evaluations and can have a profound impact on the final cost-effectiveness ratio [13, 14]. This highlights the importance of accurate estimation of productivity costs, which has been shown to be quite challenging in terms of their identification, measurement, and valuation [15–20].

Estimates of productivity costs typically focus on paid work and, within that context, especially on production losses related to absenteeism from work. Increasingly, productivity costs due to presenteeism (being less productive while at paid work due to health problems) are also included, which may become more important as working from home becomes more common [21]. Moreover, productivity costs related to unpaid work still receive little attention—both methodologically and in actual economic evaluations [22].

In estimating productivity costs due to absenteeism and presenteeism in paid work, important unresolved issues remain. Next to debates about valuation methods (e.g., the human capital versus the friction cost method) [23–25], this also pertains to the impact of so-called multiplier effects and compensation mechanisms on production losses and productivity costs.

Multiplier effects can be described as the effects on overall or 'team output' due to absenteeism or presenteeism of a worker with health problems [18]. To illustrate, consider a software development team in which a key developer with unique knowledge is absent due to illness. In that case, the full development team may be less productive due to interdependencies in the development process. Multiplier effects are relevant in this example as the reduced productivity or absence of one individual negatively affects the productivity of others, leading to a larger overall loss in productivity.

Compensation mechanisms are described as compensation for lost labor, referring to situations in which a person's work is compensated [17, 18, 28, 29]. For example, if an employee is absent from work due to a health problem, his or her colleagues, or temporary hires, may take over certain tasks in order to keep the production levels constant. In certain types of jobs, it may also be possible for the absent employee to make up for lost work after his or her return to work. In such cases, compensation mechanisms mitigate the production losses due to absence.

Regarding multiplier effects, it has been argued that conventional estimates of productivity losses at the individual level may *underestimate* total productivity losses, as reduced productivity of one person may negatively affect the productivity of others [26]. Compensation mechanisms, on the other hand, refer to a potential *overestimation* of production losses, since the absence or presenteeism of a worker with health problems may be compensated by colleagues, temporary workers, or the ill employee him- or herself at a later moment [27]. This compensating for otherwise lost work obviously reduces production losses. Whether it also reduces productivity *costs* depends on the costs of the compensation mechanisms themselves [30].

One of the unresolved issues in measuring productivity losses and costs is how to deal with multiplier effects and compensation mechanisms in calculating productivity losses and costs in health economic evaluations. Due to measurement challenges, compensation mechanisms and multiplier effects are usually not included in such evaluations, despite their potential influence on productivity cost estimates and final cost-effectiveness results. [13, 16, 20, 31]. Neglecting compensation mechanisms and multiplier effects in the measurement of productivity losses and costs may lead to inaccurate estimation of the cost-effectiveness outcomes, which may ultimately lead to incorrect policy decisions.

Currently, the underlying mechanisms of compensation mechanisms and multiplier effects as well as whether and how they influence productivity losses and costs are understudied [16, 18, 27]. Understanding how compensation mechanisms and multiplier effects should be identified, measured, and valued, as well as what their impact is on productivity losses and costs, remains important. Although previous research has studied the inclusion of compensation mechanisms and multiplier effects in health economic evaluations, clear guidance on whether and how to consider multiplier effects and compensation mechanisms in this context is lacking [17]. The current study, therefore, aims to provide an overview of the currently available literature focusing on compensation mechanisms and multiplier effects, as well as on their impact on productivity cost estimates.

2 Methods

2.1 Databases and Key Concepts

Studies focusing on compensation mechanisms and multiplier effects were identified through a systematic literature search. A systematic search was conducted in the electronic bibliographic databases of EconLit and PubMed, in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement [32].

The search strategy included the following keywords: (1) compensation mechanisms or multiplier effects, (2) productivity costs or productivity losses, and (3) identification, measurement, validation, or impact. Also, synonyms of multiplier effects and compensation mechanisms were used in the search strategy, such as team output and team effect. The search queries are presented in the appendix. The searches were conducted on February 28, 2023.

2.2 Inclusion and Exclusion Criteria

Studies were included if they were written in English and their full text was available. Moreover, they needed to meet one or more of the following inclusion criteria, evaluated first based on title and abstract:

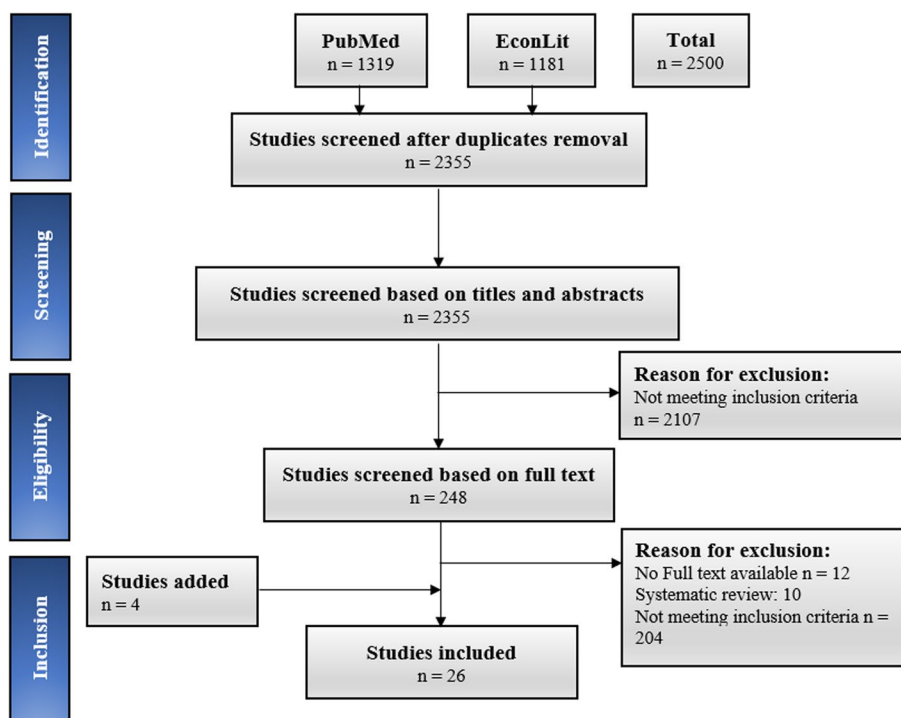
1. Multiplier effects or compensation mechanisms were mentioned.
2. Measurement methods of multiplier effects or compensation mechanisms were investigated or mentioned.
3. Factors influencing multiplier effects and compensation mechanisms were investigated.
4. The impact of multiplier effects and compensation mechanisms on costs and productivity losses was investigated.

Systematic reviews were excluded, but their references were screened for relevant literature. Additionally, reference lists of included studies were reviewed for relevant additional literature.

2.3 Study Selection

First, all duplicated studies were removed from the identified studies in EconLit and PubMed using the EndNote de-duplicate function. Second, titles and abstracts of the retrieved studies were examined for relevance based on the above-specified inclusion criteria by two researchers independently (NH and KH). In case of unclarity or uncertainty, inclusion or exclusion was discussed between NH and KH. In case of doubt, the study was included for full-text review. Finally, full texts were obtained after the selection based on titles and abstracts. NH assessed whether the full-text studies met the inclusion criteria. In case of doubt, inclusion was discussed with LH. Furthermore, the reference lists of the selected studies and of the excluded systematic reviews were manually searched for potentially relevant additional literature by NH. Full-text extractions were independently conducted by three reviewers (LH, MK, NH). Disagreements were resolved by discussion between two or three of the reviewers (LH, MK, NH).

Fig. 1 PRISMA flow diagram of the systematic review. *PRISMA* preferred reporting items for systematic reviews and meta-analyses



2.4 Data Extraction and Analysis

A data extraction form was developed to extract relevant data from the selected studies regarding compensation mechanisms and multiplier effects. The following general aspects were extracted from the studies: title, authors, and year of publication. Also, the type of study was extracted, for instance, whether papers reported on an empirical study, a critical review or a study developing, or refining methodology. The latter was labeled as a methodological study. In addition, objectives, general methods applied in the included studies, and information on the role of multiplier effects and compensation mechanisms were collected, such as how these were identified, measured, and valued, and their impact on productivity losses and costs. Next, the conclusions and recommendations that were presented in the papers regarding multiplier effects and compensation mechanisms were extracted.

3 Results

3.1 Study Selection

A total of 2355 unique articles were identified from PubMed and EconLit. After title and abstract screening, 248 full-text papers were examined. Of these, 22 met the inclusion criteria. Additionally, four studies were added to the study after reviewing the reference lists of the excluded systematic reviews and the 22 already included studies. This resulted in

a total of 26 included studies. The PRISMA flow diagram of the systematic review is shown in Fig. 1.

3.2 Literature Overview

Table 1 provides an overview of the studies included in this review, listed in chronological order to illustrate how the research has evolved over time. The first identified study addressing compensation mechanisms was published in 1998, and the first study reporting on multiplier effects originates from 2002 [26, 29].

The 26 included studies were a mix of methodological papers, empirical studies, and critical reviews. Of these 26 studies, 15 were empirical studies aiming to estimate compensation mechanisms and multiplier effects in different contexts [18, 28, 29, 33, 36, 38, 39, 42, 46–49, 51–53], two studies combined methodological research with empirical research [19, 42], three studies were methodological studies [17, 26, 35], four were critical reviews [16, 27, 34, 40], one study was a critical review combined with methodological research [37], and one study was a cost–benefit analysis [45].

3.3 Definitions and Terminology

No clear uniform definition or operationalization of compensation mechanisms was observed in the identified literature. In their 1998 paper, Severens and colleagues operationalized compensation mechanisms by distinguishing between six different compensation mechanisms [29]:

Table 1 Included studies in chronological order

Authors, year of publication	Type of study	Objective	Methods	Topics addressed regarding ME and CM	Conclusions about ME/CM	Recommendations ME/CM	Lessons learned for HEE
[29] Severens et al., 1998	Empirical	To use a conservative approach to calculate productivity costs, taking CM in consideration	Data of 66 patients with dyspepsia were analyzed. Patients filled in questionnaires on absence from work	Definition CM; measurement methodology of CM; impact of CM on productivity cost estimates	The actual cost to society may be lower due to CM of productivity losses	Estimates including CM should be presented next to regular productivity cost estimates	CM can be relevant. Further research on the methods for measuring CM is needed
[33] Brouwer et al., 2002	Empirical	To find and refine appropriate methods for productivity cost measurement to use in economic evaluation, focusing on productivity costs before and after absence from paid work and CM	Employees of a Dutch trade firm completed a survey about productivity before and after absenteeism. The survey included some questions about compensation of missed work. Data of 51 respondents was analyzed	Exploring the application of CM measurement	There are different ways people try to compensate for production losses. These methods seem to differ between roles people have in a firm	CM seem important, and therefore more research in this area is needed	CM to reduce production losses in firms may have an influence on actual productivity costs. Further research is needed
[26] Pauly et al., 2002	Methodological	To specify a more general model of the incidence and effects of reductions in the lost work time based on available methods in published literature	Discussion paper on the development of a general model on reductions of work time based on the literature	Addressing the relevance of ME	The cost of lost work time can be substantially higher than the wage when perfect substitutes are not available to replace absent workers and there is team production, or a penalty associated with not meeting an output target	The wage rate should be adjusted for ME to estimate the actual productivity loss	ME can be relevant to include in HEE
[51] Rees et al., 2003	Empirical	To study the interdependence of workers in an empirical setting	Data from 3795 telephone sales workers at a single company were analyzed to assess interdependencies in co-workers' productivity. Productivity was defined as the sales figures	The interdependence of workers' productivity levels	Productivity is related to co-worker productivity. Interdependencies arise from financial compensation, peer pressure, supervision, and information exchange. Especially the productivity of trainees is influenced by the productivity of their co-workers	None provided	The productivity of employees is influenced by their colleagues' productivity

Table 1 (continued)

Authors, year of publication	Type of study	Objective	Methods	Topics addressed regarding ME and CM	Conclusions about ME/CM	Recommendations ME/CM	Lessons learned for HEE
[36] Jacob-Tacken et al., 2005	Empirical	To investigate the impact of CM on productivity cost estimates; to examine the relationship between reported compensating mechanisms and the duration of absence; to explore the level of agreement between supervisors and employees regarding the extent of compensation undertaken; to explore the relationships between compensating mechanisms and personal and occupational characteristics to determine their impact upon compensating mechanisms	A survey was conducted on employment status, absenteeism, and reduced productivity while at work among patients with persistent dyspepsia, chronic fatigue syndrome, psoriasis vulgaris, rheumatoid arthritis, and low back pain, and among employees of a pharmaceutical company. Data were analyzed of 763 patients and 153 employees	Different types of CM, impact of CM on productivity costs, relationship between CM and absence duration and personal and occupational characteristics	Lost work due to absenteeism is often compensated for without incurring productivity costs. Compensating mechanisms correlate with absence duration. Different compensating mechanisms were reported for different occupational mechanisms. Compensating mechanisms differ with personal characteristics and occupational characteristics	Conventional methods for calculating productivity costs should be adjusted. If compensating mechanisms are not measured, only include 30–55% of the productivity costs calculated using conventional methods. Further research regarding compensating mechanisms and productivity costs is needed	CM seem important and should be considered
[27] Koopmanschap et al., 2005	Critical review	To set the research agenda for productivity costs related to paid productivity in health economic valuations	A non-systematic review was performed describing several key topics in productivity cost methodology in HEE	The relevance of CM and ME	An important question that needs to be addressed is as follows: How does one measure and value the extent and costs of CM for absence from paid work using person-oriented instruments?	Existing and new instruments should be validated in numerous employee settings to measure CM (at least retest and analyzing interobserver variation). After this, the instruments could be applied in patient settings, with subsequent feasibility checks	Instruments need to be developed and well validated for inclusion of CM in productivity cost estimations

Table 1 (continued)

Authors, year of publication	Type of study	Objective	Methods	Topics addressed regarding ME and CM	Conclusions about ME/CM	Recommendations ME/CM	Lessons learned for HEE
[37] Koopmanschap, 2005	Methodological + critical review	To report on the development of a modular questionnaire for the measurement (and valuation) of productivity costs in patient and worker settings for use in economic evaluations	A description is provided on how the PRODISQ productivity cost measurement instrument is developed and tested	Types of CM, impact of CM on productivity costs, relationship between CM and absence duration	CM reduce productivity costs considerably and depend on the length of the absence episode. Employees appear to be a reliable information source for reporting CM in the case of sick leave	The CM module of the PRODISQ should be included in economic evaluations for HTA. Research is needed regarding the simultaneous occurrence of several CM	CM information can be collected by asking employees
[19] Nicholson et al., 2006	Empirical + methodological	To test the hypothesis that the cost or productivity loss associated with missed work varies across types of jobs with the specific characteristics; to estimate a 'multiplier' for a set of jobs of different types	ME were estimated for 35 jobs based on a telephone survey among 804 managers	The relevance of ME, the impact of ME on productivity cost estimates, estimating job specific ME for absenteeism	Managers think that workers who are hard to replace and who work in teams producing time sensitive output cause greater productivity loss, other things equal; the study illustrates a method for developing empirical estimates of job-specific wage multipliers for absenteeism	A similar study should be conducted for exploring the importance of ME in presenteeism	ME differ substantially between professions and jobs with different job characteristics
[45] Lo Sasso et al., 2006	Cost-benefit analysis	To construct a cost-benefit analysis of depression treatment under different workplace assumptions from an employer perspective	Productivity costs are calculated in a group of 198 employees treated for depression. Regular productivity cost estimates are compared with three scenarios including different ME	The impact of ME on productivity cost estimates	Return of investments for employers offering depression treatments to depressed workers are larger in professions characterized by team production, expensive labor substitutes, and/or output shortfall penalties and low turnover rates	None provided	ME can be influential on productivity cost estimates

Table 1 (continued)

Authors, year of publication	Type of study	Objective	Methods	Topics addressed regarding ME and CM	Conclusions about ME/CM	Recommendations ME/CM	Lessons learned for HEE
[43] Pauly et al., 2008	Empirical + methodological	To provide a general model to calculate whether the costs of lost work are greater than the wage of the ill workers and to estimate multipliers for absenteeism and presenteeism	Multipliers for absenteeism and presenteeism estimated on data from 790 US managers to determine the characteristics of various jobs and the relationship to costs of absenteeism and presenteeism	The relevance of ME, the impact of ME on productivity cost estimates, estimating job-specific ME for absenteeism and presenteeism	Jobs with high values of team production, high requirements for timely output, and difficult to substitute had significant higher ME	Further research needed into measurement of ME	ME differ strongly for different types of jobs. Further research is needed regarding the measurement of ME
[46] Sjøgaard et al., 2010	Empirical	To evaluate the empirical significance of presenteeism and absenteeism in terms of lost productivity using the event of rheumatoid arthritis	Patients of 11 hospital-based rheumatology clinics were invited to fill out a questionnaire of absence from work and presenteeism (the HLQ). The questionnaire (HLQ) included a module on CM of absence from work and presenteeism	Impact of CM on productivity costs, relationship	The value of productivity loss due to absence from work and presenteeism in rheumatoid arthritis was increased by nearly a factor 2 if CM included or not	Future empirical studies needed to strengthen methodological development of measuring presenteeism and correction for CM	Including CM could make a large difference in the estimates on productivity loss
[34] Zhang et al., 2011	Critical review	To review current measurement issues and valuation methods such as human capital and friction cost for estimating productivity loss due to illness	Review of the literature on measurement issues and valuation methods for estimating productivity costs	The relevance of ME and CM for HEE	ME and CM can be important. CM in normal working hours is likely not without costs	Information on job type, industry type, production process (team of individual, time sensitivity of the output, availability of perfect substitute (inside or outside of workplaces), and CM is required to estimate productivity loss	To estimate productivity loss including CM and ME, information is needed on job type, industry type, production process, time sensitivity of the output, availability of perfect substitute (inside or outside of workplaces), and CM is needed research is needed

Table 1 (continued)

Authors, year of publication	Type of study	Objective	Methods	Topics addressed regarding ME and CM	Conclusions about ME/CM	Recommendations ME/CM	Lessons learned for HEE
[18] Krol et al., 2012	Empirical	To increase knowledge on how diminished productivity is actually compensated within firms; to further investigate the association between CM and occupational and job characteristics; to explore how compensation and ME potentially affect productivity costs; to contribute to the discussion on how to increase accuracy of productivity cost estimates	Data were collected among 187 smokers living in the Netherlands about absenteeism CM and job characteristics. ME came from the paper by Nicholson et al. (2006) [19]. Respondents' professions were compared with the professions in the paper. If professions were a (near) match, the published ME was applied. Otherwise, the median multiplier of 1.28 was applied. Productivity costs were compared with and without CM and ME	Types of CM, impacts of CM and ME on productivity costs, relationship between CM and absence duration and personal and occupational characteristics	Both ME and CM are important to consider in the area of productivity cost research. To some extent, including ME and CM seem to level each other out	Further research to increase insight in these processes is critical before considering adopting adjustments for CM and ME as common standard	Adjusting productivity cost estimates for CM while ignoring ME, or the other way around, may potentially lead to incorrectly low or high productivity cost estimates. It may not be advisable to include one, but not the other
[35] Zhang et al., 2012	Methodological	To develop a questionnaire that aims to capture absence from work and workplace characteristics to estimate productivity losses from a societal perspective	Draft questionnaire was developed based on existing questionnaires and tested in a focus group. After refinements, the feasibility was assessed in 140 employed patients with rheumatoid arthritis. The questionnaire included team dynamics, availability of substitutes, time sensitivity, and CM	Measurement of CM and ME	Questionnaires for measuring productivity loss should capture job and workplace characteristics to measure absenteeism and presenteeism including ME and CM	Job characteristics on team dynamics, availability of substitutes, time sensitivity, and CM are needed to estimate the actual productivity loss	ME and CM are relevant for estimating the actual productivity loss in HEE

Table 1 (continued)

Authors, year of publication	Type of study	Objective	Methods	Topics addressed regarding ME and CM	Conclusions about ME/CM	Recommendations ME/CM	Lessons learned for HEE
[28] Knies et al., 2013	Empirical	To understand whether CM for paid work differ in type and frequency across countries and to explore whether this would result in between-country differences in relevant lost productivity	A survey was conducted among 800 people with a rheumatic disorder in the Netherlands, the United Kingdom, France, and Germany. The survey included questions about absenteeism and CM. Absenteeism and CM were compared between countries	Differences in CM between countries, impact on lost productivity estimates	CM are important. CM differ strongly between countries. The extent to which CM fully compensate productivity losses is unclear	CM should be considered in national pharmacoeconomic guidelines. ME should also be explored	CM are important and should be taken into account. The extent to which CM fully compensate productivity losses needs to be investigated
[16] Krol et al., 2013	Critical review	To discuss the main debates and developments regarding the inclusion, identification, measurement, and valuation of productivity costs; to summarize the most topical unresolved issues regarding productivity costs in economic evaluations; to encourage future research in this area	A non-systematic review was performed describing several key topics in productivity costs methodology in HEE	Identification, measurement, and valuation of CM and ME for inclusion in HEE	CM and ME are rarely included in economic evaluations. CM are not costless. Little is known about their actual costs. ME can be substantial. The FCM may already include CM through the 0.8 elasticity. Additionally, inclusion of CM could be double counting	Explore interaction ME and CM; explore how productivity changes affect team productivity and team output; develop and validate CM and ME measures; investigate the relationship between wages and ME; investigate robustness and transferability of ME	Many CM and ME questions are unanswered, hampering inclusion in HEE
[40] Lensberg et al., 2013	Critical review	To explore methodological challenges related to the measurement and valuation of productivity costs, and to propose solutions to these challenges	A non-systematic review was performed describing several key topics in productivity costs methodology in HEE	The relevance of ME	None provided	None provided	ME can be relevant

Table 1 (continued)

Authors, year of publication	Type of study	Objective	Methods	Topics addressed regarding ME and CM	Conclusions about ME/CM	Recommendations ME/CM	Lessons learned for HEE
[42] Rost et al., 2014	Empirical	To investigate work loss due to depression among workers	Cross-sectoral empirical data from senior health benefit professionals ($n = 325$) of companies with 100+ employees. A paper and pencil survey among employers; data on 1-year absenteeism and presenteeism were collected. Productivity costs were (1) estimated conventionally, (2) correcting for ME, and (3) correcting for CM	The impact of CM and ME on productivity cost estimates	ME increased productivity costs with 5%, CM decrease productivity cost estimates with 50%	All methods are still work in progress. Several challenges need to be overcome to use CM and ME in practice	The substantial variation in costs estimates with conventional methods, correcting for CM, or ME, show that the choice of method is important
[17] Krol and Brouwer, 2014	Methodological	To contribute to standardization of productivity cost methodology by offering practical guidance on how to estimate productivity costs in economic evaluations	Guidance is provided on how to identify, measure, and value productivity losses for the inclusion in HEE	The relevance of CM and ME for inclusion in HEE	Little research has been conducted regarding ME and CM for inclusion in HEE	While awaiting results of further research in this area, it is advised not to correct for multipliers or compensation	It may be questionable with the limited evidence available whether to currently include CM and ME in HEE
[39] Zhang et al., 2015	Empirical research	To test whether relative wage equals marginal productivity among team workers and non-team workers with different frequencies of presenteeism	Analysis using data of a linked employer-employee survey of the Statistics Canada data set	The relevance of ME for productivity cost estimation	Productivity loss due to presenteeism could exceed wages if team works is involved	A wage multiplier can be used to estimate the productivity loss to include ME	The use of a wage multiplier could be considered to include ME in HEE

Table 1 (continued)

Authors, year of publication	Type of study	Objective	Methods	Topics addressed regarding ME and CM	Conclusions about ME/CM	Recommendations ME/CM	Lessons learned for HEE
[49] Sedatole et al., 2016	Empirical research	To investigate the implicit incentives for horizontal supervision and team member dependency on team members	Data were collected at a company level and via an online survey among employees of an internal audit department of a large organization ($n = 223$)	Research regarding member dependency including ME	Monitoring can reduce ME because team members often have information about each other's job	This study concluded that team member dependency can be used as a control mechanism	This research was not related to HEE, absenteeism, and presenteeism
[48] Arcidiacono et al., 2017	Empirical research	To develop and test a model of team productivity to measure the importance of the productivity of peers on the productivity of others	Based on possession-level data from games played in the National Basketball Association (NBA), a model was created to demonstrate that productivity spillovers play an important role in team production	Develop and test measurement method of ME	Productivity spillovers play an important role in team productivity and production output	The ability to bring out the best in others (the level of productivity spillover) may be part of selection procedures	The developed model is not generalizable. It is not developed, nor directly applicable to HEE
[47] Strömberg et al., 2017	Empirical research	To investigate wage multipliers that can be used to determine the costs of lost productivity from an employer's perspective	Data on absence from work and presenteeism from a survey panel of 758 managers to estimate their impact on group productivity and costs	Relevance of ME	The use of wage multipliers is recommended for the calculation of health-related productivity loss to properly account costs	If the calculation does not allow job-specific multipliers, using median estimates of the ME is recommended	ME are relevant for HEE, but additional research in needed regarding ME for use in HEE
[38] Hanly et al., 2019	Empirical research	To explore the distributional impact of changes in productivity costs methodology	527 prostate cancer survivors completed questions on work patterns since diagnosis. Occupation-specific ME from a previous study were applied. In the supplementary materials, results are presented of including ME and CM (methods not specified)	Impact of CM/ME on productivity cost estimates	Using different productivity costs methodology is very influential on the outcomes. ME can substantially influence presenteeism and absenteeism	It is recommended to present productivity losses in physical units and to conduct sensitivity analysis with different methodology. In the recommended base case, ME and CM are not included	Applying ME and CM can be very influential on the productivity costs outcomes

Table 1 (continued)

Authors, year of publication	Type of study	Objective	Methods	Topics addressed regarding ME and CM	Conclusions about ME/CM	Recommendations ME/CM	Lessons learned for HEE
[52] Chiu et al., 2022	Empirical research	To quantify the burden of productivity loss among working-age breast cancer and non-small-cell lung cancer patients and caregivers and to study the extent to which the value of productivity loss is affected when omitting the effects of team production	A survey was conducted among 200 breast cancer and non-small-cell lung cancer patients and 200 caregivers via patient panels in the USA. The survey included questions about absenteeism and presenteeism. Work characteristics were asked to estimate multipliers	Impact of ME on productivity costs	The average teamwork multiplier was 1.85. Time in current job and income were important predictors of the teamwork multiplier. Current methods for calculating productivity loss may severely underestimate the true value of lost productivity due to illness	None provided	Applying ME can be very influential on the productivity costs outcomes
[53] Keita et al., 2023	Empirical research	To quantify caregiving-related work productivity loss	A telephone survey was conducted among 2204 caregivers. Data were collected about work characteristics, absenteeism, and presenteeism. A multiplier of 1.28 was applied	Applied ME in their productivity cost estimates	None provided	None provided	Not applicable

CM compensation mechanisms, FCM Friction Cost Method, HEE health economic evaluations, HLQ Health and Labour Questionnaire, HTA Health Technology Assessment, ME multiplier effects, PRODISQ Productivity and Disease Questionnaire

1. Compensation by colleagues during normal working hours.
2. Compensation by colleagues during extra working hours.
3. Compensation by extra temporary workers.
4. Self-compensation during normal working hours.
5. Self-compensation during extra working hours.
6. No compensation for lost work and compensation mechanisms unknown.

In the included studies, compensation mechanisms were discussed descriptively, i.e., describing how through which mechanisms lost productivity was partially or fully compensated for. Compensation mechanisms can take different forms, such as colleagues taking on additional work, the use of temporary staff or contractors, or the absent employee compensating for lost work after his or her return to work, in normal or additional working hours. Additionally, compensation may involve changes in work schedules, work processes, or the allocation of resources to minimize the impact of the absenteeism on overall productivity.

It should be noted that certain compensation mechanisms may also have additional costs associated with them, for instance, when hiring temporary staff. This compensation may not always fully offset production losses [16–18, 27, 28, 33–39]. The majority of included studies used the term ‘compensation mechanisms’ [13, 16–18, 27, 28, 33–41]. One study used the term ‘compensation methods’ instead [42].

Similarly, no uniform definition of multiplier effects was encountered in the included papers. Nicholson and colleagues define multipliers “as the cost of an absence as a proportion (often greater than one) of the absent worker’s daily wage” [19]. Pauly and colleagues do not provide a definition but describe that “health-related impact on productivity, measured relative to the average daily paid wage of a worker, can be several multiples of that wage in some jobs, but not in others, depending on job characteristics” [43]. Similar descriptions were used in ten studies [26, 34, 35, 38, 39, 42, 44–47]. In seven studies, multiplier effects were described as the impact of a worker’s absenteeism or presenteeism on the productivity of co-workers [16–18, 27, 28, 37, 38]. The terminology used to describe multiplier effects differed across the identified articles. The term multiplier effects was used in seven studies [16–18, 27, 37, 42, 46]. Productivity spillovers, team member dependency, and team dependency were each reported in one study [42, 48, 49]. Arcidiacono et al. (2017) describe multiplier effects as workers who can bring out the best in other co-workers and, hence, boost peer productivity [48]. Rost et al. (2014) make the distinction between team member dependency and team dependency [42]. In case of team member dependency, a worker is dependent on a colleague’s work to fulfill his

or her own task, but not necessarily the other way around. In case of team dependency, workers’ performance within teams is interdependent and, therefore, the dependency is not one-sided [42].

3.4 Critical Reviews

All four identified critical reviews, as well as the critical review with methodological research, addressed broader methodological challenges related to productivity cost estimation in (health) economic evaluations; compensation mechanisms and/or multiplier effects were subtopics in these reviews. In all reviews, it was stipulated that compensation mechanisms and/or multiplier effects can be important in this context. The oldest of these reviews was published in 2005 and the most recent ones in 2013 [16, 27, 40]. One review also included methodological research, i.e., the development of a productivity costs measurement instrument (the PROductivity and DISease Questionnaire [PRODISQ]) [37, 50]. This instrument includes a module for measuring compensation mechanisms. This review advocated the inclusion of compensation mechanisms in health economic evaluations, but also argued that more research investigating the simultaneous inclusion of different types of compensation mechanisms is required [37]. Importantly, the paper also highlighted that using the compensation mechanisms module and estimates of productivity losses that were corrected for compensation mechanisms would result in a ‘conservative’ estimate of productivity costs. All but one review expressed the importance of more research into the measurement and valuation of compensation mechanisms and multiplier effects in order to allow their inclusion in health economic evaluations. Krol and colleagues for instance concluded that many questions remain unanswered regarding compensation mechanisms, multiplier effects and their interaction, which hampers their inclusion in economic evaluation [16].

3.5 Methodological Research

Of the six papers (also) presenting methodological research, three studies focused purely on estimating multiplier effects, two studies described the development of an instrument for measuring productivity costs, and one paper aimed to offer guidance on how to measure and value productivity costs in economic evaluations [17, 19, 26, 35, 37, 43].

The first paper on multiplier effects by Pauly et al. from 2002 provided a theoretical rationale for the importance of¹ multiplier effects. The paper described three factors influencing the magnitude of multiplier effects: (1) the extent

¹ The PRODISQ was later replaced by the iMTA Productivity Costs Questionnaire (iPCQ). The iPCQ does not include CM or ME modules [37].

to which the work is team oriented rather than individually oriented, (2) the costs associated with replacing an absent worker, and (3) the magnitude of consequences of a decrease of productive output of a worker [26]. The second study on multiplier effects, by Nicholson et al. (2006), provided a conceptual model explaining how the consequences of an employee's reduced productivity can be larger in certain jobs than the wage of the employee suggests. In addition, based on a survey among 804 managers in the United States, multipliers were estimated for a total of 35 professions, both for a 3-day and a 2-week period of absence [19]. These multipliers can be used to adjust traditional productivity loss estimates to also reflect the diminished productive output of team members, above and beyond what is already reflected in the wage of the worker with health problems. With these multipliers, it is possible to calculate the full effect of a co-worker's reduced productivity in relation to relevant work characteristics of the ill-worker. With reliable and generalizable multipliers, the calculation of full productivity costs would be possible with only individual data and information about the job of the worker with health problems, without direct measurement. The calculated multipliers varied between 1 (for a fast-food cook, based on responses of six managers) and 11.4 (for a construction engineer, based on eight manager responses) [17]. The median multiplier was 1.28. The third methodological study investigating multiplier effects was similar to the second [43]. However, in this study, multiplier effects related to both absenteeism and presenteeism were considered. Based on a survey among 790 managers, absenteeism and presenteeism multipliers were presented for 22 different professions. Multipliers ranged from 1.05 (auto service technicians and hotel maids, based on 19 and 22 observations, respectively) to 2.04 (engineers, based on 25 observations).

Two papers described the development of measurement instruments for productivity costs [35, 37]. One only included a compensation mechanisms module (the PRODISQ) [37], while another one included questions pertaining to both compensation mechanisms and multiplier effects (the Valuation of Lost Productivity [VOLP] questionnaire) [35]. The PRODISQ included a compensation mechanisms module. As previously stated, the authors indicated that when using this module, the resulting productivity cost estimates should be considered as 'conservative' estimates [37]. The VOLP includes questions about job characteristics to develop multipliers for absenteeism and presenteeism [35, 37], similarly as done in the research of Pauly et al. However, it bases the estimates on employee rather than manager responses [37, 43]. In the paper reporting the development of the VOLP, multipliers were also presented for several professions. Nevertheless, since the sample size was small, multipliers per job type were based on only one to 11 responses per job type [35, 37]. The compensation mechanisms

questions in the VOLP questionnaire ask whether work was (partly) taken over by colleagues or temporary workers, or postponed. The way the questions were phrased does not directly allow for compensation mechanism-specific adjustments of productivity cost estimates [35, 37].

The final methodological paper included in this review consisted of a guidance document for productivity cost identification, measurement, and valuation in the context of health economic evaluations [17]. The authors only briefly discuss compensation mechanisms and multiplier effects, but advise to not yet include compensation mechanisms and multiplier effects in health economic evaluations until more research in this field has been conducted [17].

3.6 Empirical Research

In total, we retrieved 18 studies conducting empirical research including estimations of compensation mechanisms and/or multiplier effects. A general description of the objectives and methods of these studies can be found in Table 1. Five of these studies addressed compensation mechanisms [28, 29, 33, 36, 46], ten addressed multiplier effects [19, 26, 39, 43, 45, 47, 48, 51–53], and only three included both compensation mechanisms and multiplier effects [18, 38, 42].

The five studies only considering compensation mechanisms included four exploratory studies investigating how lost productivity was compensated and whether applied compensation mechanisms varied with duration of absenteeism and between countries [28, 29, 33, 36]. Two of these studies (Severens and colleagues, 1998, and Jacob-Tacke and colleagues, 2005) explored the impact of accounting for compensation mechanisms on productivity cost estimates [29, 36]. In those studies, about 25–30% of conventionally estimated productivity costs remained after accounting for compensation mechanisms. Note that these 'naïve calculations' assumed that compensating lost work during regular work hours by the ill employee or colleagues would not involve any additional costs—an assumption that has been criticized [26, 33]. The fifth empirical study only including compensation mechanisms, aimed to estimate productivity costs in rheumatoid arthritis and included a compensation mechanisms module [46].

Three of the ten empirical studies only including multiplier effects were studies investigating team or co-worker dependencies outside of the context of health economic evaluations [48, 49, 51]. These studies all concluded that an employee's productivity partly depends on the productivity of colleagues. Five empirical studies estimated multipliers for absenteeism and/or presenteeism for different job types in order to allow their application in the health economic evaluations [19, 39, 43, 47, 52]. One study applied a median multiplier of 1.28 taken from an earlier study [19,

53]. Finally, one cost–benefit analysis examined treatment of depression and used multipliers for three different job types [45]. The study concluded that depression treatment offered more value for money in jobs characterized by team production, expensive substitutes, and/or important consequences of diminished productive output.

Three studies included both compensation mechanisms and multiplier effects [18, 38, 42]. Krol and colleagues investigated the impact of simultaneously correcting for compensation mechanisms and multiplier effects [18]. When only ‘naively’ correcting for compensation mechanisms, productivity cost estimates were 57% lower than conventionally calculated productivity costs. When correcting for both compensation mechanisms and multiplier effects, estimates were still 29% lower than conventionally calculated productivity costs [18]. Rost and colleagues also investigated the impact of including both compensation mechanisms and multiplier effects on productivity cost estimates [42]. They included compensation mechanisms and multiplier effects separately [42], and their results indicated a 5% increase of conventional cost estimates when correcting for multiplier effects and a 50% reduction when ‘naively’ correcting for compensation mechanisms [42]. Hanly et al. reported that applying multipliers resulted in an increase in productivity costs of 41–45%. The combined analysis with compensation mechanisms and multipliers was presented in supplementary material, which we were not able to access [38].

3.7 Recommendations

When it comes to the inclusion of compensation mechanisms and multiplier effects in health economic evaluations, the papers included in this review provided several recommendations. Most of the papers that were conducted in the context of health economic evaluations acknowledge the potential relevance and influence of compensation mechanisms and multiplier effects and that they could be measured and included [17, 28, 38, 47]. Several studies provide more explicit recommendations. For instance, Koopmanschap and colleagues (2005) advised to include the compensation mechanisms module of the PRODISQ measurement instrument in economic evaluations [27]. Moreover, Knies et al. (2013) suggest that the inclusion of compensation mechanisms could be recommended in health economic guidelines [28]. Strömberg et al. (2017) recommended including multiplier effects in economic evaluations from the employer perspective [47]. On the other hand, for instance Rost et al. (2014) stated that the methodology to include compensation mechanisms and multiplier effects is still work in progress [42]. Similarly, Krol and Brouwer (2014) recommended to not include compensation mechanisms and multiplier effects in productivity cost estimates until further research is conducted and, therefore, both effects can be included with more

precision and certainty [17]. In line with this, Hanly et al. (2019) recommended not including compensation mechanisms and multiplier effects in the base case [38].

4 Discussion

While including productivity costs in economic evaluations of health interventions can be impactful, important unresolved methodological issues remain regarding their estimation. Whether and how to adjust productivity costs for compensation mechanisms and multiplier effects is an important example. This systematic review focused on this issue and identified 26 papers with a focus on compensation mechanisms, multiplier effects, or both. These papers consist of a mix of methodological papers, empirical studies, and critical reviews.

The included studies showed that both compensation mechanisms and multiplier effects are important to include in health economic evaluations. Although scarce, the available evidence suggests that both compensation mechanisms and multiplier effects can greatly affect productivity cost estimates. However, the current evidence shows a broad range of estimated impact in different contexts and with varying underlying assumptions. Consequently, it is still largely unclear how compensation mechanisms and multiplier effects affect ultimate productivity costs. In addition, little is known about how multiplier effects and compensation mechanisms interact, as they are often studied independently from each other.

There are, however, limitations in this review that should be addressed. The current study faced several general limitations, such as the search strings used, the fact that our search was limited to PubMed and EconLit, and the fact that we focused on published papers in English. These issues may have resulted in incomplete identification of relevant studies and publications. Additionally, the inclusion criteria were restricted to titles and abstracts. This again may have limited the number of relevant articles identified. This means that studies discussing or reporting on compensation mechanisms and multiplier effects without specifically alluding to this in the title or abstract were not included in this review. Therefore, our results need to be interpreted within that context.

To our knowledge, this review is the first paper that systematically reviewed and classified what has been published to date on compensation mechanisms and multiplier effects. As it appears that there is no clear definition on what compensation mechanisms and multiplier effects are, we propose the following working definitions:

- *Compensation mechanisms* are ways in which the consequences of the reduced productivity of a worker due to health problems are avoided or mitigated.

- *Multiplier effects* can be defined as the impact of the reduced productivity of a worker due to health problems on the productivity of co-workers.

Nevertheless, there are still multiple questions to be answered regarding the identification, measurement, and valuation of both compensation mechanisms and multiplier effects. Regarding the identification of compensation mechanisms and multiplier effects, current evidence suggests that both may well be relevant in estimating productivity losses in economic evaluations. However, the exact influence of compensation mechanisms and multiplier effects on productivity losses and, subsequently, costs remains underexplored. The actual impact of compensation of lost productivity and of team dependencies on productivity on the team or firm level has not been investigated. More knowledge in this area is important. First explorations may take the form of further broad qualitative research with dyads of managers, employers, and (co-)workers in different work settings to explore what actually happens with productivity and productive output of individuals, their co-workers, and the firm when individuals face health issues at work, or when they are absent. This most likely will be related to job type and function, as well as firm, sector, and labor market characteristics. Based on this qualitative research a conceptual model² could be developed. This model should not only describe the types of compensation mechanisms and multiplier effects, but also the pathways of impact of health problems on productivity and productivity costs. This will help guide additional research.

Regarding the measurement of compensation mechanisms and multiplier effects in the context of health economic evaluations, it is still unclear exactly what to measure and how to measure it. Although there are measurement instruments available that include questions on compensation mechanisms and/or multiplier effects, such as the PRODISQ and the VOLP, these differ, and their modules on compensation mechanisms and multiplier effects have not been validated elaborately [17, 37]. This is even more important since these instruments are designed to be completed by the worker with health problems and it is not clear whether they have sufficient insight into how lost productivity is compensated, or whether and how their productivity losses affect the productivity of colleagues. Developing, refining, and validating measurement methods remains important. Alternative approaches, like developing general correction factors for multiplier effects, compensation mechanisms, or both, which

could be applied more generally in economic evaluations, based on productivity cost estimations and patient job characteristics, can also be explored. Such an approach may be practical and, in general, appears promising, as mentioned in previous publications [19, 39, 43, 47]. However, such alternative approaches also need to be validated and well developed, for which, broader research is indispensable. Moreover, applying general correction factors to employee-specific productivity cost estimates may be troublesome. Commonly, productivity costs are based on average age and sex-dependent wages or actual wages. This information may not be specific enough to adequately apply correction factors, which may require more specificity in terms of function or work sector. Transferability of correction factors between jurisdictions also requires attention, since compensation mechanisms and multiplier effects may differ between countries and labor market arrangements [28].

Before using correction factors, the link between measurement and valuation needs to be clear. Our results highlight that much is unknown regarding how compensation mechanisms and multiplier effects affect actual productivity losses and, especially, related costs. This was also mentioned by, for instance, Bouwmans and colleagues [50], who wrote, “Empirical research has shown that coworkers often compensate productivity losses during regular hours [...] and that absenteeism and presenteeism can negatively affect the productivity of coworkers in cases of team dependency [...]. To what extent such mechanisms affect final production and actual costs, however, remains largely unclear.” For instance, in the currently limited amount of published explorative research, compensation of lost work in normal working hours by the employee or a co-worker has been assumed to be costless. From an economic point of view this is incorrect. If co-workers take over work in normal working hours, this may signal that a firm may have consciously created slack to be able to deal with absenteeism and reduced productivity. Such measures are, of course, not without costs. Research investigating the costs of compensation mechanisms is encouraged. If correction factors would be used to adjust production losses, they obviously would need to be adjusted to highlight the costs involved—or this should be dealt with separately.

In addition to potential compensation correction factors, the availability of reliable and generalizable multipliers would greatly facilitate calculating full productivity costs in economic evaluations. Such multipliers would ideally allow for the estimation of productivity losses beyond the affected individual, using only individual data and information about the worker's job, without the need for direct measurement of multipliers. Such information would be helpful in the context of economic evaluations of health interventions, but also provide more insight into the general economic impact of health problems.

² Note that Hubens and colleagues did not focus on compensation mechanisms and multiplier effects in their review of instruments, as it there was “insufficient clarity about how compensation mechanisms and multiplier effects influence overall productivity costs and to what extent employees are capable of estimating compensation or multipliers during their work absence” [54].

Similarly, the translation of multipliers' effects to productivity costs requires attention. Often, these multipliers are related to production losses in co-workers. However, the dependency of co-workers on the productivity of a worker with health problems may partly be reflected in the wage of the latter. Some publications indeed discussed multipliers in relation to the wage of absent workers [17, 23]. Only when the wages do not fully reflect these broader dependencies, adjustment based on multiplier effects is needed. The extent to which wages reflect co-workers' dependencies also requires more attention in order to avoid double-counting dependencies in wages and multipliers. In this context, it is important to stress that research into the relationship between productivity losses and productivity costs in light of compensation mechanisms and multiplier effects may be complex, especially in the context of professions in which objective productivity or productive output are hard to quantify. Moreover, the discussion on and investigation of multipliers and compensation mechanisms in the current literature seem to be primarily focused on the effects of absent workers within their own organization. However, it may be relevant to also consider broader potential impacts. For instance, production losses in one firm may be offset by increased output from another firm, which may represent a broader type of compensation. Likewise, reduced production in firm A may also lead to production losses in firm B if production in B depends on products from A, which would represent a broader type of multiplier. Quantifying such firm-transcending effects may be relevant but will impose new methodological challenges.

Finally, several studies have proposed ways to include compensation mechanisms and multiplier effects in health economic evaluations. Some studies tested these methods in practice, but none of the identified studies (elaborately) tested the validity of the proposed methods [17]. It is, therefore, not surprising that most of the identified studies recommended that additional research is needed regarding the methodology of estimating and including compensation mechanisms and multiplier effects in the context of health economic evaluations. Multiple issues regarding compensation mechanisms and multiplier effects still need to be investigated, in order to facilitate their inclusion in economic evaluations.

Given the limited amount of currently available evidence, as well as the remaining uncertainties regarding the size, scope, and generalizability of multiplier effects and compensation mechanisms and how they would translate into productivity costs, (advocating in favor of) including these elements in base-case analyses of economic evaluations seems premature. A structured approach would be used in developing an appropriate methodology and knowledge base. This may include qualitative research (e.g., interviewing

employees with health problems as well as their colleagues and managers in a variety of work settings), which would improve our understanding of the dynamics of absenteeism, presenteeism, and productive input and output in different contexts. For instance, currently, in some studies, data were collected among employers and, in others, among employees. They might provide different estimates, but it is not clear whose estimates would be more accurate and whether this would differ in different work settings. Qualitative research could also provide more insight into what elements need to be measured and are relevant in the context of multipliers and compensation, which in turn may lead to intensified targeted quantitative empirical research. Ideally, this would be done with validated, standardized methods (also based on the qualitative insights) that can be used in different contexts. Current standardized measurement instruments will most likely not adequately capture all relevant aspects [52], implying that new instruments may need to be developed and validated. As a consequence, a better understanding of the costs of compensation mechanisms (e.g., costs of hiring and training temporary replacements) as well as multiplier effects (as these effects need not take place in people with similar wages to those of the absent employee) is also required in this context to be able to move from productivity losses to productivity costs.

The development of appropriate methodology enabling the reliable inclusion of multiplier effects and compensation mechanisms in economic evaluations remains important. By more precisely estimating production losses and productivity costs in economic evaluations from a societal perspective, policy decisions can be better informed.

5 Conclusion

This systematic review summarized the currently available literature focusing on compensation mechanisms and multiplier effects for use in health economic evaluations. Although the evidence is scarce, the potential relevance of compensation mechanisms and multiplier effects in estimating productivity losses seems clear. Nevertheless, much remains unknown about both phenomena, also in combination. Hence, the currently limited amount of evidence appears too weak to serve as a firm basis for the practical inclusion of compensation mechanisms and multiplier effects in health economic evaluations. To conclude, additional research leading to better tools and methodologies is needed in order to use compensation mechanisms and multiplier effects in economic evaluations.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s40273-023-01304-4>.

Acknowledgements We would like to thank Wichor Bramer for his help with designing the search strategy, and we would like to thank Kimberley Hubens, MSc. for her contributions in selecting eligible studies, titles, and abstracts for the full-text reading.

Declarations

Author contributions MK: Conducted and updated the systematic literature review alongside author 4 in the capacity of independent reviewer, including study selection, assessment of methodological quality, and data extraction; updated the manuscript and contributed critical revisions to the paper, including the update of the systematic literature review; drafted the manuscript and revised it based on editor and reviewer comments; approved the final manuscript version to be published. NH: Conceived and designed the systematic literature review protocol (objective, research question, PICO, inclusion/exclusion criteria, and methodology); conducted the first draft of the systematic review, including the search strategy, study selection, assessment of methodological quality, data extraction, first analysis, synthesis, and presentation; assisted in revising the manuscript prior to resubmission; approved the final manuscript version to be published. WB: Provided substantial intellectual contributions to the update of the systematic literature review; provided critical revisions to the background, result interpretation, discussion, and relevance/conclusion of the manuscript; contributed to addressing reviewer comments and provided input to revised the manuscript prior to resubmission; approved the final manuscript version to be published. LH: Established the research question and research design; conducted and updated the systematic literature review alongside author 1 in the capacity of independent reviewer; updated the manuscript and provided critical revisions to the manuscript; provided critical revisions to the full manuscript, ensuring overall accuracy, consistency, and rigor; addressed and processed reviewer comments and provided input to revised the manuscript prior to resubmission; approved the final manuscript version to be published.

Funding The research team received no external funding for this study.

Conflict of interest MK, NH, WB, and LH declare that they have no conflict of interest.

Ethics approval Not applicable.

Consent to participate Not applicable.

Consent for publication Not applicable.

Data availability The papers were collected using PubMed and EconLit databases. The search string and period is included in the paper.

Code availability Not applicable.

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