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ORIGINAL RESEARCH ARTICLE

Production Losses due to Absenteeism and Presenteeism: The Influence of Compensation Mechanisms and Multiplier Effects

Werner Brouwer[1,2] · **Kaya Verbooy**[3] · **Renske Hoefman**[4] · **Job van Exel**[1,2]

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Abstract

Background Productivity costs can form a large and influential component of total costs in an economic evaluation taking a societal perspective. In calculating productivity costs, estimating productivity losses is a central element. *Compensation mechanisms* and *multiplier effects* may influence these losses but remain understudied. Compensation mechanisms could reduce productivity losses while multiplier effects may increase them.

Methods Data on productivity losses were collected in 2015 using an online survey among a sample of persons aged 15–65 years in The Netherlands who worked at least 12 h per week and reported to have experienced absenteeism and/or presenteeism during the past 4 weeks. A total of 877 respondents completed the survey that contained questions on productivity losses, compensation mechanisms, and multiplier effects.

Results We found that 45.5% of the respondents reported absenteeism (average 6.5 days) during the past 4 weeks, losing on average 48.7 working hours, while presenteeism was experienced by 75.9% of respondents, with an average loss of 10.7 working hours. Compensation mechanisms were reported by 76.9% of respondents, compensating almost 80% of their lost production, while multiplier effects were reported by 23.6% of respondents, reducing the productivity of 4.2 colleagues by 27.8% on average, implying a multiplier of 2.1 in that subgroup.

Conclusions This study highlights that compensation mechanisms and multiplier effects are common and may substantially affect production losses. Investigating these mechanisms and effects further, as well as their interactions, remains important. Translating these findings into productivity cost calculations in economic evaluations is not straightforward and requires attention, especially since compensation mechanisms may not be costless and, for multiplier effects, the value of hours of colleagues may not be similar to that of the person experiencing health problems.

Key Points for Decision Makers

Productivity costs can be an influential part of total costs in economic evaluations of health interventions.

Both compensation mechanisms and multiplier effects can substantially affect how much production is actually lost due to illness, disability, and premature death.

More research is needed before these impacts can be accurately measured and valued, and ultimately included in health economic evaluations.

Extended author information available on the last page of the article

1 Introduction

Economic evaluations can provide information on the relative efficiency of health care interventions. Such evaluations are increasingly used in several jurisdictions to inform healthcare decisions, especially those related to funding and reimbursement of new pharmaceuticals. Notwithstanding their increased use, important questions and debates remain regarding the methodology of economic evaluations in health care. Important issues relate to the appropriate perspective to take in such evaluations (e.g., a health care perspective or a societal perspective) and the definition, measurement, and valuation of relevant cost categories and outcomes.

When a societal perspective is taken, all societal costs and benefits need to be included in the analysis, whether they fall on the health care budget or not [1–3]. Only when

taking this broad perspective, a full welfare economic trade-off can be made between the costs and benefits of a new health technology. This is especially true since the costs and benefits of health care interventions that occur outside the health care sector can be substantial, in both absolute and relative terms [4–7]. The broader impacts on society of measures taken during the recent coronavirus disease 2019 (COVID-19) pandemic underline this [8].

Productivity costs perhaps are a prominent cost component in economic evaluations of health interventions that do not fall on the health care budget [5, 9–11]. Productivity costs are "the costs associated with production loss and replacement due to illness, disability and death of productive persons, both paid and unpaid" [12]. If people cannot be (fully) productive due to illness, disability, or premature death, this leads to societal costs since the associated production losses represent genuine opportunity costs. Productivity losses in paid work can occur due to both absence from work ('absenteeism') and reduced productivity while being at work (often called 'presenteeism'). Both causes of production losses occur frequently in many types of diseases (e.g. [13–15]).

Even in economic evaluations that claim to take a societal perspective, productivity costs are frequently ignored [6, 15, 16]. This is already true for absence from paid work, but even more common for costs due to presenteeism [15, 17] and productivity losses in unpaid work [18]. While the emphasis in the literature has been on absenteeism from paid work, presenteeism and lost unpaid work can also lead to substantial productivity costs [13, 18], and may have become more important with changing work patterns after COVID-19 [8, 19]. Ignoring these real societal costs in economic evaluations can substantially impact cost-effectiveness calculations and consequently result in inaccurate estimates of the relative efficiency of interventions and non-optimal decisions about care provision [4, 5]. It has been recommended to present the results of economic evaluations both with and without productivity costs in economic evaluations, as this enables decision makers to have a clear view of the impact of including productivity costs on final results, also in terms of distributional consequences [3, 20].

The exclusion of productivity costs from economic evaluations, even those claiming to adopt a societal perspective, may be related to the fact that productivity costs have long been controversial. This controversy relates to both whether and how productivity costs should be included. Indeed, the issue of *whether* to include productivity costs does not only relate to debates about the appropriate perspective to take in health economic evaluations but also to equity concerns. Including productivity costs in economic evaluations (like any other type of costs, for that matter) can have distributional consequences, which need to be explicitly considered. Ignoring these and other costs as a rule seems to be an inappropriate answer to the genuine concerns regarding equity [21]. The issue of *how* to include productivity costs also attracted much attention, again especially in relation to paid work [1, 11]. For example, there is no consensus on the most appropriate method to measure and value lost paid productivity [1, 15, 22–25], with classical debates concentrating on the choice between the human capital and friction cost methods [9, 15].

One of the additional debates in this context, which thus far has attracted less attention, relates to the difficulty of measuring productivity costs, since not all lost work hours of an ill employee necessarily lead to (proportional) production losses. For example, *compensation mechanisms*, including employees compensating for reduced productivity during regular working times or by working longer, colleagues taking over work from the ill worker, or the temporary outsourcing of work, may occur [15, 26–28]. Such compensation mechanisms may, albeit potentially against higher costs, decrease actual production losses due to illness. On the other hand, being absent from work or less productive while at work may not only affect the output of the ill worker him or herself but may also have a negative effect on the productivity of colleagues; for instance, when the latter depend on input or supervision from the person experiencing health problems for their own productivity. Such *multiplier effects* may increase the total production losses due to absenteeism or presenteeism considerably [29–32]. The two phenomena of compensation mechanisms and multiplier effects therefore generally work in opposite directions: compensation mechanisms may reduce production losses while multiplier effects increase them.

This paper aims to contribute to the ongoing discussions on how to include productivity costs related to paid work in economic evaluations by focusing on the influence of compensation mechanisms and multiplier effects on production losses. This is important since empirical knowledge on the occurrence of compensation mechanism and multiplier effects is (very) limited. Moreover, the few previous studies on this topic considered either compensation mechanisms or multiplier effects (e.g. [26–32]), but to our knowledge not on combinations of these two phenomena. Krol et al. [32] included both effects in a study based on a smoking cessation trial but only the data on compensation mechanisms were collected in that study. The influence of multiplier effects was estimated based on published literature. Moreover, the study [32] focused on production losses due to absenteeism only, while presenteeism may be an important component of total production loss [14].

More knowledge is required therefore to allow sound estimations of the joint influence of multiplier effects and compensation mechanisms on production losses and, ultimately, productivity costs. In people who are less productive (either

absent from work or present at work but less productive due to illness), compensation mechanisms and multiplier effects may either occur separately, simultaneously, or not at all. Our study therefore adds to the literature by (1) empirically estimating compensation mechanisms and multiplier effects due to both absenteeism and presenteeism in one survey; (2) using self-reported measures of both compensation mechanisms and multiplier effects; and (3) using a sizeable, representative sample of the working population in The Netherlands reporting productivity loss in the past 4 weeks.

In this paper, we first focus on the quantities of hours lost and compensated, not on the valuation of these hours or the costs of the compensation mechanisms. This is important to stress since compensation mechanisms are likely not without costs, and translating multiplier effects into costs may also not be straightforward. Some of the challenges of translating hours lost into costs are addressed in the Sect. 4.

2 Methods

Data on productivity losses were collected using an online survey among a sample of persons aged 15–65 years in The Netherlands in April 2015, recruited by a professional sampling agency. Within this age range, our sample was quota-sampled to be representative for the general population in terms of age, sex, and educational level. Members of the sample of a survey sampling agency were consecutively invited to participate and included in the study based on two selection questions, namely (1) whether they had paid work for a minimum of 12 h per week, and (2) whether they had been absent from work in the past 4 weeks or had experienced mental or physical health problems while being at work during that same period. Based on the available sample at the agency, a total of 877 respondents could be included in the study and completed the survey.

2.1 Questionnaire

The survey included questions on (1) job characteristics of the respondent; (2) net income of respondents; (3) absenteeism and presenteeism; (4) compensation mechanisms; and (5) multiplier effects. The survey company provided information on respondents' age, sex, and educational level (low, middle, high).

Regarding job characteristics, information was collected on the number of contracted hours of paid work per week and whether respondents worked more hours than their contracted hours, with answering categories of 'yes, structurally'; 'yes, incidentally'; and 'no, never'. The maximum number of hours worked per workday was set to 16 h. When the reported number of hours exceeded the contracted hours, the latter were used in the calculation of productivity losses. Information was also collected on whether respondents worked in shifts, with answering categories of 'yes, always'; 'yes, regularly'; 'yes, sometimes'; and 'no'.[1] Furthermore, we asked about the proportion of working time sitting, standing, and moving around. This was used to classify respondents into those having an 'active' job (higher proportion standing and/or moving than sitting) or 'inactive' (vice versa). Respondents were also asked to indicate the number of persons they supervised in their jobs. Respondents were considered to perform management tasks when they supervised at least one person. Respondents indicated how physically or mentally intensive their work was, with answering categories of 'heavy'; 'moderate'; 'light'; 'barely' or 'not'. Jobs were classified as physically or mentally demanding when respondents chose the category 'heavy'. We also recorded whether respondents had colleagues or not (see the section on 'Multiplier effects' for the specific wording of this question).

Information was collected on net monthly income in Euros (using 13 income bands and a category 'I do not know/do not want to say'). Responses were classified into one of three income categories: low (< €2000[2]); middle (€2000–€3500); and high (> €3500). In addition, approximately one in five respondents did not report their income. Multiple imputation using the Multivariate Imputation by Chained Equations (MICE) package in R [33] was used to estimate their income level, using information on age, educational level, and partner status, as well as information on household income collected by the internet survey company preceding the survey.

2.2 Absenteeism and Presenteeism

Respondents were asked whether they had been absent from work due to illness during the past 4 weeks and, if so, how many days (absenteeism). In addition, information was collected on whether they had been less productive in terms of quantity of work due to illness while being at work (presenteeism). Respondents could indicate whether they experienced mental or physical health problems during work and, if so, on how many days during the last 4 weeks. Next, respondents were asked to indicate on a scale from 0 to 10 how productive they had been on those days, with 0 labeled as 'I couldn't do anything on these days', 5 as 'I could do about half the work I can normally do', and 10 as 'I was as productive as usual' [34]. The answers were rescaled to a

[1] In the analyses, this was dichotomized into 'yes' (including always, regularly, and sometimes) and 'no'.

[2] This was slightly higher than the minimum monthly wage rate in The Netherlands in 2015 (https://www.government.nl/topics/minimum-wage/amount-of-the-minimum-wage).

variable capturing the impact of presenteeism on their productivity ranging from 0 to 1, with 1 indicating that 100% of the total hours worked were lost due to the illness, and 0 indicating that no work was lost. Assuming 5 working days per week, the maximum number of days respondents could be absent or experience presenteeism in 4 weeks was 20 days.

Based on the collected information on absenteeism and presenteeism, total productivity losses L of respondent i can be calculated as follows (Eq. 1):

$$L_i = A_i \times h_i + P_i \times h_i \times Q_i^p \quad (1)$$

in which A_i is the number of days on which respondent i was absent, and h_i indicates the number of hours respondent i on average works per day; P_i denotes the number of days that respondent i experienced presenteeism in the past 4 weeks, h_i again indicates the number of hours respondent i works per day, and Q_i^p indicates the reduced productivity in terms of quantity of the work due to health problems while being at work. Given a maximum of 20 working days during the recall period, A_i plus P_i could not exceed 20 days.

2.3 Compensation Mechanisms

To collect information on compensation mechanisms, respondents who experienced absenteeism and/or presenteeism could first indicate whether and how the work lost was compensated. They could indicate whether colleagues took over their work during normal work hours or extra work hours, whether someone was temporarily hired to take over the work, or whether they made up for lost work at a later time themselves, during normal or extra work hours. To estimate the quantity of compensation for each of the specified compensation mechanisms, respondents could indicate the percentage of lost work compensated by themselves or others. Respondents could also indicate that their lost work was not compensated or that they did not know whether their lost work was compensated. The responses were used to calculate the absolute and relative number of compensated lost hours of work.

2.4 Multiplier Effects

Multiplier effects were measured by asking respondents whether their colleagues could perform their tasks as usual when the respondent was absent or less productive due to illness, with answering categories of 'yes'; 'no'; 'I do not have any colleagues'; 'I do not know'. Respondents reporting 'no' to this question were asked how many colleagues could not perform their tasks as usual. Moreover, they could indicate how their absence influenced the quantity of work performed by colleagues on these days using a scale from 0 to 10, with 0 defined as 'They could not do anything', 5 defined as 'They lost about half of their normal work', and 10 defined as 'They could conduct all their work as usual'. The productivity losses in colleagues were calculated by multiplying the number of affected colleagues by the reduction in the quantity of their work on the days the respondent was absent or less productive. To illustrate, if four workers were affected by the absence of a colleague and the fraction of work lost for them was 30%, this implied a multiplier effect of $1 + (4 \times 0.3) = 2.2$. This means that for every hour of work loss of the ill person, a total of 2.2 h of work is lost. (Note that not all hours necessarily have the same value.)

Furthermore, as an additional angle on multiplier effects, respondents were asked whether one of their colleagues had been ill in the past 4 weeks and, if so, for how many days and whether and to what extent (using the same scale as above) this absence influenced their work. In addition, we asked whether it ever occurred to them that one of their colleagues was ill and, as a result, all work came to a standstill. These questions provided additional information on *experienced* multiplier effects.

2.5 Analysis

Descriptive statistics regarding characteristics of respondents, absenteeism, presenteeism, compensation mechanisms, and multiplier effects are presented. Productivity losses were calculated in average hours lost and in the total number of hours of work lost in the sample. Frequencies of respondents reporting compensation mechanisms and multiplier effects and the resulting number of work hours lost are reported.

3 Results

3.1 Study Sample

Table 1 presents background and work situation characteristics of the study sample ($n = 877$). Just over half of our respondents were female (56.4%) and the average age was almost 45 years. The mean number of hours of paid work per week was 31.7. This was 38.9 h for people working full-time and 24.7 h for people working part-time. Full-time employed people worked 8 h per day on average, and for part-time employed respondents this was 6.2 h. The large majority of respondents had colleagues (94.3%), did not work in shifts (85.1%), were not in a managerial position (86.3%), and did not work overtime incidentally or structurally (79.5%). Job satisfaction scored a 7.1, on average.

Figure 1 shows that 31.1% of respondents (strongly) agreed that structural provisions have been made at work so

Table 1 Background characteristics of the study sample [$n = 877$]

	%	Mean (SD)
Sex		
Female	56.4	
Age, years		44.6 (12.3)
Educational level		
Low	41.8	
Middle	48.8	
High	9.4	
Income		
Low	45.2	
Middle	27.0	
High	5.6	
Missing	22.2	
Health		7.0 (1.4)
Type of contract		
Full-time (≥36 h per week)	49.4	
Part-time	50.6	
Hours paid work per week		31.7 (9.2)
Working hours per day		7.1 (3.3)
Job characteristics		
Work in shifts	14.9	
Managerial position (be in command of five or more colleagues)	13.7	
Mentally demanding tasks	39.7	
Physically demanding tasks	18.0	
Works overtime		
No	20.5	
Sometimes	55.5	
Most of the time	23.9	
Job satisfaction		7.1 (1.8)

SD standard deviation

that their work is taken over in case of absenteeism or presenteeism, but only in 8.7% of cases there is structural overcapacity. Almost half (45.8%) of the respondents (strongly) agreed that their work can easily be taken over by a colleague at the same quality, and one in four (25.5%) agreed this to also be the case for a temporary replacement. Additionally, about one in four respondents (23.5%) [strongly] agreed that their work could easily be delayed by a few days.

Two of three respondents (66.1%) [strongly] agreed that colleagues can continue with their own work in case these respondents could not work (at all or less well) because of illness. However, 7.3% of respondents indicated that if they were absent for 3 days due to illness, their colleagues could not continue with their own work. Almost one in three (31.0%) respondents (strongly) agreed that if they could not do their job (as well as normally) due to illness, this would lead to loss of turnover or missing deadlines.

3.2 Productivity Losses

Table 2 presents information on absenteeism, presenteeism, and the resulting productivity losses. More than 45% of the respondents were absent on at least 1 day during the past 4 weeks. The average period of absence was 6.5 days, while almost 8% of all respondents (approximately 17% of those reporting absence) were absent from work for the full 4 weeks (i.e., 20 working days). On average, 48.7 working hours were lost due to absenteeism (range 2–800 h) over the 4-week period.

Table 2 also highlights that presenteeism was experienced by more than three in four respondents, on average, on 6.2 days during the last 4 weeks. On those days, approximately one-quarter of productive hours were lost. This amounted to an average loss of 10.7 working hours in this group, ranging from 0 to 259 h. Note that 94 respondents indicated that they experienced presenteeism but could perform as much work as normal. Possibly they could not perform their tasks at the usual quality of work [34], but this was not measured in the current study. In total, 24.1% of the sample experienced only absenteeism, 54.5% only presenteeism and 21.4% both absenteeism and presenteeism. The average production loss during the 4-week period amounted to 30.3 h per week (range 0–800 h), which amounts to approximately 24% of total work hours in this sample of workers experiencing productivity losses.

3.3 Compensation Mechanisms

Table 3 reports the prevalence of the five compensation mechanisms reducing productivity losses. In total, 17.9% of the respondents reported that their work loss was not compensated, 5.2% did not know, and a large majority (76.9%) of the respondents indicated that one or more compensation mechanisms were relevant in their situation. Of this latter group, 80% reported one compensation mechanism, 18% reported two mechanisms, and 2% reported three mechanisms to be relevant. Respondents most often indicated that colleagues took over their work during normal work hours (41.4%), compensating 83.3% of lost work. More than one in four respondents reported that they made up for lost work themselves later, during normal working hours, compensating 82.4% of lost work.

Excluding the 46 respondents who did not know whether their lost work was compensated, on average 24.4 h (standard deviation [SD] 52.7) of lost work were made up for through compensation mechanisms. In total, at least 76.4% of total hours lost due to illness were compensated. (This could be more if compensation was relevant for some of the 46 respondents who answered 'I do not know').

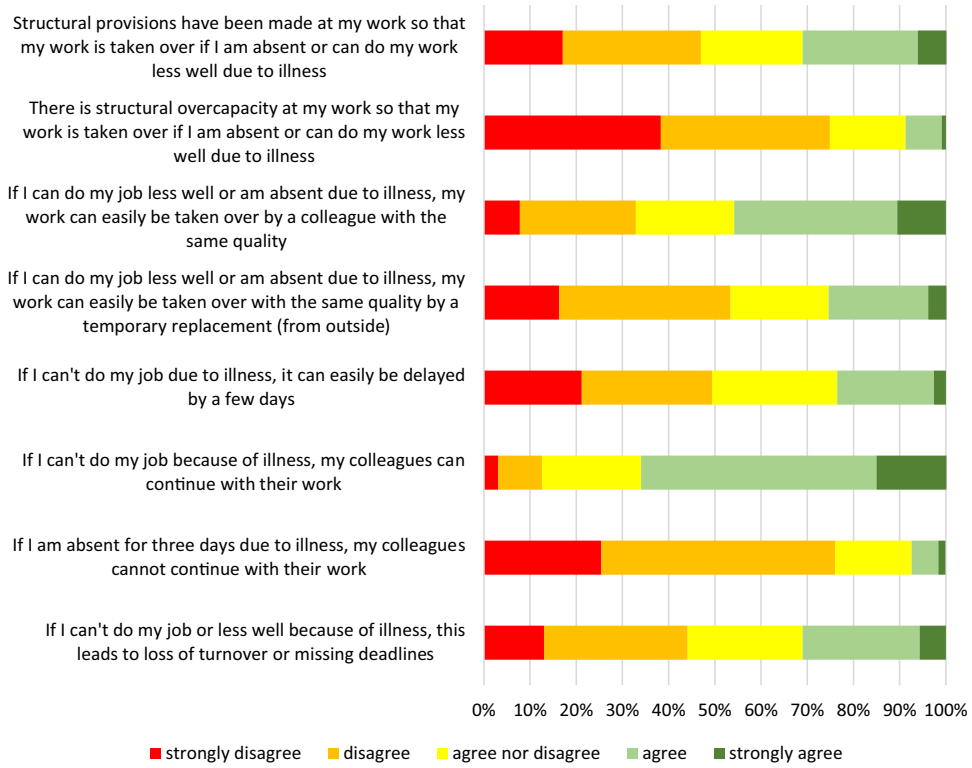

Fig. 1 Statements about effect of absenteeism or presenteeism on work ($n = 877$)

Table 2 Absenteeism, presenteeism, and productivity losses during the past 4 weeks [$n = 877$]

	N (%)	Mean (SD)
Absenteeism		
Respondents reporting absenteeism	399 (45.5)	
Days of absence		6.5 (6.8)
Long absence (20 days or more absent from work)	68 (7.8)	
Number of hours paid work per week		31.7 (9.3)
Number of hours per workday		7.3 (3.9)
Absenteeism (in hours)		48.7 (75.1)
Presenteeism		
Respondents reporting presenteeism	666 (75.9)	
Days of presenteeism		6.2 (5.5)
Productivity lost (%)		25.3 (18.3)
Number of hours paid work per week		31.8 (9.0)
Number of hours per workday		7.0 (2.9)
Presenteeism (in hours)		10.7 (17.5)
Productivity losses during 4 weeks		
Absenteeism (in hours; total sample)		22.2 (56.2)
Presenteeism (in hours; total sample)		8.1 (15.9)
Total productivity losses (in hours; total sample)		30.3 (58.8)

SD standard deviation

Figure 2 shows that colleagues or temporary additional staff taking over lost work was more frequently reported in the case of absenteeism, while catching up themselves or no compensation were more common in the case of presenteeism.

3.4 Multiplier Effects

Table 4 shows that 207 respondents (23.6%) indicated that their absenteeism or presenteeism had affected the productivity of their colleagues. On average, 4.2 (range 1–65)

Table 3 Compensation mechanisms [$n = 877$]

	N (%)	Hours of lost work (mean)	Percentage of lost work compensated [mean (SD)]	Hours of lost work compensated (mean)	Hours of lost work compensated (total)
Compensation mechanisms reported[a]					
Colleagues took over work during normal working hours	363 (41.4)	36.0	83.3 (27.6)	29.4	10,672
Colleagues took over work outside normal working hours	44 (5.0)	70.5	54.5 (37.3)	43.9	1,932
Caught-up work during normal working hours	238 (27.1)	18.3	82.4 (25.5)	13.6	3,237
Caught-up work outside normal working hours	92 (10.5)	19.0	67.3 (34.7)	13.7	1,260
Hired temporary staff	87 (9.9)	43.6	83.5 (26.4)	36.9	3,210
Work was not compensated	157 (17.9)	24.8	0	0	0
I do not know	46 (5.2)	31.0	n/a	n/a	n/a

SD standard deviation

[a]Multiple compensation mechanisms could be reported

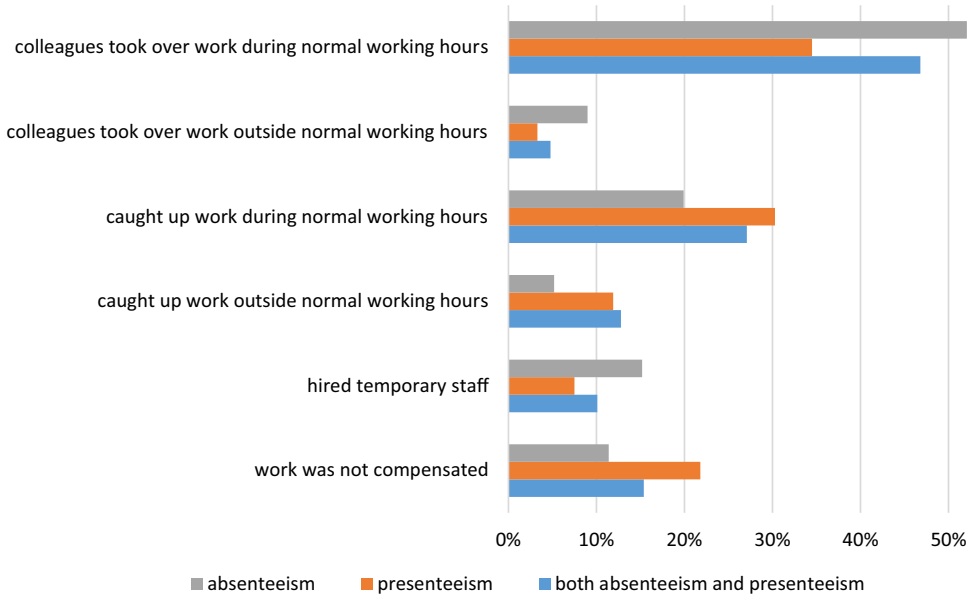

Fig. 2 Compensation mechanisms ($n = 877$)

colleagues were affected per respondent who indicated that multiplier effects occurred, and these colleagues were estimated to lose 27.8% of their work due to illness of the respondent. This corresponds to a multiplier of 2.1 (range 1–21) in the group of respondents who report multiplier effects. For the total group, considering that 76.4% reported no multiplier effects in their case, the average multiplier effect amounts to 1.25.

The number of colleagues affected was higher for workers reporting both absenteeism and presenteeism (6.7) than for those reporting only absenteeism (3.0) or only presenteeism (3.7). However, the proportion indicating multiplier effects to be relevant, the percentage of work lost, and the estimated multiplier effects was very similar across groups.

The mean productivity loss of the 207 respondents who reported multiplier effects was 31.3 h. The lost hours due to multiplier effects would therefore increase the production loss for this group to 63.3 h per worker.

More than half of the respondents (56.3%) indicated that a colleague had been ill during the past 4 weeks, but that they could do their work as usual in that situation. Another 79 respondents (9.0%) indicated that they had experienced productivity losses as a result of a colleague being ill. On average, this colleague had been absent for 7.3 days (range

Table 4 Multiplier effects [$n = 877$]

	N (%)	Number of affected colleagues [mean (SD)]	Percentage of work lost [mean (SD)]	Multiplier effect
Co-workers affected by absenteeism and/or presenteeism				
Yes	207 (23.6)	4.2 (6.4)	27.8 (20.1)	2.1 (1.8)
No	558 (63.6)			
I do not have co-workers	50 (5.7)			
I do not know	62 (7.1)			

SD standard deviation

1–20) and the productivity loss resulting from the absence of their colleague amounted to 31.4% of their work. Furthermore, 110 respondents (12.5%) reported that they experienced (at some point in time, not restricted to the past 4 weeks) a situation that one of their colleagues was ill and, as a result, work came to a complete standstill.

3.5 Association of Compensation Mechanisms and Multiplier Effects

Table 5 displays the frequencies of presence of compensation mechanisms and multiplier effects. Compensation mechanisms were more often reported than multiplier effects (i.e., 76.9% vs. 23.6%). Approximately half of the respondents (50.5%) reported compensation mechanisms to be relevant, but not multiplier effects. Only 10.4% reported no multiplier effects and no compensation mechanisms, as is commonly (implicitly) assumed in estimations of productivity losses.

Total productivity loss from absenteeism and presenteeism in our sample equalled 26,573 h.[3] In terms of calculating the implications of compensation mechanisms and multiplier effects, several assumptions need to be made. To illustrate the impact, we used a naïve approach that calculated the impact of compensation mechanisms and multiplier effects independently. The total compensation of productivity losses could then be estimated to be 20,311 h[4] and the total multiplier effect amounted to 13,412 h[5]. Using these figures, the total productivity loss adjusted for compensation mechanisms and multiplier effects was (26,573 − 20,311 + 13,412 =) 19,674 h, corresponding to 74.0% of the non-adjusted amount. The mean productivity loss in the sample, adjusted for compensation mechanisms and multiplier effects, then becomes 22.4 h.

[3] Based on mean productivity loss of 30.3 h in the full sample ($n = 877$) [see Table 2].

[4] Based on the sum of the last column in Table 3.

[5] Based on mean productivity loss of 31.3 h and a multiplier of 2.1 in the corresponding sample ($n = 207$) [see Table 4].

Table A1 in the online supplementary material shows some associations of productivity losses, compensation mechanisms, and multiplier effects with personal and job characteristics. The associations of production losses and compensation mechanisms with health level, type of contract, working in shifts, and job satisfaction seem interesting to explore further. Unsurprisingly, the multiplier effect was strongly associated with having a managerial position.

4 Discussion

The measurement of production losses related to health changes remains as important as it is challenging. To our knowledge, this was the first study to measure the prevalence and impact of compensation mechanisms and multiplier effects on lost working hours simultaneously. Moreover, it studied these concepts in relation to both absenteeism and presenteeism due to illness, in a representative sample of the working population in The Netherlands. Respondents were included if they had experienced absenteeism or presenteeism in the previous 4 weeks. Our results emphasize the relevance of compensation mechanisms and multiplier effects, both in terms of prevalence and in potential impact on production losses. Only about 10% of the respondents indicated that compensation mechanisms and multiplier effects were both not

Table 5 Presence of compensation mechanisms and multiplier effects [$n = 877$]

Multiplier effects	Compensation mechanisms			
	Yes	No	Do not know	Total
Yes	163 (18.6)	40 (4.6)	4 (0.5)	207 (23.6)
No	443 (50.5)	91 (10.4)	24 (2.7)	558 (63.6)
Not applicable[a]	30 (3.4)	15 (1.7)	5 (0.6)	50 (5.7)
Do not know	38 (4.3)	11 (1.3)	13 (1.5)	62 (7.1)
Total	674 (76.9)	157 (17.9)	46 (5.2)	877 (100)

Data are expressed as *n* (%)

[a]Does not have co-workers

relevant in their situation, as usually (implicitly) assumed in economic evaluations incorporating productivity costs. As compensation mechanisms reducing production losses were larger than the multiplier effects increasing them, total productivity losses (naively) adjusted for compensation mechanisms and multiplier effects amounted to 74.0% of the directly measured productivity losses in terms of work hours lost. However, some of these findings deserve further discussion and emphasis.

First, our study showed that lost work due to illness according to our respondents was compensated for to a large extent. More than three of four respondents reported that lost work was (partly) compensated through various mechanisms. Often, this involved colleagues taking over work or the ill person him- or herself catching up later within regular working hours. Overall, these compensation mechanisms were estimated by the respondents to make up for about 80% of the initial productivity losses due to illness. Other studies also showed that lost work is often compensated, and reported that 23–43% of regular productivity losses remained after correcting for compensation mechanisms [26, 27, 32]. As elaborated on later, we stress that in this context there is a clear need to distinguish between *productivity losses* and *productivity costs*, since the latter may include the costs of compensation mechanisms. Moreover, the relevant compensation mechanisms appear to differ between absenteeism and presenteeism (Fig. 2), which is interesting to investigate further in future research. The same holds for their relationship with job characteristics (see online supplementary material) as well as with different causes for absence (e.g. chronic illness, acute illness, work-related illness).

Second, our results highlight that absenteeism and presenteeism can also affect the productivity of colleagues. Such multiplier effects were reported by one in five respondents in our sample. Although less common than compensation mechanisms (with about one in four respondents reporting that their reduced productivity negatively affected colleagues' productivity), when relevant, these multiplier effects were substantial. On average, multiplier effects approximately doubled the initially calculated productivity losses in the subgroup of respondents who reported multiplier effects, with a multiplier of 2.1. Translated to the full sample, this amounted to a multiplier of 1.25. The latter estimate would be more appropriate to use when actual information about who experiences multiplier effects are lacking in a sample. Despite differences in methods and study populations, previous research has shown comparably sized mean multiplier effects ranging between 1.21 and 2.00 [29–31]. In our study, multiplier effects were strongly associated with having a managerial position (see online supplementary material). Their relationship with job characteristics therefore deserves more attention in future studies.

Third, the results of our study suggest that compensation mechanisms and multiplier effects can occur both separately and also jointly. In our sample, 18.6% of the respondents reported both compensation mechanisms and multiplier effects to be relevant in their situation, while for 10.4%, both were deemed irrelevant. Moreover, the impact on lost production can be substantial. On the one hand, estimates of productivity losses may overestimate the quantity of work actually lost when not corrected for the work compensated by the ill worker him- or herself or by colleagues. On the other hand, common estimates of productivity losses may underestimate lost production if additional productivity losses occurring in colleagues of the ill employee are ignored. Comparing the relative sizes of both influences, in our study the decreasing effect of compensation mechanisms on the estimates of productivity losses was larger than the increasing effect of multiplier effects. This is in line with the findings in the study by Krol et al. [32]. In that study, overall estimates of productivity loss reduced to 74% of initial losses after correcting for both mechanisms. Again, we emphasize the difference between production losses and productivity costs, as compensation mechanisms may not be costless.

Some limitations of this study need to be addressed before we discuss a few implications of our findings. First, we conducted an online survey on both compensation mechanisms and multiplier effects among people who performed paid work and experienced productivity losses in the past 4 weeks. Although this allowed us to compare the presence of both phenomena as reported by the ill workers themselves, using self-reported data is not without problems. For example, recall inaccuracy may hamper a sound estimation of absenteeism and presenteeism. Moreover, not all respondents may be aware of whether, how, and the degree to which reduced productivity was compensated for by others or had affected others [28, 30]. In that sense, while it may be reassuring to observe that only a small percentage of respondents indicated that they do not know whether compensation mechanisms (5.2%) or multiplier effects (7.2%) occurred in their situation, the answers provided about the degree to which they occurred and resulted in reduced or increased production losses should be validated. This would require observations in firms, or complementary information from supervisors who, for instance, might be involved in hiring temporary replacements. Indeed, it has been argued that a managerial perspective should be taken when investigating productivity losses [29–31]. This especially seems relevant for measuring the effects of reduced productivity on other employees [27, 28]. Interestingly, in our sample, 9% of respondents experienced (substantial) productivity

losses due to the absence of a colleague. It is difficult to directly compare the figures alluding to one's own health problems affecting others and others' health problems affecting respondents, especially in terms of numbers of people affected. In particular, it is important to consider that the study sample consists of people reporting considerable productivity losses themselves, and that the potential population of workers affected by the absence of a colleague is probably much larger. Interestingly, the reported average percentage of work lost seemed comparable (i.e., 27.8% vs. 31.4%; see Table 4 and text below). This highlights the relevance of multiplier effects as well as the need to think about how (and in whom) to properly measure and validate these figures. Given that the conventional source for this type of information would be the person experiencing the health problems, it needs to be asserted that this approach leads to accurate estimations of multiplier effects.

Second, in this paper we used a dataset from 2015, which was not analyzed before. This dataset provides important insights by highlighting the relevance of both compensation mechanisms and multiplier effects in the context of both absenteeism and presenteeism. The fact that we used a 4-week period that was similarly timed for all respondents also means we did not observe seasonal influences (e.g. flu or holiday season) in our study, which may impact the variables studied in this study. The same holds for macroeconomic factors. Moreover, we stress that recent developments in working modes, such as working from home, accelerated by technological advances, but especially the COVID-19 pandemic, warrants more investigation in this important area. The line between absenteeism and presenteeism may have become blurred (and the labels as such less meaningful) [8, 19], and the way in which, and the degree to which, reduced productivity may affect others and be compensated for may have changed.

Third, like most studies investigating productivity losses and costs, our focus has been on productivity losses in paid work only. We emphasize that health changes will also have important consequences for productivity in unpaid work, like household tasks, informal care, and voluntary work. In this context, we know even less about compensation mechanisms and multiplier effects, although it is very likely that at the level of the household such impacts could occur [28]. The topic of measuring and valuing productivity losses in unpaid work deserves more attention in future studies.

Notwithstanding these limitations, the results of this study (ideally confirmed in future studies in this area) have some important implications. First, compensation mechanisms and multiplier effects are common both in the context of productivity losses due to absenteeism as well as those due to presenteeism. Moreover, their influence is substantial, with many lost hours of work compensated for through various mechanisms reducing productivity losses, and also large impacts on colleagues, increasing productivity losses. Increasing our knowledge about these effects and how they interact with each other and with aspects such as job characteristics is a prerequisite before using them more broadly. Ideally, such aspects are captured using standardized questionnaires for measuring productivity costs [35–39], which might be used more broadly, for instance to also capture productivity changes in informal caregivers [40].

Studies explicitly addressing how compensation mechanisms and multiplier effects interact are also important, and also for understanding how to come to overall estimates of productivity losses for use in economic evaluations. We used a fairly naïve approach in which the hours compensated were subtracted from the original estimate and the additional hours lost in others through multiplier effects added. This resulted in a reduction to 74% of original productivity losses. However, if one would expect that the hours lost through multiplier effects could also be compensated for (e.g., making up for lost work later), this would be an overestimation. Indeed, if one assumes compensation to be as common for productivity losses due to the multiplier effect, only around 20% of these hours would count as productivity losses. Similarly, if colleagues need to take over tasks from an ill employee, taking time away from their normal tasks, this might in turn also affect their colleagues, leading to additional multiplier effects. Furthermore, compensation mechanisms and multiplier effects are likely not independent. For instance, if compensation is instant and complete, no multiplier effects would occur. Finally, the higher the multiplier effects, the more pressure a company is likely to feel to implement compensation mechanisms (e.g., hiring additional staff). Understanding these mechanisms better is required in order to make sound calculations of the actual productivity losses due to illness.

In addition, even more caution is needed when moving from estimates of productivity losses to *productivity costs*. In the context of economic evaluations, productivity losses are typically translated into a monetary estimate of productivity costs. This is often done by multiplying lost hours of work with a relevant value (e.g., wage rate of the ill worker). If we would use an estimate of productivity losses that is corrected for compensation mechanisms and multiplier effects for this (even when established more informedly, as discussed above), this will likely be a misrepresentation of the actual productivity costs. This holds for multiplier effects, which appear to constitute real additional productivity losses, and certainly for compensation mechanisms. For multiplier effects, it needs to be asserted that the wage of the ill worker does not partly reflect the dependency of others on his or her productivity, in order to avoid double-counting. Moreover, the people affected by the productivity loss of the ill worker may have a different wage (especially if the ill worker is functioning at a different hierarchical

level). This highlights that we should not only know *how many* hours are lost in others but also *in whom*, and that we would also need an estimate of the productive value of these hours lost (e.g., the wage rate of the affected colleagues). Simply multiplying the 'inflated' hours lost with the wage rate of the ill worker will most likely be inaccurate. For compensation mechanisms, while these may lower productivity losses, they may not be *without additional costs*. Indeed, recall that productivity costs are defined as 'the costs associated with production loss and replacement due to illness, disability and death of productive persons, both paid and unpaid' [12] (underscore added). To illustrate the issue with using adjusted estimates of productivity losses, consider the following example. One of the compensation mechanisms to reduce productivity losses is hiring additional temporary staff. Assume employee X calls in sick and is absent during a 40-h work week. Assume his employer now hires person Z as a temporary replacement for X. If Z is paid the same amount per hour (and let us assume the hiring process and onboarding process are costless), is hired for the full 40 hours X is absent, and compensates all production lost due to the illness of X, then the compensation amounts to 100% and no production is lost. However, also in that case there are of course still *productivity costs*. This holds since the costs of compensation are equal to the value of production otherwise lost. Especially for compensation mechanisms, it is unclear at this stage to what extent they result in less *productivity costs,* since many of them do not appear to be costless. For instance, if colleagues are taking over tasks during normal working hours, this may indicate that the company is (purposely) creating slack in the organization in order to avoid production losses, which again is not costless.

The costs associated with compensation mechanisms may differ per mechanism, both in terms of how high the associated costs are as well as regarding who bears them (e.g. the employer, the employee, or colleagues). Krol et al. [32] already pointed to the possible differences in associated costs of using compensation mechanisms within regular working hours or during extra working hours, by the ill or by the involvement of colleagues. Moreover, Pauly and colleagues [31] argued that some costs associated with compensation mechanisms may already, indirectly, be considered in the wage rates of employees. (This needs to also be investigated for multiplier effects.) In addition, some valuation methods of lost work input, such as the Friction Cost Method, may already, implicitly, express the influence of compensation mechanisms, for instance by assuming that only a fraction (80%) of lost hours of work translates into productivity costs [22, 32]. As Koopmanschap et al. wrote: "*Numerous studies have demonstrated that a reduction of annual labour time causes a less than proportional decrease in labour productivity per year. […] In our main variant we assume the elasticity to be 0.8. It should be noted however, that because these elasticities were estimated on the level of the firm, they inevitably reflect the composite result of two possible components: the diminishing returns on labour and a possible reduction of the internal labour reserve.*" [22] Therefore, when calculating productivity costs, researchers should be aware of the true costs of compensation mechanisms as well as avoiding double counting their possible mitigating effect on productivity costs. Next to more investigation into the prevalence and impact of compensation mechanisms and multiplier effects, we therefore also encourage more research into these true costs of compensation mechanisms before being able to use them to adjust estimates of productivity costs in economic evaluations. Moreover, the relationships between absenteeism, presenteeism, compensation mechanisms and multiplier effects and job characteristics, as well as types and causes of illness, are important to explore further in order to also prevent or reduce productivity losses.

Future studies could explore these topics further in order to facilitate the inclusion of these effects on productivity cost estimates in economic evaluations. If not directly captured, guidelines for average corrections for compensation and multiplier effects (ideally tailored based on aspects such as job characteristics), could be developed and subsequently applied in cost-effectiveness calculations in health care.

5 Conclusion

The results of this study highlight the relevance of compensation mechanisms and multiplier effects in the context of productivity losses due to absenteeism and presenteeism. For coming to sound estimates of actual productivity losses and ultimately productivity costs due to illness, these effects need to be studied more often and in more detail, and also in terms of their interactions. Moreover, the costs of the compensation mechanisms commonly implemented for lowering productivity losses need to be investigated in order to see whether they actually lower productivity costs. Ultimately, this can contribute to more accurate estimations of productivity costs in society that can be used in economic evaluations informing policy decisions in health care.

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Data availability Data is available upon request from the authors.

Declarations

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Authors and Affiliations

Werner Brouwer[1,2] · Kaya Verbooy[3] · Renske Hoefman[4] · Job van Exel[1,2]

✉ Werner Brouwer
brouwer@eshpm.eur.nl

[1] Erasmus School of Health Policy and Management, Erasmus University Rotterdam, Burgemeester Oudlaan 50, PO Box 1738, 3000 DR Rotterdam, The Netherlands

[2] Erasmus Centre for Health Economics Rotterdam, Erasmus University Rotterdam, Rotterdam, The Netherlands

[3] Hotel Management School Maastricht, Maastricht, The Netherlands

[4] The Netherlands Institute for Social Research, The Hague, The Netherlands