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ORIGINAL PAPER

Variation in the methodological approach to productivity cost valuation: the case of prostate cancer

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Abstract

Background Standardised integration of productivity costs into health economic evaluations is hindered by equity and distributional concerns. Our aim was to explore the distributive impact of productivity cost methodological variation, describing the consequences for different groups.

Methods 527 prostate cancer survivors (2–5 years post-diagnosis) completed questions on work patterns since diagnosis. Productivity loss, categorised into temporary/permanent absenteeism, reduced hours and presenteeism, were costed in €2012. Valuation approaches included the human capital approach (HCA) and the friction cost approach (FCA), with wage multipliers (WM) applied in additional analyses. Both national and self-reported wages were used. Costs were compared across socio-demographic and economic characteristics using non-parametric tests.

Results The estimated base case (HCA, using national wages) total productivity cost was €44,201 per prostate cancer survivor. Permanent absenteeism accounted for the largest cost (€18,537), followed by reduced work hours (€11,130), presenteeism (€8148) and temporary absenteeism (€6386). Alternative valuation estimates ranged from − 90% ($FCA_{national\ wage}$: €4625) to + 82% ($HCAWM_{self\text{-}reported\ wage}$: €80,485) compared to the base case and were consistently higher for self-reported wages compared to national wages. Statistically significant differences in productivity cost were found across four of the six survivor socio-demographic and economic characteristics by valuation approach, despite no significant difference in their physical unit equivalents.

Conclusions Our results indicate that the distributional impact of productivity costs varies by socio-economic and demographic characteristics. We advocate that: productivity loss should be reported in physical units where possible; cost estimation should be subject to sensitivity analysis, and only where this is not feasible, that the HCA and national wages be used to value productivity loss where equity concerns are paramount.

Keywords Productivity costs · Cancer · Equity · Prostate cancer

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Introduction

Allocation and rationalising decisions within healthcare are informed by the key economic principle of constrained optimisation/minimisation. The approach aims to maximise health benefits produced or minimise disease burden for a constrained healthcare budget in a resource-limited setting [1, 2] and, hence, offer guidance to decision makers in the prioritisation of interventions [3]. A key ethical consideration underpinning assessment of interventions or health technologies is whether indirect costs of illness should be included amongst the effects of an intervention [4]. The answer, to some degree, rests on the choice of evaluation perspective.

National health economic evaluation guidelines differ in their guidance [5]. A narrow healthcare payer perspective excludes indirect productivity costs [5]. A societal perspective, in contrast, necessitates the incorporation of all costs and effects associated with the intervention, regardless of where they occur [5, 6]. It is argued that not accounting for both direct and indirect costs and effects could result in suboptimal resource allocation [7] and fail to meet the social welfare maximisation objective. However, the societal approach is not without criticism as many social welfare functions are predicated on Paretian criteria where optimality is biased towards maintenance of the status quo and is dependent on an optimal initial distribution of income [8]. The debate continues.

The effects from a health intervention generate positive externalities beyond those obtained by the individual including enhancing the productive capacity of the economy. The individual gains from an intervention include improved health status, a satisfying return to a social role, and the potential to earn income again [4]. Production gains to the economy arise when individuals return to health and are able to resume work [9]. From a societal perspective, illness can lead to (1) an absence from work leading to a reduction in output and/or (2) a reduction in labour input while at work due to limitations caused by the illness. Absenteeism and presenteeism disrupt the productive capacity of the economy and create productivity losses that may extend into the future. Valuation of these losses generally necessitates the application of a suitable wage to monetarise the time and effort lost from work, with appropriate discounting for future values. Despite the importance of potential productivity gains of treatment and other interventions [10, 11], economic assessments have been slow to incorporate these in their incremental cost effectiveness ratios (ICERs) perhaps—in part—due to unresolved ethical concerns, or a lack of guidance and standardisation in the valuation methodology [5].

Valuation methods for productivity costs include, primarily, the human capital approach (HCA) and the friction cost approach (FCA). Recent adjustments to these methods have included the application of wage multipliers (WM). Each approach has a different distributional effect on the derived productivity costs, but these have rarely been compared in the literature. From an ethical perspective, the disparate distributional effects present concerns.

It has been argued [12] that the inclusion of productivity costs in economic evaluations prioritise health interventions aimed at individuals who return to paid work over interventions whose health benefits accrue to non-paid working or non-working individuals. Because paid income is the primary valuation device for all three valuation approaches, existing labour market discrepancies tend to be transposed directly into productivity cost estimates. Women, the elderly, the very young and some minority groups are discriminated against due to differences in labour market participation and compensation levels [13]. Compensation mechanisms or imputing implicit wages for non-paid individuals may overcome some of these issues, however, the problem of disparate productivity levels across populations remains [12].

This paper estimates productivity costs in a group of working prostate cancer survivors using two different primary valuation methods: the HCA and the FCA, with both subsequently modified with WM. To illustrate the potential distributional consequences and their ethical implications, we explored the distributive impact of each approach according to key socio-demographic characteristics of the study population.

Methods

Sample and questionnaire

A population-based sample of survivors of prostate cancer on the island of Ireland participated in the study [14]. This analysis focused on those survivors in the Republic of Ireland (RoI) who were between 2 and 5 years post-diagnosis and working at the time of diagnosis.

Briefly, potentially eligible survivors were identified from the cancer registries in Ireland. Following screening for eligibility by their general practitioners, 1229 survivors 2–5 years post-diagnosis in ROI were sent a postal questionnaire to complete between April and September 2012. This questionnaire sought information on socio-demographic characteristics, employment status and absenteeism/presenteeism before and after their prostate cancer diagnosis. Data on the duration of time absent from work and presenteeism were self-reported.

817 survivors completed the questionnaire. After restricting to those either employed or self-employed at the time of cancer diagnosis, the analysis included 527 survivors.

Defining productivity costs

Productivity costs can be defined as 'costs associated with production loss and replacement costs due to illness, disability and death of productive persons, both paid and unpaid' [11]. We focused on those productivity costs associated with prostate cancer survivors in paid work only, at diagnosis, and valued time lost because of their treatment and ongoing recovery.

The cost reference year was 2012, with future values discounted by 5% as recommended by Irish Health Technology evaluation guidelines [15], and wage inflation accounted for by average wage growth of 1% extrapolated from the Structure of Earnings Survey: Hourly Earnings 2008–2012 (https://ec.europa.eu/eurostat/web/labour-market/methodology).

Productivity cutoff age

Productivity costs for temporary and permanent absenteeism were followed to an assumed retirement age of 65. In the cases of presenteeism and reduced hours, where respondents indicated being in employment beyond the official 65 years age of retirement, productivity loss was valued up to age 70.

Components of productivity loss

Temporary absenteeism

Temporary absenteeism includes missed days from work and associated output loss due to a period of illness [16]. Missed days can occur due to attendance at medical appointments for diagnosis and treatment, or treatment side effects, which can be longer lasting. Participants were asked: "Did you take any time off work for your cancer treatment?". If yes, participants were asked: "how long were you or have you been off work?". We measured temporary absenteeism as the number of days absent from work due to the individual's cancer multiplied by the reported average number of hours usually worked per day prior to diagnosis.

Permanent absenteeism

Permanent absenteeism arises when an employed individual takes early retirement due to illness. Participants were asked: "Have you returned to work?" and "If no, do you intend to return to work in the future?". We calculated permanent absenteeism when a survivor indicated that they had not returned to work following their diagnosis, did not intend to return to work, and were below the age of 65 (statutory retirement age in 2012).

Reduced hours

Reduced hour costs refer to the output lost when individuals return to work following an illness but work fewer hours than pre-diagnosis. This may occur due to ongoing psychological or physical effects of the illness or its treatment. Participants were asked: "How many hours do you usually work per week now?". We estimated reduced hours by computing the difference between the average hours worked following return to work and those worked prior to the illness, aggregated per year, and summed until retirement age, assuming reduced hours remain over this period.

Presenteeism

Presenteeism refers to the reduced intensity and/or quality of work while working due to health problems [17]. Our study employed a filter question asking respondents who had returned to work: "Was your work productivity in the last week impaired by your prostate cancer?", and if so, by how much (on a scale of 0–100%, following previous studies [17]). Costs were computed based on the percentage reduction in productivity as a portion of the individual's wage and aggregated until retirement. Impairment was assumed until retirement due to the average age of the sample (63 years of age), and the average number of years post-diagnosis (3.9 years) for respondents.

Valuation approaches

We applied two primary valuation approaches: the human capital approach (HCA) and the friction cost approach (FCA), with both approaches subsequently modified according to wage multipliers (WM) in additional analysis.

HCA

The HCA measures production loss due to illness by the present value of all lost future earnings of the individual, with income used as a proxy for output loss, assuming firms employ workers at a rate directly proportional to their contributions to the firm, or their marginal revenue product [5, 13]. The potential productivity loss is followed until return to work at previous productivity levels or retirement age, whichever is appropriate. In the base case, we applied the national gross median wage ($HCA_{\text{national wage}}$) for the male working population in 2012 to productivity loss (https://ec.europa.eu/eurostat/web/labour-market/methodology). A second application of the HCA was based on self-reported wages ($HCA_{\text{self-reported wage}}$) from the questionnaire.

FCA

The FCA has been developed to measure actual rather than potential productivity loss [18, 19]. Assuming the existence of involuntary unemployment, and that ill workers can be replaced from a pool of unemployed workers, productivity losses arise only during a limited friction period following which a firm's output is assumed restored to its initial level [5]. Even where production is made up for by the ill worker upon return, or by colleagues, an assumed loss still occurs due to a loss of leisure time to make up for this lost work.

Friction costs were calculated by applying national male gross median wages ($FCA_{national\ wage}$) for the working population to temporary absenteeism, reduced hours, permanent absenteeism and presenteeism. Separate estimates were calculated using self-reported wages ($FCA_{self\text{-}reported\ wage}$) as per the HCA (and an additional scenario is provided in Supplementary Table 1 where the FCA is adjusted for both compensation mechanisms and wage multipliers).

Absences and presenteeism loss were capped at 11.3 weeks (as previously used for Ireland [20]), following which the productivity cost was assumed zero. The friction period is comprised of an average vacancy duration for positions in Ireland of 7.3 weeks based on the results of a nationally representative survey plus an additional 4 weeks to account advertisement of the new role following permanent absenteeism and the duration necessary for the uptake of a position following a successful application [20]. A reduction in labour time is assumed to cause a less than proportional decrease in production. As no estimate of this value exists for Ireland, an elasticity factor of 0.8 has been applied to derived estimates following the most frequently cited elasticity value in the literature originating from the Netherlands [21].

Presenteeism costs do not constitute time away from work as such but the application of the FCA to presenteeism can be justified, since in a competitive market, any reduction in on the job productivity by a returning worker will have to be compensated for by either, a colleague (under the assumption of lost leisure time) through internal slack or the reorganisation of work or a temporary staff member, to return productivity to previous levels. Our method assumed that when presenteeism was indicated by a participant, it occurred directly upon return to work, occurred only once, and was compensated for by a firm following the friction period due to the employment of additional staff so that it reduced to zero thereafter.

Adjustment for WMs

Many tasks in the workplace of the modern economy are undertaken as part of a team [22]. The absence of an individual due to illness therefore can impact on the timing and performance of work by other team members. These externality effects have been presented in the literature as wage multipliers which capture productivity losses in excess of the market wage. The size of the multiplier is, in addition, dependent on the degree of substitutability of workers in a team environment in the workforce and the sensitivity of output to deadlines. Where perfect labour substitutes are unavailable and where output is sensitive to timing, the production loss following worker absence is greater than the wage rate [22]. Wage multipliers have therefore been developed to account for these negative work loss effects with a recent study estimating an average wage multiplier of 1.97 for absenteeism across occupation types and 1.54 for chronic presenteeism [23].

We accounted for multiplier effects across all types of productivity loss by applying occupation-specific multiplier estimates (for both absenteeism and presenteeism) derived from a recent survey of managers in Sweden [23: please refer to this study for a full list of occupation-specific multipliers] to our HCA productivity estimates based on national gross median male wages ($HCAWM_{national\ wage}$) and separately for self-reported wages ($HCAWM_{self\text{-}reported\ wage}$). In supplementary analysis, we also adjusted our FCA estimates with WM (Supplementary Table 2).

Statistical analysis

To assess the implications of each valuation approach across groups of workers, productivity cost totals were disaggregated by four socio-demographic characteristics (age at diagnosis, highest level of education, marital status at diagnosis and whether the individual had children), and two economic characteristics—(employment status at diagnosis (employed versus self-employed) and receipt of social welfare payments at diagnosis).

Descriptive statistics were reported to summarize key categories of work-related productivity loss in their physical units (days absent from work, etc.) and in their monetarised form for the two primary valuation approaches and the WM-adjusted alternatives. Productivity costs were compared across survivor socio-demographic and economic groups using non-parametric statistical tests, since data were not normally distributed) (i.e., Mann–Whitney and Kruskal–Wallis tests). Statistical significance was set at $p < 0.05$ and two-sided tests were used throughout.

Results

Survivor characteristics

Table 1 presents an overview of survivor characteristics. The majority (71.4%) of prostate survivors were older than 60 at the time of diagnosis (mean = 61) and the survey (mean = 63). Just over two-thirds were educated only up to secondary level. Most (85.8%) were married or cohabiting at the time of diagnosis, had children (61.4%), were not claiming social welfare benefits (86.7%) and were employed (61.5%) rather than self-employed.

Table 1 Summary of survivor characteristics

Characteristic	No.	%
Age at diagnosis		
Up to 60	141	28.6
Over 60	352	71.4
Highest level of education		
Up to secondary	332	69.2
Tertiary	148	30.8
Marital status at diagnosis		
Married/cohabiting	416	85.8
Other	69	14.2
Have children		
No	128	38.6
Yes	204	61.4
In receipt of social welfare payments		
No	418	86.7
Yes	64	13.3
Employment status at diagnosis		
Employed	303	61.5
Self-employed	190	38.5

Equivalent days lost from work

The largest number of days lost from work (mean = 188) was due to permanent absenteeism, as would be expected (Table 2). This is followed by temporary absenteeism (86 days), reduced hours (85 days equivalent) and presenteeism (68 days equivalent). These components total 427 equivalent days on average lost from work due to cancer by employed or self-employed survivors.

Productivity costs

Estimated total and sub-total mean productivity costs are presented in Table 2. The base case ($HCA_{national\ wage}$) estimated total productivity cost was €44,201 per working prostate cancer survivor which equates to €104 per work day lost. Amongst individual productivity cost drivers, permanent absenteeism accounted for the greatest proportion of the base case (€18,537; 41.9%), followed by the cost of reduced work hours (€11,130; 25.2%), presenteeism (€8148; 18.4%) and temporary absenteeism (€6386; 14.4%).

Productivity costs estimated according to the alternative valuation techniques using national wages deviated widely from the base case, ranging between − 89% ($FCA_{national\ wage}$: €4625) and + 49% ($HCAWM_{national\ wage}$: €65,764). When individual cost components were considered, this range was − 95% ($FCA_{national\ wage}$ presenteeism costs) to + 106% ($HCAWM_{national\ wage}$ reduced hours costs) of the base case.

Using self-reported survivor wages rather than gross national wages resulted in higher estimated productivity costs ($HCA_{self\text{-}reported\ wage}$: €53,678; + 21.4% compared to base case). This finding was consistent across estimates ($FCA_{self\text{-}reported\ wage}$: €7840; + 69.5% compared to $FCA_{national\ wage}$ and $HCAWM_{self\text{-}reported\ wage}$: €80,485; + 22.4% compared to $HCAWM_{national\ wage}$).

None of the valuation techniques ranked cost drivers equivalent to their physical unit ranking and the ranking varied by approach. In the base case, for example, temporary absenteeism fell from second ranked in physical units to fourth ranked in terms of cost. Reduced hours rose from third ranked to second, while presenteeism rose from fourth to third. Valuation approaches also differed in their ranking of costs. For example, the HCAWM ranked the cost of reduced hours highest, while the FCA ranked temporary absenteeism costs highest.

Distribution effects of socio-demographic and economic sample characteristics

Considering equivalent days lost, amongst the six tested variables, age group alone emerged as statistically significant, with those aged up to 60 years reporting 608 days lost on average, compared to 304 for those aged 61 years and above ($p < 0.001$) (Table 3). This significant finding was repeated across all monetary valuation techniques applied. There was no significant difference in days lost by marital status, and this was also consistent across all approaches.

In the case of highest level of education, having children, social welfare payments and employment status at diagnosis, the results of significance testing were incongruent between physical and monetary measures. For each characteristic, at least one valuation technique (and in the case of social welfare payments, three techniques) exhibited statistically significant differences, where no such difference was reported for the physical days equivalent measure. In addition, statistical differences were twice as commonly found for self-reported wage valuation approaches compared to national wage approaches (4 versus 2 outside of the base case).

Discussion

Monetary approaches to valuing work absence and presenteeism

The magnitude of estimated productivity costs can affect the size of an ICER in economic evaluations when included, and the resultant policy decision on a proposed health technology intervention [10, 11]. A primary concern in their estimation is the choice of translation metric from physical units into monetary values [19]. Our study revealed striking differences in derived productivity costs both by cost component and in aggregated form due to choice of valuation approach.

Table 2 Mean productivity costs per working prostate cancer survivor (€2012) and subcomponent costed by HCA, HCAWM and FCA

Productivity cost categories	Physical units (days or days equivalent)	Rank of cost component	Base case: HCA national wage (€)	Rank of cost component	HCA self-reported wage (€)	Rank of cost component	% change from base case
Cost of temporary absenteeism	86	2	6386	4	6893	4	7.9
Cost of permanent absenteeism	188	1	18,537	1	23,778	1	28.3
Cost of reduced hours	85	3	11,130	2	15,128	2	35.9
Cost of presenteeism	68	4	8148	3	7879	3	− 3.3
Summed total	427		44,201		53,678		21.4

Productivity cost categories	HCAWM national wage (€)	Rank of cost component	% change from base case	HCAWM self-reported wage (€)	Rank of cost component	% change from base case	FCA national wage (€)	Rank of cost component	% change from base case	FCA self-reported wage (€)	Rank of cost component	% change from base case
Cost of temporary absenteeism	12,454	3	95.0	13,465	3	110.9	2675	1	− 58.1	5514	1	− 13.6
Cost of permanent absenteeism	18,537	2	0.0	23,778	2	28.3	1005	2	− 94.6	1235	2	− 93.3
Cost of reduced hours	22,944	1	106.1	31,740	1	185.2	566	3	− 94.9	719	3	− 93.5
Cost of presenteeism	11,829	4	45.2	11,502	4	41.2	380	4	− 95.3	373	4	− 95.4
Summed total	65,764		48.8	80,485		82.1	4625		− 89.5	7840		− 82.3

HCA human capital approach, *HCAWM* human capital approach adjusted for wage multipliers, *FCA* friction cost approach

Total summed productivity cost estimated ranged between −90% (FCA$_{\text{national wage}}$) and +82% (HCAWM $_{\text{self-reported wage}}$) compared to the base case (HCA$_{\text{national wage}}$). Such large deviations would equate to substantial differences when added to the direct costs associated with, in this case, prostate cancer treatment and would potentially alter the ICER result of an economic evaluation compared to a stipulated threshold. For example, our base case productivity costs of €44,201 are 3.2 times the size of the estimated direct healthcare costs for prostate cancer from diagnosis up to 4 years post-diagnosis at €13,818 per patient in Ireland [24].

Interestingly, our results revealed that the valuation approach was not only important for the magnitude of total productivity costs estimated but also distorted the ranking of individual cost components. For example, under the HCA$_{\text{(national wage)}}$, permanent absenteeism emerged as the highest ranked monetary cost component, compared to temporary absenteeism under the FCA$_{\text{(national wage)}}$ and the cost of reduced hours when the HCA was modified by WM (under the HCAWM$_{\text{national wage}}$). Researchers should be cognisant of this potential divergence when focusing on individual productivity cost components rather than aggregated totals. This finding rarely arises in the literature due to the limited number of productivity components usually estimated and the lack of reporting of productivity loss in physical units for comparative purposes. More studies are required to explore this divergence across other population groups and cancers types.

Recent research [25] has highlighted the impact of different wage estimation approaches on productivity loss estimation by focusing on the use of average gross national mean wages versus age-specific wages. The findings indicated that gross average wages overestimated lifetime productivity loss for younger individuals affected by illness, but underestimated losses during the prime working age. Our study extended that analysis to compare productivity costs estimated using gross national wages to self-reported wages. Gross wages in this case cover remuneration in cash paid during the reference year before any tax deductions and social security contributions payable by wage earners and

Table 3 Significance results of non-parametric tests for differences in median total productivity costs by valuation approach based on socio-demographic and economic sample characteristics

Category	Total days lost	$HCA_{national\ wage}$ (base case)	$HCA_{Self\text{-}reported\ wage}$	$HCAWM_{national\ wage}$	$HCAWMs_{elf\text{-}reported\ wage}$	$FCA_{national\ wage}$	$FCA_{Self\text{-}reported\ wage}$
Age group (*p* value)	0.000***	0.001**	0.000***	0.000***	0.000***	0.011*	0.001**
Up to 60	60	8614	12,000	15,371	21,000	4752	4800
Over 60	26	2970	3671	7248	7070	2376	2304
Education level (*p* value)	0.214	0.474	0.959	0.505	0.887	*0.035**	0.861
Up to secondary	50	6683	6000	12,520	10,708	4519	2838
Tertiary	35	3713	4731	8094	10,434	2838	2044
Marital status (*p* value)	0.406	0.948	0.676	0.963	0.653	0.919	0.311
Married/cohabiting	45	5941	6308	11,881	11,631	3904	3044
Other	26	3910	2633	8094	5450	1880	1262
Children (*p* value)	0.205	0.101	0.077	0.089	0.065	*0.046**	0.062
No	20	2970	3548	5614	5925	2128	1716
Yes	50	5941	8467	13,738	15,015	4671	3529
Social welfare (*p* value)	0.172	0.133	*0.049**	0.107	0.033	0.125	0.035*
No	16	743	335	1240	941	934	229
Yes	50	5941	7048	12,297	12,599	3692	2873
Employment status (*p* value)	0.166	0.188	0.088	0.227	0.092	0.135	0.007**
Employed	48	6312	7269	12,297	13,873	4117	3342
Self-employed	33	2970	3318	6237	6380	2376	1664

Statistical significance: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

HCA human capital approach, *HCAWM* human capital approach adjusted for wage multipliers, *FCA* friction cost approach

retained by the employer [https://ec.europa.eu/eurostat/statisticsexplained/index.php/Glossary: Structure_of_earnings_survey_(SES)]. To enhance comparability, self-reported wages from our survey, which were collected in net wage form using the question "Immediately before your diagnosis, what was your weekly take home pay?" followed by ten potential ranges, were modified to their gross sum based on the specifics of the Irish tax system and social welfare system. Deviations between wage rates in this study should therefore be based on the sample of wage earners included, rather than wage-based definition differences.

The impact of using self-reported wages to monetarise days lost from work increased the derived productivity cost estimate ranging from + 21% for $HCA_{self\text{-}reported\ wage}$ to + 70% for $FCA_{self\text{-}reported\ wage}$, a result consistent across all productivity cost components and valuation types. Consequently, the use of self-reported wage data appears insensitive to valuation approach and results in higher monetary values, compared to gross wage equivalents. Key sample characteristics such as an older age distribution of prostate cancer survivors at diagnosis compared to the average member of the working population upon whom national average wages are based, and a higher socio-economic status for prostate cancer survivors, may account for these results, but this finding requires further exploration across other population groups. Furthermore, the use of mean wages as opposed to median wages similarly increased derived productivity estimates, in this case between 14% (HCA and HCAWM) and 44% (FCA) compared to the base case (Supplementary Table 2).

The inclusion of presenteeism as a distinct component of productivity costs has been shown to represent a significant portion of the total societal costs associated with certain diseases [26]. A lack of consensus exists though on the most appropriate approach to measuring and valuing presenteeism costs in the literature. This can impact on the comparability of derived results across studies and hinder the inclusion of presenteeism costs in economic evaluations.

Our approach to measurement followed an indirect quantification method whereby respondents were asked their perceived overall estimate of how much the illness hindered their work on a 0–100% scale. This resulted in an estimated presenteeism cost of €8148 or 18% of total costs in the base case, the absence of which would have resulted in a considerable underestimation of the productivity costs associated with prostate cancer. Other measurement approaches exist including the direct approach which asks respondents about, for example, low concentration levels or feeling fatigue at work and the duration of these episodes [26] and a further approach using a comparison of respondent perceived work performance to that of a colleague in a similar role. Nevertheless, the indirect approach is the most widely used in the literature [26].

An additional finding that adds to the extant productivity cost literature includes the adjustment of presenteeism costs for multiplier effects. It has been argued that wages underestimate the productivity loss resulting from absence from work [23] due to job-specific characteristics such as teamwork, the ease of substitution of workers and the time sensitivity of output. A recent review [17] observed that these wage multiplier effects have not been previously used to adjust presenteeism costs. Our estimates revealed that the application of occupation-specific presenteeism multipliers resulted in an increase in costs to between 41 and 45% compared to the base case ($HCA_{national\ wage}$) and so carry the potential to significantly impact derived estimates. In addition, our study reported estimates of presenteeism cost according to the FCA which has been underreported in the literature to date [17]. In our study, the estimates for FCA presenteeism costs amounted to 5% of the base case equivalent estimates and 8% of total summed FCA costs.

Productivity cost valuation and its distributional impact

A major reason for excluding productivity costs from economic evaluations to date, beyond issues over methodological standardisation, is related to ethical concerns [5]. It is argued that incorporating productivity gains into economic evaluations will favour interventions targeted at those that are employed over those not reimbursed by the market, the unemployed and retirees [12]. However, as stated by Krol et al. [5], such distributional consequences do not justify their exclusion. More so, it is a reason for researchers and policymakers to be cognisant of the implications of including productivity costs/gains in economic evaluations, the manner in which the selection of valuation approach can affect derived estimates and, crucially, being transparent about the resulting equity implications of these.

The current study focused on the distributional consequences of alternate productivity cost valuation techniques for a relatively homogenous group of employed and self-employed prostate cancer survivors. While equity concerns have traditionally focused on working versus non-working cohorts, the distribution of productivity costs may also vary across groups depending on methodological approach. We have shown that this is indeed the case, and heterogeneity in income levels, age and education caused equity concerns and distributional issues.

All but two socio-demographic and economic characteristics included in the study (age and marital status) produced statistically significant variations in our estimated productivity costs depending on the valuation technique applied. Only the base case $HCA_{national\ wage}$ monetary valuation approach produced an equivalent distribution of productivity costs to their physical unit measures (days equivalent). All other valuation approaches, using both national wages and self-reported wages, produced significant differences in productivity cost by survivor characteristic indicating variation in distributional impact. Indeed, the use of self-reported wage data rather than national wages tended to exacerbate this effect and resulted in four significantly different cost results compared to two for national wages amongst our approaches. Therefore, as valuation methods begin to resemble more closely real-world labour market conditions at a micro level, the associated distributional issues present there are transposed onto derived productivity costs resulting in greater variability by survivor characteristic.

A trade-off appears to exist between greater accuracy based on real-world labour market data to estimate productivity costs specific to the cohort under study (a key efficiency concern), and the increased distributional concerns that arise (a key equity concern). We agree with Zhang et al. [27] and recommend that where researchers use productivity costs for health care decision making, they should also report the costs in their physical unit form for transparency, so that alternative valuation approaches may be applied where necessary and equity issues derived from these are explored through sensitivity analysis. Greater transparency thus constitutes a key approach moving forward in the productivity cost estimation literature, where efficiency versus equity concerns can be judged on a case-by-case basis by the appropriate decision makers based on personal preference sets and national-specific welfare functions where appropriate. Where sensitivity analysis of alternative valuation approaches cannot be undertaken, due to time or data constraints, based on the results here, we would recommend the selection of the HCA and national wages to value productivity loss to minimise distributional issues where equity is a key concern.

Strengths and limitations

Our study adds to the literature by indicating the impact of survivor characteristics on productivity costs using alternative estimation approaches indicating a distinct efficiency–equity trade-off in current methodological practice. We also encompass a broad range of productivity types (absenteeism, permanent absenteeism, reduced hours and presenteeism) in the study, in addition to applying the most up to date estimates for WM.

While the use of a sample of prostate cancer survivors was advantageous in terms of the homogeneity of the cohort where distributional concerns by characteristic would not be perceived as substantial a priori, this decision limited our choice of relevant testable demographic variables, namely gender, which would have been of interest in the analysis. Responses to our questionnaire were provided, on average, 3.9 years post-diagnosis. This may have caused issues with recall which may have impacted on our results. In addition, this may explain the small percentage of respondents who reported presenteeism (13%).

Our estimates of wage multipliers by occupation were derived from a Swedish study, where labour market conditions may not be perfectly matched to Irish labour market conditions, however, no estimates of multipliers exist for Ireland currently. Estimates derived for the FCA are also dependent on the extant labour market conditions in a country and variation in the friction period can occur due to deviations in the unemployment rate and the vacancy rate. Specifically, shorter friction periods are predicted as unemployment rates rise and longer periods are predicted from increasing vacancy rates. This issue is explored further for Ireland in [20]. Variation in labour market conditions between the estimation of the friction period for Ireland used in this study (2006) and the analysis year (2012) may hinder the accuracy of the results. This, however, is a general limitation of the FCA approach and not specific to this study.

There exists an ongoing conflict between the FCA and the application of WM where absenteeism is assumed to result in a less than proportionate decrease in production according to the FCA compared to a greater than proportionate increase for WM. This conceptual incongruence is beyond the current study to assess but remains an interesting field of further study. We have, however, attempted to account for both compensation mechanisms and wage multipliers in the FCA in this study following [28] and placed the results of this in Supplementary Table 1.

Finally, in the base case, we applied the national gross median wage to estimate productivity losses. This may have led to a degree of overestimation of productivity costs compared to the use of age-specific wages [25]. To account for this, we also applied survey specific (and thus age-specific sample wages) in a second application.

Conclusion

Equity and distributional concerns remain a major hindrance to the integration of productivity costs into health economic evaluations. This study shows that striving for greater accuracy in the efficiency of productivity cost estimates may come at the expense of equity and distributional concerns. Derived productivity cost estimates varied depending on the selection of valuation approach and the underlying sociodemographic characteristics of the sample. We advocate that productivity loss should be reported in physical units where possible, cost estimation should be subject to sensitivity analysis in terms of approach, and where this is not feasible, we recommend selection of the HCA and national wages to value productivity loss where equity as opposed to efficiency concerns are paramount.

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