Appl Health Econ Health Policy (2015) 13:359–367
DOI 10.1007/s40258-015-0155-8

ORIGINAL RESEARCH ARTICLE

Productivity Losses Associated with Head and Neck Cancer Using the Human Capital and Friction Cost Approaches

Alison M. Pearce · Paul Hanly · Aileen Timmons · Paul M. Walsh · Ciaran O'Neill · Eleanor O'Sullivan · Rachael Gooberman-Hill · Audrey Alforque Thomas · Pamela Gallagher · Linda Sharp

Published online: 19 February 2015

Abstract

Objectives Previous studies suggest that productivity losses associated with head and neck cancer (HNC) are higher than in other cancers. These studies have only assessed a single aspect of productivity loss, such as temporary absenteeism or premature mortality, and have only used the Human Capital Approach (HCA). The Friction Cost Approach (FCA) is increasingly recommended, although has not previously been used to assess lost production from HNC. The aim of this study was to estimate the lost productivity associated with HNC due to different types of absenteeism and premature mortality, using both the HCA and FCA.

Methods Survey data on employment status were collected from 251 HNC survivors in Ireland and combined with population-level survival estimates and national wage data. The cost of temporary and permanent time off work, reduced working hours and premature mortality using both the HCA and FCA were calculated.

Results Estimated total productivity losses per employed person of working age were EUR253,800 using HCA and EUR6800 using FCA. The main driver of HCA costs was premature mortality (38 % of total) while for FCA it was temporary time off (73 % of total).

Conclusions The productivity losses associated with head and neck cancer are substantial, and return to work assistance could form an important part of rehabilitation. Use of both the HCA and FCA approaches allowed different drivers of productivity losses to be identified, due to the different assumptions of the two methods. For future estimates of productivity losses, the use of both approaches may be pragmatic.

Electronic supplementary material The online version of this article (doi:10.1007/s40258-015-0155-8) contains supplementary material, which is available to authorized users.

A. M. Pearce (✉) · A. Timmons · P. M. Walsh · L. Sharp
National Cancer Registry Ireland, Cork, Ireland
e-mail: a.pearce@ncri.ie

P. Hanly
National College of Ireland, Dublin, Ireland

C. O'Neill · A. A. Thomas
National University of Ireland Galway, Galway, Ireland

E. O'Sullivan
Cork University Dental School and Hospital, Cork, Ireland

R. Gooberman-Hill
University of Bristol, Bristol, Ireland

P. Gallagher
Dublin City University, Dublin, Ireland

Key Points for Decision Makers

Productivity losses following head and neck cancer are substantial, and are higher than seen in other cancers.

Productivity losses are higher for those with pharyngeal cancer, more advanced disease and who receive chemotherapy.

The HCA is a societal approach, giving an estimate of the upper bound of productivity losses, while the FCA takes an employer's perspective, giving the lower bound estimate.

The differing assumptions behind the HCA and FCA identify different drivers of productivity loss estimates. Premature mortality was the main driver of HCA costs while temporary time off drove FCA results.

The demographics of the patient population, length and severity of illness, and impact on work performance will influence whether the HCA or FCA is more appropriate for estimating productivity losses. A pragmatic approach may be to use both methods.

1 Introduction

Head and neck cancer, which encompasses cancers of the mouth, salivary glands, pharynx, nasal cavity/middle ear/sinuses, and larynx [1], has an estimated age standardised rate of 11 per 100,000 in Europe [2]. While traditionally a cancer of older men, the emergence of Human Papilloma Virus (HPV)-related cancers of the head and neck has markedly changed incidence patterns [3, 4]. HPV-related head and neck cancer occurs primarily among younger (40–59 years) non-smokers from higher socio-economic groups [4], resulting in head and neck cancer becoming increasingly common in those of working age.

Similar to other cancers, most people diagnosed with head and neck cancer who are working at the time of diagnosis are likely to take some time out of the workforce for treatment (surgery, radiotherapy or chemotherapy), recuperation and rehabilitation. Published rates of return to work following a diagnosis of head and neck cancer range from 40 % at 1 year [5] to over 80 % after at least 2 years [6, 7], although some people take up to 5 years [8].

In addition to impacting on the individual's identity [9] and quality of life [10], time away from the workplace as a result of cancer has implications both for the employer and for society as a whole in the form of productivity losses. Estimates of productivity losses can contribute to decision making from a cost of illness perspective, and to economic evaluations of new drugs, devices and services within a healthcare system.

The traditional approach to estimating productivity losses in health economics has been the Human Capital Approach (HCA), which sees individuals as potentially producing a stream of output over a working life [11–13]. HCA measures lost productivity as the time the working life is shortened by due to illness, valued at the market wage.

An alternative to the HCA is the Friction Cost Approach (FCA), which takes into account that absent workers are usually replaced within the workplace [14]. Lost productivity is limited to the time taken to replace the worker (the so called 'friction period'), again valued at the market wage. The choice of method for calculating productivity losses remains under debate; although most jurisdictions who recommend the inclusion of indirect costs in economic evaluations recommend HCA, a growing number suggest using the FCA [15].

A small number of previous studies report productivity losses associated with head and neck cancer [4, 16–18]. They suggest losses due to premature mortality are higher for head and neck cancer than other types of cancer [16] and that socio-demographic and clinical factors such as age, gender and cancer site may contribute to lost productivity [17]. However, these studies only included losses due to a single aspect of productivity, such as absenteeism [18], or premature mortality [16, 17], and only used the HCA.

This analysis aimed to estimate the cost of lost productivity due to different types of absenteeism and premature mortality associated with head and neck cancer using both the HCA and FCA.

2 Methods

2.1 Setting

The study was conducted in Ireland, which has a mixed public-private universal healthcare system. Individuals with income below a certain threshold are entitled to a Medical Card that provides free primary and tertiary medical care and subsidised pharmaceuticals. Under employment law an employee has no right to be paid whilst on sick leave and sick pay policies are at the discretion of employers [19]. Those whose employer does not provide sick pay may apply to receive statutory illness benefit. In cases where an employee has consistently been absent from work due to illness employment can be terminated [19].

2.2 General Approach

To estimate productivity costs using the HCA and FCA, survey data of workforce participation prior to and following head and neck cancer diagnosis were combined for each individual survey respondent with population level survival data and national economic data. Four types of productivity loss were calculated: (1) Temporary time off work (TTO): individuals who take time off work after diagnosis, but then return to work. (2) Permanent time off work (PTO): individuals who cease working as a result of their diagnosis. (3) Reduced hours at work (RHW): individuals who continue working after their diagnosis (with or without a period of TTO) but work fewer hours than before diagnosis. (4) Premature mortality (PM): projected 'excess' years of life lost (to age 65) for every individual—excluding background mortality losses. PTO and RHW losses were corrected for total mortality—background or excess—to avoid double counting of costs. Costs were calculated in 2013 Euros.

2.3 Data Sources

For the survey, a population-based sample of head and neck cancer survivors diagnosed during 1994–2008 was selected from the National Cancer Registry Ireland. Eligible individuals included those: with a primary head and neck cancer (ICD-10 codes C00–C14 or C32), at least 8 months post-diagnosis, and who had been treated in one of 14 public or private hospitals (including all of the main head and neck cancer treatment centres) throughout Ireland. Eligible individuals were invited to participate following the agreement of their treating clinician. Ethical approval was provided by the research ethics committee for each of the participating hospitals.

A total of 991 head and neck cancer survivors were sent a survey in August to October 2012 which, in addition to demographic and clinical questions, collected information on occupation and workforce participation. Questions were included on employment status at diagnosis (i.e., working for an employer, self-employed, unemployed, looking after family or home, retired), occupation at diagnosis, weekly hours worked at diagnosis and currently, and time taken off work following diagnosis. No questions were asked about performance at work pre- and post-diagnosis and so presenteeism costs were not included in the calculations. Survivors were included in the analysis if they returned a completed questionnaire and indicated that they were working (either for an employer or self-employed) and of working age (under 65 years) at the time of diagnosis.

Occupation at diagnosis was coded to the Standard Occupational Classification [20]. The average wage rates for Ireland by gender and occupational group were identified from the Central Statistics Office National Employment Survey [21]. The same source was used to impute the average hours worked per week by gender for the 44 survey respondents who did not provide their weekly working hours at both pre-diagnosis and the time of the survey. When working hours were provided at only one time point, it was assumed that these did/had not change(d). Wage growth was estimated as forecasted Gross National Product growth at an average 1.7 % per year, based on a major study of the medium-term economic outlook for Ireland 2013 to 2020 [22]. A discount rate of 4 % was applied to future earnings, consistent with the Irish standard [23].

For the FCA, the friction period was assigned based on average Irish vacancy rates by occupation type [24]. Professional occupations (managers, professionals and associate professionals) were assumed to have a friction period of 13.3 weeks [24]. Service occupations (clerical sales and service occupations) had a friction period of 9.9 weeks, and manual occupations (production, transport, craft and other manual occupations) had a friction period of 10.1 weeks [24]. As no accurate estimate of the elasticity of annual labour supply in Ireland was available it was assumed to be 1.0 [25].

National Cancer Registry population-level survival data (available on request) for all head and neck cancer types and stages combined and Irish life table data [26] were used to estimate premature mortality [25, 27].

2.4 Calculations

Productivity costs were calculated up to age 65 years, the current pensionable age in Ireland. Individuals with missing data for occupation type were given the average wage for their gender and age. Individuals with missing data for other work pattern variables (such as temporary time taken off work) were excluded from descriptive statistics, and assumed to have no costs associated with corresponding productivity losses; thus the resulting cost estimates are conservative. The working status, working hours and occupation at the time of the survey were assumed to continue without change to retirement age. Individuals who left the workforce permanently due to their cancer were assumed to cease work from the date of diagnosis.

For the HCA, TTO was calculated as weekly income multiplied by the number of weeks off, adjusted for growth rate and discounting when time off was greater than 12 months. PTO was calculated as annual wage multiplied by the number of years from diagnosis to retirement age (65 years), adjusted for wage growth, discounting and total mortality. If an individual had both a PTO and TTO cost, it was assumed the PTO commenced at the end of the TTO and thus the later was subtracted from the former to avoid double-counting.

RHW was calculated as the wages for lost hours each year, adjusted for wage growth, discounting and total mortality, from diagnosis to retirement age. For those with a TTO cost, the period of TTO was subtracted from the period of RHW. For PM, the projected average loss of years to age 65 for each patient in the survey was computed by estimating the probability of 'excess' (cancer related) mortality annually to age 65 (having subtracted background mortality), applying this to the number of patients at risk at each age, weighting the results by the number of years remaining, then summing. PM costs therefore exclude costs associated with 'background' deaths in the general population under age 65, which are adjusted for as part of total mortality costs in the PTO and RHW calculations.

Similar calculations were used for the FCA, although the period of time for which the losses applied was capped at the relevant friction period. Consistent with FCA methods, total mortality, discounting and wage growth were not adjusted for in the FCA calculations due to the short (9- to 13-week) friction periods, although it is recognised that PM may occur well into the future.

All data management and analyses were done in SAS 9.3.

2.5 Sensitivity Analyses

Sensitivity analysis was conducted to assess the impact of various data assumptions on the overall lost productivity costs. The discount rate was varied from 0 to 6 % [23], wage growth was varied from 1 to 2.8 % [22] and the friction period was increased and reduced by 20 %.

3 Results

There were 583 eligible surveys received (response rate 59 %). The survey responders were similar to non-responders in all comparisons: gender, age group (up to age 65), cancer site, cancer stage and time since diagnosis (chi-squared tests, $P > 0.05$). Of the survey responders, 424 were of working age (<65 years) and 285 reported being either employed or self-employed at the time of diagnosis. There were 252 respondents who were both of working age and employed or self-employed at the time of diagnosis; however, missing data meant that 251 individuals were included in the analysis.

3.1 Socio-demographics, clinical and work details of analysis group

Table 1 presents the demographic and clinical characteristics of the analysis sample and Table 2 their working arrangements. The mean age at diagnosis was 51 years and 71 % of subjects were male. Seventy-seven percent of the sample reported taking time off work, with 30 % not returning to the workforce by the time of the survey. The average pre-diagnosis working hours were 39 per week, and one-third of participants were self-employed.

Table 1 Socio-demographic and clinical characteristics of analysis group (individuals with head and neck cancer who were employed and aged under 65 years at the time of diagnosis)

Variable[a]	*n*	%
Gender		
Male	177	71
Female	74	29
Age		
At diagnosis (mean, range)	51 years	23–64 years
At survey completion (mean, range)	58 years	30–81 years
Education ($n = 247$)		
Primary school	59	24
Secondary school	113	45
Third-level education	51	20
Post-graduate education	24	10
Area of residence ($n = 249$)		
Urban	150	60
Rural	99	40
Medical card holder ($n = 246$)		
Yes	36	15
No	210	85
Tumour site		
Lip	2	1
Mouth	83	33
Salivary glands	22	9
Pharynx	58	23
Larynx	86	34
Stage ($n = 207$)		
Stage I	76	37
Stage II	40	19
Stage III	39	19
Stage IV	52	25
Chemotherapy		
Yes	62	25
No	189	75
Radiotherapy		
Yes	169	67
No	82	33
Surgery		
No surgery	78	31
Minor surgery	133	53
Major surgery	40	16

[a] Total $n = 251$ unless otherwise stated

3.2 Productivity Losses

Table 3 shows the average total productivity losses calculated using the HCA and FCA. Average total productivity losses for head and neck cancer were estimated to be EUR253,800 per person working at the time of diagnosis with HCA and EUR6800 per person working at the time of diagnosis with FCA. The FCA estimate is approximately 3 % of the HCA estimate. The main driver of cost using the HCA was premature mortality (which accounted for 38 % of the total cost), while using the FCA it was temporary time off (73 % of the total cost).

Table 2 Workforce participation details of analysis group (individuals with head and neck cancer who were employed and aged under 65 years at the time of diagnosis)

Work detail[a]	*n*	%
Employment status		
Employed	167	67
Self-employed	84	33
Occupational category ($n = 210$)		
Managers and administrators	21	10
Professional	31	14
Associate professional and technical	26	12
Clerical and secretarial	16	8
Craft and related	43	20
Personal and protective services	14	7
Sales	10	5
Plant and machine operatives	25	12
Other broad groups	25	12
Took time off after diagnosis ($n = 222$)		
Yes	194	77
No	28	11
Participated in the workforce after diagnosis ($n = 189$)		
Yes	117	47
No	72	30
Time taken off work ($n = 148$)		
Months (mean, range)	8.76	0.25 to 65
Weekly hours worked[b]		
Pre-diagnosis (mean, range)	39	0 to 90
Post-diagnosis (mean range)	28	0 to 75

[a] Total $n = 251$ unless otherwise noted

[b] Includes 44 individuals with imputed hours worked, where data was missing

3.3 Productivity Losses by Socio-Demographic and Clinical Factors

Table 4 shows productivity losses using the two approaches compared by socio-demographic and clinical variables. Regardless of approach, productivity losses were higher for males, those with higher education and those with professional occupations, driven by the higher wages in these groups. Using the HCA, younger individuals had much higher productivity losses than older individuals due to the longer time period of lost productivity. For clinical subgroups, both approaches found that those with pharyngeal cancer, more advanced disease and who received chemotherapy had higher productivity losses.

3.4 Sensitivity Analysis

In the HCA, varying the predicted wage growth rate and discount rate resulted in a range of total productivity losses of EUR197,952 to EUR519,332. In the FCA, varying the friction period resulted in a range of total productivity losses of EUR5843 to EUR8119. For the full sensitivity analysis results see Online Resource 1. The sensitivity analysis did not impact on the distribution of productivity cost components for either approach.

4 Discussion

This is the first study estimating the lost productivity costs associated with head and neck cancer using both the HCA (EUR253,800 per person working at the time of diagnosis) and FCA (EUR6800 per person working at the time of diagnosis). It is also the first study to estimate the productivity losses associated with different aspects of

Table 3 Estimated productivity losses per person of working age and employed at the time of head and neck cancer diagnosis calculated with the Human Capital Approach (HCA) and Friction Cost Approach (FCA) (2013 Euros)

Cost Category	HCA base case	% of total HCA productivity	FCA base case	% of total FCA productivity	FCA as a % of HCA (base case)
Temporary time off	EUR 20,423	8	EUR 4,953	73	24
Permanent time off	EUR 68,637	27	EUR 1,186	17	2
Reduce work hours	EUR 67,098	26	EUR 489	7	1
Premature mortality	EUR 97,674	38	EUR 175	3	0
Total	EUR 253,833		EUR 6,803		3

FCA friction cost approach, *HCA* human capital approach

Table 4 Estimated productivity losses per person of working age and employed at the time of head and neck cancer diagnosis comparing the Human Capital Approach (HCA) and Friction Cost Approach (FCA) by socio-demographic and clinical variables (2013 Euros)

Socio-demographic variables	HCA total	FCA total
Males	EUR254,792	EUR7,116
Females	EUR251,538	EUR6,053
<51 years at diagnosis	EUR350,962	EUR6,291
51+ years at diagnosis	EUR178,058	EUR7,203
Up to secondary	EUR220,542	EUR6,017
Tertiary/post	EUR330,572	EUR8,375
Urban	EUR253,629	EUR6,998
Rural	EUR254,707	EUR6,577
Employed	EUR279,105	EUR7,518
Self-employed	EUR203,589	EUR5,381
Professional	EUR356,294	EUR11,545
Service	EUR237,318	EUR4,257
Manual	EUR206,266	EUR5,413
Larynx cancer	EUR237,177	EUR7,203
Pharynx cancer	EUR321,627	EUR8,403
Other cancer site	EUR230,471	EUR5,614
Medical card holder	EUR238,605	EUR5,199
No medical card	EUR258,829	EUR7,084
Stage I/II	EUR212,028	EUR6,001
Stage III/IV	EUR274,805	EUR8,078
No chemotherapy	EUR235,837	EUR6,036
Chemotherapy	EUR308,691	EUR9,139
No radiotherapy	EUR223,894	EUR4,830
Radiotherapy	EUR268,359	EUR7,760
No surgery	EUR256,906	EUR6,997
Minor surgery	EUR246,582	EUR6,609
Major surgery	EUR271,947	EUR7,067

workforce absenteeism (TTO, PTO, RHW), as well as premature mortality (PM) for head and neck cancer.

4.1 Comparison of Results to Previous Work

Comparisons to previous studies of productivity losses in head and neck cancer are difficult, due to the differing methodologies used. Two studies have calculated lost productivity due to premature mortality, and found results ranging from US$299,809 in 2000 [17] to US$406,061 in 2003 [16] per death in the US. However, the denominator for these calculations is the total deaths per year, rather than survivors, as used in this study. A third study included the daily allowance paid by health insurance to compensate individuals for lost income in France, and estimated an annual total in 2007 of EUR73.9 million [18].

A small number of previous studies, all from Europe, have used similar methods to compare the productivity losses associated with breast [25, 28], prostate [25] and cervical [28] cancers using the HCA and FCA. The proportion of HCA and FCA costs were similar for cervical cancers, where FCA losses were 2.6 % of the HCA calculated costs [28], while for breast and prostate cancers FCA losses were 4.0 % [25, 28] and 7.5 % [25] respectively, of the HCA calculated costs.

The FCA estimates of total head and neck cancer costs in this study are similar to, although somewhat lower than, estimates for other cancer sites (eg, EUR8103 in breast cancer, EUR8205 in prostate cancer [25]), primarily driven by the limited period during which costs are accrued. However, the magnitude of the HCA estimates for head and neck cancer (EUR253,800) are higher than those for breast (EUR193,400) [25], prostate (EUR109,100) [25] and colorectal (EUR205,800) [27] cancers in the same setting. In particular, permanent time off costs were at least twice as high in head and neck cancer (EUR68,600) as in the other cancers (which ranged from EUR24,400 in colorectal cancer [27] to EUR34,700 in prostate cancer [25]), driven by the substantially higher proportion of individuals who depart the workforce permanently following head and neck cancer (30 % compared to 13 % in breast cancer and 12 % in prostate cancer) [25]. These higher numbers may be due to the increased morbidity associated with head and neck cancer and its treatments compared to other cancers [29].

4.2 Using the Human Capital and Friction Cost Approaches in Economic Evaluation

While productivity loss estimates have, for a long time, contributed to cost of illness estimates, they are increasingly being included in economic evaluations. One of the primary purposes of economic evaluations is to determine the reimbursement of new drugs and devices within a healthcare system. Many jurisdictions take a societal approach to economic evaluations, and these often include the consideration of productivity losses; however, the choice of method for considering productivity losses is still under debate both within and across jurisdictions [15].

The HCA takes a societal, and therefore more comprehensive, approach [25, 30] by measuring ‘potential’ losses to society. This results in estimates of the maximum of possible production lost [25]. It is thus appropriate when conducting an economic evaluation from a societal perspective [15], and the well-established methods with relatively accessible data means it is comparatively easy to apply.

In contrast, the FCA is said to more accurately estimate the ‘actual’ or lower bound of lost production [25], by allowing for co-workers to compensate for some lost production, and unemployed individuals to replace lost workers [25]. This approach is more consistent with an employer's perspective, which is particularly relevant in healthcare systems where employers pay for at least part of health insurance [30]. It has been argued that the FCA is more difficult to apply given the need for more complex data [30].

Other approaches, such as the US Panel Approach, have been suggested, but these have not yet been recommended by any jurisdictions [15].

4.3 Drivers of Differences Between Approaches

The equity implications of including productivity losses in cost-effectiveness analyses have been long recognised [31]. However, observing the estimates for different socio-demographic and clinical subgroups allows an illustration of how the different assumptions of the HCA and FCA methods result in different drivers of productivity losses differ. As seen in other studies [25, 32], this analysis found the key driver of productivity losses with HCA was age, while the FCA was driven by wage differences. The HCA results in particularly high values of lost production for younger individuals who cease working, whereas age has less of an impact of FCA estimates. The equity implications of using wages to value production have been well documented, with concern that highly paid individuals will have their health gains valued more highly. Similar issues apply with the FCA, where individuals with lower salaries tend to be easier to replace, and thus have shorter friction periods and correspondingly lower productivity losses. This highlights the ethical concerns around subgroup analysis in productivity analyses.

The length and severity of the illness under consideration will also influence estimates. Diseases with longer-term impacts, such as cancer, are likely to have greater differences between the HCA and FCA than short-term illnesses such as influenza. In addition, diseases which result in significant periods of presenteeism, such as depression, would under estimate productivity loss using the FCA, as this does not capture presenteeism.

The results of this study highlight the importance of health economists and policy makers being aware of the assumptions underpinning estimates of lost productivity. The choice of method should be based on the perspective of the decision problem and theoretical arguments for which approach will provide a true reflection of productivity losses. However, the requirements of the local jurisdiction may supersede these considerations. HTA guidelines in an increasing number of jurisdictions recommend, or at least allow, the FCA to be used as a sensitivity analysis for an HCA base case, and given the ongoing debate in the literature this may be the most pragmatic approach.

4.4 Strengths and limitations of the study

This is the first study to examine the productivity losses of head and neck cancer using the FCA, and uses a relatively large sample with longer follow up than other, similar, studies. In addition, the use of self-reported data minimises assumptions about workforce participation, and allows productivity loss due to factors other than premature mortality to be calculated—a first for head and neck cancer.

By differentiating the different types of work absence (PTO, TTO and RHW) we gain a better picture of the composition of the productivity losses of head and neck cancer. For example, the results of this study indicate that although many individuals return to work, the long-term implications of head and neck cancer influence people's ability to return at the capacity they had pre-diagnosis. This pattern is less clear in the FCA because of the truncated time frame considered by the method.

A limitation of the study is that the extended time since diagnosis for some participants introduces potential for differential recall according to time since diagnosis. A further potential difficulty related to this extended time-frame is that the economic situation in Ireland has changed dramatically over the last decade. It is possible that national economic circumstance influenced workforce participation among participants (rather than the head and neck cancer per se), and that the recent economic data used in this analysis may not reflect working conditions that applied at the time of diagnosis. The inclusion of a control group was not possible in this analysis; however, in future studies would allow the impact of wider economic factors on productivity to be quantified.

Finally, the indirect costs of cancer are not limited to loss of attendance at the workplace and premature mortality. Additional losses not included in this analysis include reduced productivity in paid work (presenteeism) and loss of unpaid production such as household responsibilities and caring [33]. These costs are difficult to incorporate into the FCA [30], but if data were available could have been included in the HCA calculations.

5 Conclusion

Productivity losses associated with head and neck cancer are a significant component of the burden of illness. Individuals with pharyngeal cancer, more advanced disease and who received chemotherapy had greater productivity losses.

Using the HCA and FCA approach to estimate productivity costs provides decision makers with information concerning the differences in costs derived according to each approach and the key drivers of costs, which change according to method applied. A pragmatic approach for future research may be to use both HCA and FCA to estimate productivity losses associated with cancer.

Acknowledgments We thank the study participants and the consultants and their teams who assisted with reviewing subjects' details. We are grateful to the following: Michal Molcho for participation in the ICE Steering Committee; Phyllis Butow for participation in the SuN Steering Committee; and National Cancer Registry Ireland staff involved in collection and processing of cancer registrations.

Financial and other support This work was funded by a Health Research Board (HRB) Interdisciplinary Capacity Enhancement (ICE) Award, which funds post-doctoral fellowships for Alison Pearce, Audrey Alforque Thomas and Aileen Timmons (ICE/2012/9). The SuN study survey development and data collection was funded by an HRB project grant (HRA/2009/262).

Conflicts of interest Alison Pearce, Paul Hanly, Aileen Timmons, Paul Walsh, Ciaran O'Neill, Eleanor O'Sullivan, Rachael Gooberman-Hill, Audrey Thomas, Pamela Gallagher and Linda Sharp report no conflicts of interest.

Author contributions All authors reviewed and provided expert input to the analysis protocol, interpretation of results and drafts of the manuscript. In addition, AP cleaned the data, conducted the analysis and drafted the manuscript. PH suggested and advised on the methodology and assisted with the analysis and interpretation. AT conducted the survey of head and neck cancer patients. PW analysed the National Cancer Registry data. LS, AT, RGH, CON and PG obtained funding. LS initiated the project, she was Principal Investigator of the SuN survey study, and is the guarantor for the overall content.

References

1. National Cancer Registry Ireland. Cancers of the head and neck. Cancer trends No. 10. National Cancer Registry Ireland: Cork; 2011.
2. Ferlay J, Steliarova-Foucher E, Lortet-Tieulent J, Rosso S, Coebergh JWW, Comber H, et al. Cancer incidence and mortality patterns in Europe: Estimates for 40 countries in 2012. Eur J Cancer. 2013;49:1374–403.
3. Adelstein DJ, Ridge JA, Gillison ML, Chaturvedi AK, D'Souza G, Gravitt PE, et al. Head and neck squamous cell cancer and the human papillomavirus: summary of a National Cancer Institute State of the Science Meeting, November 9–10, 2008, Washington, DC. Head Neck. 2009;31(11):1393–422.
4. Coughlan D, Frick KD. Economic impact of human papillomavirus-associated head and neck cancers in the United States. Otolaryngol Clin North Am. 2012;45:899–917.
5. Buckwalter AE, Karnell LH, Smith RB, Christensen AJ, Funk GF. Patient-reported factors associated with discontinuing employment following head and neck cancer treatment. Arch Otolaryngol Head Neck Surg. 2007;133(May):464–70.
6. Verdonck-de Leeuw IM, van Bleek WJ, Leemans CR, de Bree R. Employment and return to work in head and neck cancer survivors. Oral Oncology. 2010;46:56–60.
7. Chang KP, Lai CS, Hsieh TY, Wu YC, Chang CH. Two-year quality of life after free flap reconstruction in tumor-site discrepancy among Taiwanese with moderately advanced oral squamous cell carcinoma. World J Surg Oncol. 2012;10:145.
8. Pearce AM, Timmons A, O'Sullivan E, Gallagher P, Gooberman-Hill R, Thomas AA, et al. Long-term workforce participation patterns following head and neck cancer. J Cancer Surviv. 2014 [Epub ahead of print].
9. Syse A, Tretli S, Kravdal O. Cancer's impact on employment and earnings—a population-based study from Norway. J Cancer Surviv. 2008;2:149–58.
10. Ramirez MJF, Ferriol EE, Domenech FG, Llatas MC, Suarez-Varela MM, Martinez RL. Psychosocial adjustment in patients surgically treated for laryngeal cancer. Otolaryngol Head Neck Surg. 2003;129(1):92–7.
11. Weisbrod B. Economics of public health. Philadelphia: University of Pannsylvania Press; 1961.
12. Cooper BS, Rice DP. The economic cost of illness revisited. Soc Secur Bull. 1976;39:21–36.
13. Johannesson M, Karlsson G. The friction cost method: a comment. J Health Econ. 1997;16:249–55.
14. Koopmanschap MA, Rutten FF, Van Ineveld BM, van Roijen L. The friction cost method for measuring indirect costs of disease. J Health Econ. 1995;14:171–89.
15. Knies S, Severens JL, Ament AJHA, Evers SMAA. The transferability of valuing lost productivity across jurisdictions. Differences between national pharmacoeconomic guidelines. Value Health. 2010;13(5):519–27.
16. Ekwueme DU, Chesson HW, Zhang KB, Balamurugan A. Years of potential life lost and productivity costs because of cancer mortality and for specific cancer sites where Human Papillomavirus may be a risk factor for carcinogenesis—United States, 2003. Cancer. 2008;113(10 suppl):2936–45.
17. Bradley CJ, Yabroff KR, Dahman B, Feuer EJ, Mariotto A, Brown ML. Productivity costs of cancer mortality in the United States: 2000–2020. J Natl Cancer Inst. 2008;100(24):1763–70.
18. Borget I, Abramowitz L, Mathevet P. Economic burden of HPV-related cancers in France. Vaccine. 2011;29(32):5245–9.
19. Citizens Information Board. Sick leave and sick pay. 2013. http://www.citizensinformation.ie/en/employment/employment_rights_and_conditions/leave_and_holidays/sick_leave.html. Accessed 19 Nov 2013.
20. Office for National Statistics. Standard occupational classification 2010. http://www.ons.gov.uk/ons/guide-method/classifications/current-standard-classifications/soc2010/index.html. Accessed 19 Nov 2013.
21. Central Statistics Office. National employment survey. NSA06: mean and median hourly earnings by employment status, sex, occupation, year and statistic. 2013. http://www.cso.ie/px/pxeirestat/Statire/SelectVarVal/Define.asp?maintable=NSA06&PLanguage=0. Accessed 19 Nov 2013.
22. The Economic and Social Research Institute. Irish economy. 2012. http://www.esri.ie/irish_economy/. Accessed 10 July 2013.
23. Health Information and Quality Authority. Guidelines for the economic evaluation of health technologies in Ireland. In: Health Information and Quality Authority, editor. Health Information and Quality Authority; 2010.
24. Hanly P, Koopmanschap MA, Sharp L. The friction cost approach in a changing macroeconomic environment: the case of colorectal cancer productivity costs. TBC. Draft. [under review].
25. Hanly P, Timmons A, Walsh PM, Sharp L. Breast and prostate cancer productivity costs: a comparison of the human capital approach and the friction cost approach. Value Health. 2012;15(3):429–36.
26. Central Statistics Office. Irish life tables No. 15, 2005–2007. Dublin: Central Statistics Office; 2009.
27. Hanly P, Walsh PM, Ó Céilleachair A, Skally M, Staines A, Kapur K, et al. Work-related productivity losses in an era of ageing populations: the case of colorectal cancer. J Occup Environ Med. 2013;55(2):128–34.

28. Oliva J, Lobo F, Lopez-Bastida J, Zozaya N, Romay R. Indirect costs of cervical and breast cancers in Spain. Eur J Health Econ. 2005;6:30–313.
29. Penner JL. Psychosocial care of patients with head and neck cancer. Semin Oncol Nurs. 2009;25(3):231–41.
30. Lensberg BR, Drummond MF, Danchenko N, Despiegel N, Francois C. Challenges in measuring and valuing productivity costs, and their relevance in mood disorders. Clinicoecon Outcomes Res. 2013;5:565–73.
31. Williams A. Cost-effectiveness analysis: is it ethical? J Med Ethics. 1992;18:7–11.
32. Tranmer JE, Guerriere DN, Ungar WJ, Coyte PC. Valuing patient and caregiver time: a review of the literature. Pharmacoeconomics. 2005;23(5):449–59.
33. Liljas B. How to calculate indirect costs in economic evaluations. Pharmacoeconomics. 1998;13(1 (Part 1)):1–7.