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INVESTIGATIVE REPORT

Societal Cost of Skin Cancer in Sweden in 2005

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Skin cancer is one of the most rapidly increasing cancers among the Swedish population and a significant cause of illness and death. This study aims to estimate the total societal cost of skin cancer in Sweden for 2005, using a prevalence-based cost-of-illness approach. The total cost of skin cancer was estimated at €142.4 million (€15/inhabitant), of which €79.6 million (€8/inhabitant) was spent on health services and €62.8 million (€7/inhabitant) was due to loss of production. The main cost driver was resource utilization in outpatient care, amounting to 42.2% of the total cost. Melanoma was the most costly skin cancer diagnosis. Non-melanoma skin cancer was, however, the main cost driver for health services alone. For the future it is important to establish effective preventive measures to avoid increasing costs and suffering caused by skin cancer. ***Key words: skin cancer; cost; cost-of-illness; Sweden.***

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Skin cancer is one of the most rapidly increasing cancers among the fair-skinned populations worldwide and a significant cause of illness and death (1, 2). Non-melanoma skin cancers (NMSC), i.e. basal cell carcinoma (BCC) and squamous cell carcinoma (SCC), is the most common group of malignant skin cancers among the Caucasian population. The incidence of NMSC has commonly been associated with high life-time exposure to ultraviolet radiation (UV) (3, 4), especially within a population who sunburn easily and tan poorly (5–7). Cutaneous malignant melanoma (CMM), however, has been linked mainly to sunburns and intermittent sun exposure (4, 8). Accordingly, NMSC is most often found in continuously sun-exposed areas of the body, such as the face and back of hands and forearms, while CMM most frequently occurs in sun-protected areas that receive intermittent exposure (3). The steady increase in skin cancer incidence in the fair-skinned population, both CMM and NMSC, has been attributed to a change in sunbathing habits towards more intermittent and intense UV exposure in combination with a fair complexion. Consequently, skin cancer has become a rapidly growing health burden in the western world. This has led to an increased need for evaluating the effects of preventive programmes, such as public education programmes and regular skin examinations of high-risk individuals for early detection. By assessing the annual cost due to skin cancer we can establish the potential costs saved from an effective preventive programme.

The epidemiology of skin cancer in Sweden is described in Table I. The incidence of CMM in 2005 was an estimated 24.2 cases per 100,000 men and 22.8 cases per 100,000 women. For SCC the equivalent figures were an estimated 48.9 for men and 34.5 for women (9). In addition there were also 364.5 men and 345.1 women per 100,000 diagnosed with BCC the same year (10). Together this makes skin cancer, as a group, the most frequent form of cancer for both men and women, with a noticeably higher incidence rate than other cancer forms, for example prostate cancer and breast cancer (9). The trend over a 20-year period shows that CMM has increased on an annual average of 2.2% for men and 1.9% for women, while the annual increase for SCC has been an estimated 3.2% for men and 3.8% for women (9). In addition, skin cancer related mortality increased

Table I. *Epidemiology of skin cancer in Sweden. Data from the Swedish National Board of Health and Welfare.*

	CMM		SCC		BCC	
	Male	Female	Male	Female	Male	Female
Incidence (2005)	1084	1038	2187	1572	16353	16150
Annual increase (1986–2005)* (%)	2.2	1.9	3.2	3.8	NA	NA
Incidence rate per 100,000**	24.2	22.8	48.9	34.5	364.5	354.1
Deaths (2003) (*n*)	227	174	32	21	0	0
Deaths per 100,000 (2003) (*n*)**	5.1	3.8	0.7	0.5	0	0

*Non-age standardized. **Rates for males and and females were calculated seperately.
CMM: cutaneous malignant melanoma; SCC: cutaneous squamous cell carcinoma; BCC: basal cell carcinoma; NA: data not available.

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1.9% on an annual average between 1997 and 2003 and was the main cause of death in 454 cases[1] in 2003 (11). To put the magnitude of skin cancer as a cause of death into perspective, it may be compared with road traffic accidents in Sweden, which were the main cause of death in 440 cases in 2005 (12). Alarmingly, there seems to be no indication that the incidence of skin cancer in Sweden will slow down in the near future.

The trend in the Swedish population is thus similar to that in most other western countries, with a substantial increase in both incidence and mortality in skin cancer, yet the economic impact has not been fully assessed. In this cost of illness study we aim to illustrate the economic burden of skin cancer, by estimating the total cost of skin cancer in Sweden in 2005 from a societal perspective.

MATERIALS AND METHODS

This study is a prevalence-based cost of illness study, a methodology commonly used to study the economic burden of diseases, based on pioneering work by Dorothy Rice in 1966 (13). We used a top-down approach for cost associated with inpatient care and a bottom-up approach to estimate cost associated with outpatient and primary care. All identifiable direct and indirect costs related to skin cancer as a primary diagnosis during 2005 are included in the estimate. Because there were no available data on mortality and sick leave for 2005 we have used data from the closest available year. However, all costs are computed at the 2005 price level.

We used ICD-10 codes (14) to identify the study population for the estimate of costs. In addition to the main skin cancer diagnoses C43–44, we included diagnoses that constituted potential preliminary stages of skin cancer in order to capture essential costs associated with secondary prevention. The diagnoses included in our cost estimate are shown in Table II.

Direct cost

In this study direct costs are represented by those identifiable healthcare resources consumed due to detection, treatment and follow-up of skin cancer. We divided direct cost into three subcategories depending on the type of setting that facilitated care; inpatient care, outpatient care (i.e. specialist care whether hospital based or in private practice) and primary care.

Direct cost arising from outside the healthcare system, for example informal care and transportation, were not included in our estimate due to the lack of data. However, these costs can, in this case, be considered marginal and would not affect results in any significant way if included.

Table II. *Diagnoses included in our cost estimate*

ICD-Codes	Diagnosis
C43	Malignant melanoma of skin
C44	Other malignant neoplasms of skin (squamous and basal cell carcinoma)
D03-04	Melanoma and carcinoma *in situ* of skin
D22	Melanocytic naevi
L57.0	Actinic keratosis
Z08.	Follow-up examination for skin cancer

[1]The total population of Sweden on 31 December 2003 was 8,975,670.

The general approach used for identifying cost per patient (CPP) is illustrated in Fig. 1. The first step was to identify all relevant healthcare costs in the overall budget. Costs that were considered irrelevant were, for instance, costs associated with regional politics and their administration. In the second step identified costs were divided into patient-related costs and cost for joint activity[2]. After cost for joint activity was divided and distributed between healthcare units, different healthcare services were described and accounted for. Examples of questions addressed in order to assess resources used and put a unit cost on different services were: what activities were carried out during the service? Which personnel categories were involved and for how long? What materials were used? How much pharmaceuticals were used? In the final step the accounted healthcare services were connected with individual patient data. One major advantage with the CPP approach is that there are no costs left out, i.e. all existing cost must be attributed to a service, which must to be attributed to a diagnosis, which must be attributed to a patient.

Inpatient care

The total number of inpatient episodes due to skin cancer during 2005 was extracted from the Swedish National Board of Health and Welfare Inpatient Registry (15). For each inpatient episode doctors are obliged to report information such as gender, age, main diagnosis and operation codes. The annual rate of under-reporting during the last few years is estimated to be less than 1% for somatic healthcare (16). By using the national database on CPP the cost of each inpatient episode with skin cancer related diagnosis was calculated.

Outpatient care

Unfortunately, there is no national register covering episodes in outpatient care. Instead we used a defined population-based

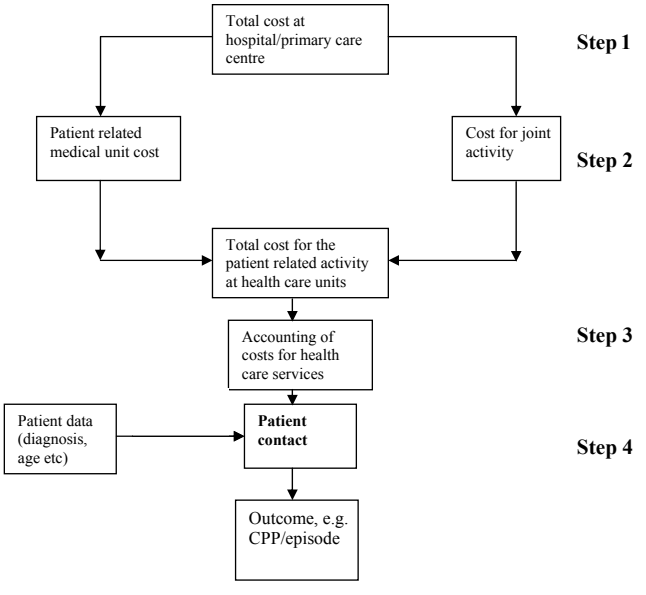

Fig. 1. General cost per patient (CPP) approach in the different steps.

[2]This refers to healthcare that *cannot* be linked to individual patient episodes. For example, cost of keeping a telephone switchboard at hospitals or other activities associated with the overall administration and maintenance.

data-set on episodes and CPP from the Östergötland County Council[3] and extrapolated this result as an estimate of the total cost of outpatient care in Sweden. There are two main reasons why we believe that this should, at present, produce the most reliable estimate possible. The county of Östergötland delivers care to approximately 4.6% of the total population and is the only county council that registers all outpatient care episodes according to established CPP principles (17). Furthermore, it has been proven in previous studies that the population of Östergötland has an incidence and mortality rates of skin cancer very close to the average rates in Sweden (15). In addition, a study on the number of melanocytic naevi (MN) has also shown that the frequency in the Östergötland population is in compliance with the national average (18). Another advantage that makes this county a good-quality region for extrapolation is that there is only one private dermatologist in the region. Since episodes in private care are not included in our original data we have collected data on episodes from the one and only private dermatology clinic in the region.

Primary care

The primary care setting is defined here as those healthcare services that deal with basic medical needs without demanding the technical and medical resources that can be found at hospitals. Similar to outpatient care, there is no national register covering episodes in primary care. We have therefore once again used data on episodes and CPP from the county of Östergötland, which is the only county in Sweden that registers primary care episodes related to diagnosis and calculates costs according to established CPP principles[4] (19).

Indirect costs

Indirect cost refers to those costs that correspond to the loss of productivity occurring as a result of an individual's inability to work on account of the disease. Such inability to work can be due to sick leave, early retirement or premature death. To estimate production loss, the length of absence from work was multiplied by relevant cost of labour. We have estimated the annual cost of labour for individuals aged 20–64 years in 2005 by using the human capital approach (21), which assumes that production loss corresponds to the annual income from employment (including payroll taxes and social fees[5]) (22). Subsequently, the valuation was made under the simplifying assumption of full employment until the age of 65 years.

Morbidity

The Swedish Social Insurance Agency registers diagnosis-specific data regarding early retirement and sick leave with durations longer than 14 days. However the Agency does not keep diagnosis-specific data regarding the total number of sick leave days. To estimate this we took the share of sick leave with skin cancer related diagnoses in December 2005 and multiplied this percentage by the total number of registered sick leave days in 2005. This data was collected from the statistical warehouse at the Social Incurance Agency through personal correspondance.

There is no nationwide data on sick leave with a duration shorter than 14 days, since this sickness benefit is financed through the employer. However, the Swedish Social Insurance Agency makes a quarterly estimate of short-term sick leave. Assuming that skin cancer represents the same share of short-term, as long-term sick leave, we estimated short-term sick leave in the same manner as long-term sick leave.

Mortality

Cost arising from premature death origins from the number of working years lost prior to the age of 65 years, which is the normal Swedish retirement age. By identifying the cause of death (C43–44) and the age at death, the number of working years lost was calculated. The average cumulative probability of an individual dying of other causes before the age of 65 years was calculated using life tables for the Swedish population (23). Costs due to future production loss were discounted at 3% yearly in accordance with Swedish and international recommendations (24, 25).

RESULTS

Direct healthcare costs

Inpatient care. There were 3125 inpatient episodes due to our selected diagnoses registered in Sweden during 2005. CMM was the most common diagnosis, with 1631 episodes, while NMSC was the second most common diagnosis, with 1335 episodes. Episodes with other skin cancer related diagnoses were only minor.

The average cost per episode due to CMM in inpatient care was €4473. This average cost estimate was based on 36% of the total number of episodes with CMM as a primary diagnosis in Sweden 2005. The corresponding cost for NMSC was approximately €3928, and this average cost estimate was based on 63% of the total number of episodes with NMSC as a primary diagnosis. The background data for estimating costs associated with inpatient care is presented in Table III.

The total cost for inpatient care due to skin cancer in 2005 was an estimated approximately €13.1 million. Costs associated with CMM represented approximately €7.3 million, while NMSC represented approximately €5.2 million. Costs associated with other skin cancer related diagnoses were minor.

Outpatient care. There were 4645 individual patients (each patient can contribute to several episodes) treated for skin cancer in outpatient care in Östergötland during 2005. Extrapolated for Sweden as a whole this signifies 100,982 individual patients. NMSC was the most common diagnosis and represented 45% of the patients in outpatient care. MN and actinic keratosis (AK) were the second most common diagnoses, both approximately 22% of all individual patients. The background data for estimating costs associated with inpatient care is presented in Table III.

The average CPP due to CMM in outpatient hospital care was €1675. This cost estimate was based on 307 patients with CMM as the main diagnosis in the county of Östergötland. The corresponding cost for NMSC was approximately €549. This cost was based on 1569

[3]The total population of Östergötland on 31 December 2005 was 416,303.
[4]For further information regarding the comprehensiveness and reliability of the population-based CPP register in Östergötland, see Wiréhn (20).
[5]We have estimated this as 40% of annual labour income.

Table III. *Background data for direct costs, in €*

	Number of and costs per episode/patient									
	CMM		NMSC		MIS/CIS		MN		AK	
Medical setting	*n*	Cost	*n*	Cost	*n*	Cost	*n*	Cost	*n*	Cost
Inpatient care (episodes)	1,631	4,473	1,335	3,928	58	3,044	92	3,589	9	4,352
Outpatient care (patients)	8,739	1,675	45,415	549	2,196	394	22,805	228	21,827	661
Primary care (episodes)	956	154	5,259	154			31,965	154	3955	154

CMM: cutaneous malignant melanoma; NMSC: non-melanoma skin cancer; MIS: melanoma *in situ*; CIS: cancer *in situ* in the skin; MN: melanocytic naevi; AK: actinic keratosis.

patients with NMSC as the main diagnosis in the county of Östergötland.

The total cost for outpatient care episodes, extrapolated from Östergötland, was an estimated €60 million. NMSC was the main cost driver, at €25 million. The second largest cost driver was CMM, at €14.6 million. However, episodes associated with potential skin cancer as MN or AK were also a major cost driver and arrived at an estimated cost of €20.5 million when added together.

Primary care. There were 1936 primary care episodes due to our selected diagnoses registered in Östergötland during 2005. Extrapolated to a national level this signifies 42,135 primary care episodes. MN was the most common diagnosis and represented 76% of the total number of episodes. NMSC was the second most common and represented 12% of the total number of episodes.

According to the CCP register in primary care, each episode for our selected diagnoses were ascribed a unit cost of €154. The total cost for primary care episodes in Sweden, extrapolated from Östergötland, was an estimated €6.5 million. The major part of this cost was attributed to examinations of MN, €4.9 million.

Indirect costs

Production loss due to morbidity. Skin cancer accounted for 0.065% of the total number of sick leave days with duration longer than 14 days in December 2005. The total number of sick leave days was registered by the Swedish Social Insurance Agency; 80,902,000 days. By multiplying 0.065% by the total number of sick days, 52,215 sick days due to skin cancer was estimated, implying 146 production years lost due to sick leave with a duration longer than 14 days.

During 2003 the total of short-term sick leave days (the first 14 days) was an estimated 20,192,418 days. Assuming the same proportion as for long-term sick leave, skin cancer would account for 12,962 days sick leave (35.5 production years lost).

In December 2002, 109 persons had been granted early retirement due to skin cancer. Of all individuals granted early retirement during 2003 to 2005 for selected diagnoses, 70% were in full retirement, 20% were working 50% and 10% were working 25%. Assuming that this also holds true for early retirement and that the stock of people in early retirement due to skin cancer has remained approximately the same, 87.75 production years were lost due to early retirement in 2005. Using an annual labour cost of €35,391 (22) the cost of sick leave and early retirement was an estimated at €9.5 million.

Production loss due to mortality. According to official statistics from the Swedish National Board of Health and Welfare, 454 patients died from skin cancer in 2003 (11). However, only 166 cases were at an age below 65 years at the point of death, subsequently only these cases involves production loss according to the methodology. CMM was the main cause of death in 157 cases and NMSC was registered as the main cause of death in 9 cases. The total number of working years lost amounted to 1816 years. Using an annual labour cost of €35,391 (22) and a discount rate of 3%, the cost of premature death due to skin cancer was an estimated €53.3 million. The results are shown in Table IV. When a 5% discount rate was applied the cost decreased to €46.6 million.

DISCUSSION

The incidence of skin cancer in Sweden is currently undergoing a rapid increase. It is therefore of great urgency to optimize the management and prevention of skin cancer, not only to avoid significant human suffering, but also to avoid a significant economic burden on society.

The only study previously estimating costs of skin cancer in Sweden was limited to the Stockholm healthcare region in 1999 (approximately 1.8 million inhabi-

Table IV. *Production loss due to premature mortality*

Age (years)	Number of deaths	Production loss* (€)
25–29	2	1,457,601
30–34	4	2,697,840
35–39	17	10,390,067
40–44	8	4,303,447
45–49	22	9,969,594
50–54	30	10,640,598
55–59	40	9,547,441
60–64	43	4,268,411
Total	166	53,275,001

*3% discount rate.

Table V. *Cost of skin cancer in Sweden 2005, presented in €1000 (figures in parentheses represent percentage of total cost)*

Type of cost	CMM €/1,000 (%)	NMSC €/1,000 (%)	MIS/CIS €/1,000 (%)	MN €/1,000 (%)	AK €/1,000 (%)	Total €/1,000 (%)
Direct costs	22,082 (15.5)	30,988 (21.8)	1,042 (0.7)	10,456 (7.3)	15,077 (10.6)	79,643 (55.9)
Inpatient care	7,296 (5.1)	5,244 (3.7)	177 (0.1)	330 (0.2)	39 (0.1)	13,087 (9.2)
Outpatient care	14,638 (10.3)	24,933 (17.5)	865 (0.6)	5,200 (3.7)	14,428 (10.1)	60,064 (42.2)
Primary care	147 (0.1)	810 (0.6)		4,925 (3.5)	609 (0.4)	6,492 (4.6)
*Indirect costs**	57,589 (40.4)	5,214 (3.7)				62,803 (44.1)
Mortality	50,588 (35.5)	2,687 (1.9)				53,275 (37.4)
Morbidity	7,002 (4.9)	2,527 (1.8)				9,528 (6.7)
Total costs	79,671 (55.9)	36,202 (25.4)	1,042 (0.7)	10,456 (7.3)	15,077 (10.6)	142,446 (100.0)

*3% discount rate.

CMM: cutaneous malignant melanoma; NMSC: non-melanoma skin cancer; MIS: melanoma *in situ*; CIS: cancer *in situ* in the skin; MN: melanocytic naevi; AK: actinic keratosis.

tants) (26). If the results from this study (€17.4 million) are assumed to be representative for the whole country this would extrapolate to an annual cost of approximately €95.5 million (adjusted to the 2005 price level). The study presented here is, however, the first to evaluate the annual economic burden of skin cancer in Sweden, including healthcare costs and lost productivity, using a general, prevalence-based cost-of-illness model. The annual cost of skin cancer in Sweden during 2005 was estimated to be €142.4 million as presented in Table V. Healthcare costs and lost productivity accounted for 55.9% and 44.1% of the total burden, respectively. The two main cost drivers were outpatient resource utilization and loss-of-production due to premature death, amounting to 42.2% and 37.4% of the total costs, respectively. Melanoma was found to be the diagnosis contributing the largest economic burden, with an estimated cost of €79.7 million (55.9%). Other malignant neoplasms of skin, which had the greatest number of patients, were associated with a total cost of €36.2 million (25.4%). Our presented cost estimate is considerably higher than what the study from Stockholm indicates (26). Part of this discrepancy may be explained by the steady increase in incidence and mortality rates between 1999 and 2005, and that we include costs associated with early retirement in our estimate. However, the full magnitude of the discrepancy cannot be explained by these differences alone. Differences in data-sets may be another explanatory factor, since there has been a rapid positive development regarding economic administrative systems during recent years, which has improved the quality of available data immensely. The CPP register in Östergötland contain data on all patient episodes and cost for its defined population. Consequently, the data-set used in this paper is more robust for the outpatient and primary care setting than earlier studies, which could help to explain the relatively large share of costs associated with outpatient care (42.2%).

Although the estimated cost presented in this article is substantial, it is important to note that it is still likely to be an underestimate for a number of reasons. First, we relied on administrative systems that did not include costs related to visits where skin cancer was a secondary diagnosis. Hence, individuals who seek medical consultations for other main diagnoses, but have suspicious skin lesions examined at the same time are not included in our estimate. Secondly, our study does not estimate burden of informal care because it is difficult to assess, and because large studies of costs to caregivers for skin cancer patients have not been conducted. There were also a lack of reliable data in some other areas, for example long-term care provided by municipalities and transportation. Thirdly, the consulted dermatologists found the number of skin cancer episodes reported in the primary care setting unreasonably low, which makes us believe that our estimates of incidence are a clear underestimation. However, it is unlikely that this under-reporting will have any significant impact on the total economic burden. Finally, it is important to note that there is a considerable number of episodes being diagnosed as benign skin tumours when malign skin tumours are suspected by the patient, for instance seborrhoeic keratoses, histiocytoma and benign actinic lentigo. We have, however, chosen not to include costs associated with these diagnoses, since they constitute benign lesions without malignant potential. We have not been able to present any valid figures for these diagnoses in primary care and out-patient screening clinics and have therefore chosen not to include these diagnoses. An approximation, however indicates that the cost might well be in the same order of magnitude as for MN. Furthermore, it can be argued that extrapolating data on skin cancer prevalence and costs from the county of Östergötland to national level are not reliable estimates. However, as the incidence and mortality of both skin cancer and MN in this county is in compliance with the national average and the guidelines for treatment of skin cancer do not differ significantly between counties in Sweden, we believe our calculated approximation is reliable.

In Table VI the cost of skin cancer is compared with the result of other fairly recent cost-of-illness studies performed in Sweden. This shows that skin cancer is the

least costly illness from a societal perspective, which can be explained mainly by the relatively low share of cost associated with productivity loss for skin cancer. We used the human capital approach to estimate the value of the productivity loss due to absenteeism from work and premature mortality. A common criticism of this approach is that it discriminates against those elderly people who are not in employment. This criticism is especially relevant when estimating indirect cost for skin cancer, since the majority of individuals diagnosed with skin cancer are of retirement age or older. Most of the other illnesses in Table VI affect individuals who are of working age, making the indirect cost considerably higher. When comparing only cost associated with medical consumption, skin cancer is, however, more costly than equivalent costs for both multiple sclerosis and brain tumours, and is close to the cost of breast cancer. It is also worth pointing out that while cost-of-illness studies of the kind presented here are useful for providing summary figures for the magnitude of the impact of particular diseases, they are unlikely to be useful for setting priorities in terms of funding for prevention and treatment. Of more use for this purpose are cost-effectiveness analyses, which also take into account outcomes in terms of changes in survival and quality of life associated with specific interventions aimed at treating and preventing a particular health condition. There are, today, few studies that have assessed the cost effectiveness of preventive programmes for skin cancer. Two examples in the case of skin cancer are, however, the evaluation of a national skin cancer primary prevention campaign conducted in Australia (34) and the simulation model focusing on melanoma screening in high-risk individuals in the USA (35). The Australian study demonstrates that a comprehensive health promotion campaign aimed at skin cancer might constitute excellent value for money from a societal perspective. The US study develops a simulation Markov model, which demonstrates that a one-time screening of the general population above the age of 50 years is likely to be a very cost-effective strategy compared with alternative treatments (35). In addition, the study also concludes that screening every 2 years in siblings of patients diagnosed with melanoma is likely to be a cost-effective strategy. However, none of the existing cost-effectiveness studies are applicable in the Swedish setting; hence future studies should focus on assessing the cost-effectiveness of screening and other preventive programmes in Sweden.

Table VI. *Cost of illness in Sweden presented in million € in 2005[a] prices (figures in parentheses represent percentage of total cost for each illness)*

Illness	Year (Ref.)	Indirect costs € (%)	Direct costs € (%)	Total costs €
Depression	2004 (28)	1,727 (65)	946 (35)	2,673
Stroke	1991 (29)	323 (24)	1,042 (76)	1,365
Diabetes mellitus	1994 (30)	399 (57)	298 (42)	697
Breast cancer	2002 (31)	233 (70)	99 (30)	332
Multiple sclerosis	1994 (32)	166 (79)	45 (21)	211
Brain tumours	1996 (33)	118 (74)	41 (26)	159
Skin cancer	2005 (This paper)	63 (44)	80 (56)	142

[a]This comparison is a development from Lidgren (2007) (27).

In conclusion, there is little doubt that skin cancer constitutes a major public health issue, and we hope that the results presented here lead to further research and resources being devoted to addressing the rapidly increasing problem of skin cancer from an economic and societal perspective.

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