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Gustav Tinghög, Per Carlsson, Ingrid Synnerstad and Inger Rosdahl

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INVESTIGATIVE REPORT**SOCIETAL COST OF SKIN CANCER IN SWEDEN 2005**

Gustav TINGHÖG¹, Per CARLSSON¹, Ingrid SYNNERSTAD² and Inger ROSDAHL²

¹Center for Medical Technology Assessment, Department of Medical and Health Sciences

and ²Division of Dermatology, Department of Clinical and Experimental Medicine, Faculty of

Health Sciences, Linköping University, Linköping, Sweden

Short title – SOCIETAL COST OF SKIN CANCER

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 2005, using a prevalence based cost-of-illness approach. The total cost of skin cancer was estimated to €142.4 million (€15 per inhabitant), of which €79.6 million (€8 per inhabitant) were spent on health services and €62.8 million (€7 per inhabitant) were due to production loss. The main cost driver was resource utilisation 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. In 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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Gustav Tinghög, Department of Medical and Health Sciences, Linköpings University, SE-581 83 Linköping, Sweden. E-mail: gustav.tinghog@ihs.liu.se

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 burn easily and tan poorly [5-7]. Cutaneous malignant melanoma (CMM), however, has mainly been linked to sunburns and intermittent sun exposure [4, 8]. Accordingly, NMSC is most often found in continuously sun-exposed areas of the body, like 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 programs, 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 program.

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 for men and 22.8 for 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 and breast cancer [9]. The trend seen over a 20-year period shows that CMM has increased on an annual average of 2.2 percent for men and 1.9 percent for women, while the annual increase for SCC has been an estimated 3.2 percent for men and 3.8 for women [9]. In addition skin cancer related mortality increased 1.9

Table I. Epidemiology of skin cancer in Sweden

	CMM		SCC		BCC	
	Male	Female	Male	Female	Male	Female
Incidence (2005)	1 084	1 038	2 187	1 572	16 353	16 150
Annual increase (1986-2005)*	2.2%	1.9%	3.2%	3.8%		
Incidence rate per 100 000	24.2	22.8	48.9	34.5	364.5	354.1
Deaths (2003)	227	174	32	21		
Deaths per 100 000 (2003)	5.1	3.8	0.7	0.5		

*Non-age standardized

CMM: cutaneous malignant melanoma; SCC: cutaneous squamous cell carcinoma; BCC: basal cell carcinoma

percent on an annual average between 1997-2003 and was the main cause of death in 454 cases¹ in 2003 [11]. To put the magnitude of skin cancer as a cause of death into perspective it can 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 seen in the Swedish population is thus similar to 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, subsequently our main objective is to estimate the total cost of skin cancer in Sweden in 2005 from a societal perspective.

METHODS AND MATERIAL

This study is a prevalence-based cost of illness study, a methodology commonly used to study the economic burden of diseases based on the 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 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

¹ The total population of Sweden on 31 December 2003 was 8 975 670

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. Besides the main skin cancer diagnoses C43-44 we also 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.

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 nevi
L57.0	Actinic keratosis
Z08.	Follow-up examination for skin cancer

Direct cost

In this study direct costs are represented by those identifiable health-care resources consumed due to detection, treatment and follow-up of skin cancer. We have 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 health-care 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.

The general approach used for identifying cost per patient (CPP) is illustrated in Fig. 1. The first step was to identify all relevant health-care costs in the overall budget. Costs that were considered irrelevant were, for instance costs associated with regional politicians and their administration. In the second step identified costs were divided into patient-related costs and cost for joint activity².

² Refer to health care that can NOT be linked to individual patient episodes. For example cost for keeping a telephone switchboard at hospitals or other activities associated with the overall administration and maintenance.

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

Medical setting	Number of and costs per episode/patient									
	CMM		NMSC		MIS/CIS		MN		AK	
	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	3 955	154

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

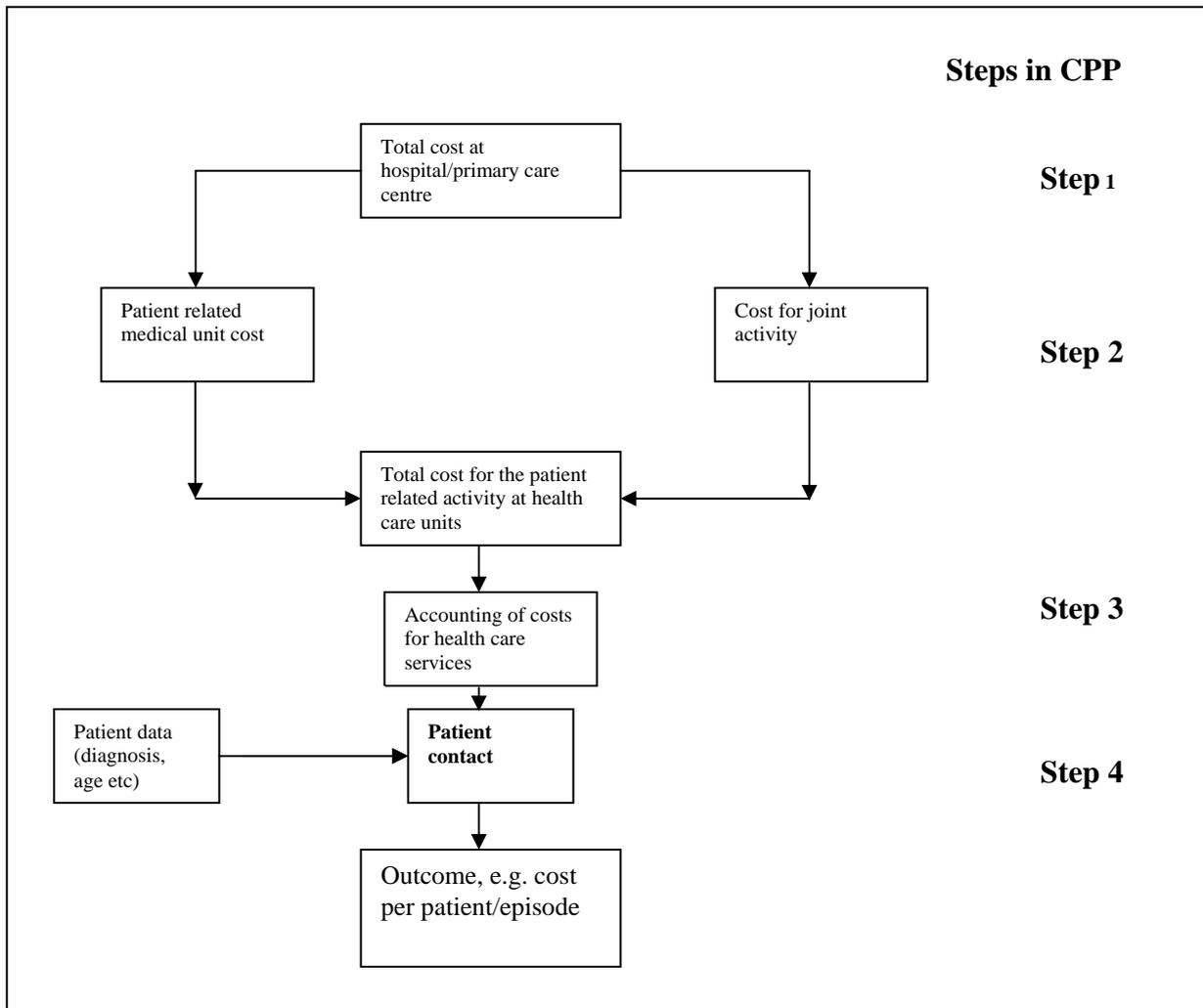


Fig. 1. General cost per patient approach (CPP).

After cost for joint activity was divided and distributed to health-care units, different 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 done 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 health-care services were connected to individual patient data. One major advantage with the cost per patient approach is that there are no costs left behind, 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 obligated by law to report information such as gender, age, main diagnosis and operation codes. The annual rate of underreporting during the last few years is estimated to be less than one percent for somatic health-care [16]. By using the national database on cost per patient (the CPP database) 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 dataset on episodes and cost per patient from the Östergötland County Council³ 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 percent of the total population and is the only County council which registers all outpatient care episodes according to established cost per patient principles [17]. Further 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 MN has also shown that the frequency in the Östergötland population is in compliance with the national average [18]. Another advantage which 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

³ The total population of Östergötland on 31 December 2005 was 416 303

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 here defined as those health-care 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 cost per patient from the County of Östergötland, which is the only County in Sweden which registers primary care episodes related to diagnosis and calculates costs according to established cost per patient principles⁴ [19].

Indirect costs

Indirect cost is costs which 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 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 fees⁵) [22]. Subsequently, the valuation was made under the simplifying assumption of full employment until the age of 65.

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

⁴ For further information regarding the comprehensiveness and reliability of the population based cost-per-patient register in Östergötland see Wiréhn (2007) [20]

⁵ We have estimated this to 40% of annual labour income

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.

There is no nationwide data on sick leave with a shorter duration 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 originates from the number of working years lost prior to the age of 65, 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 was calculated by using life tables for the Swedish population [23]. Costs due to future production loss were discounted at 3 percent yearly in accordance with Swedish and international recommendations [24, 25].

RESULTS

Direct costs

Health-care costs due to inpatient care

There were 3 125 inpatient episodes due to our selected diagnoses registered in Sweden during 2005. CMM was the most common diagnosis with 1 631 episodes, while NMSC was the second most common diagnosis; 1 335 episodes. Episodes with other skin cancer related diagnoses were only minor.

The average cost per episode due to CMM in inpatient care was €4 473. 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 €3 928 and this average cost estimate was based on 63% of the total number of episodes with NMSC as a primary diagnosis.

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.

Health-care costs due to outpatient care

There were 4 645 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 percent of the patients in outpatient care. Melanocytic nevi (MN) and actinic keratosis (AK) were the second most common diagnoses, both approximately 22% of all individual patients.

The average cost per patient due to CMM in outpatient hospital care was €1 675. 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 1 569 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 with €25 million. The second largest cost driver was CMM with €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 summed together.

Health-care costs due to primary care

There were 1 936 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 cost per patient 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 amount of sick leave days with duration longer than 14 days in December 2005 [25]. The total amount of sick leave days was registered by the Swedish Social Insurance Agency; 80 902 000 days [26]. 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 time 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 2003-2005 for selected diagnoses, 70 percent were in full retirement 20 percent were ½ retirement and 10 percent were ¼ retirement. 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 €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 at the point of death, subsequently only these cases involves production loss according to the

methodology. CMM was the main death cause 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 1 816 years. Using an annual labour cost of €35 391 [22] and a discount rate of 3 percent, 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.

Table IV. Production loss due to premature mortality

Age	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

DISCUSSION

Skin cancer is an illness in which the incidence is currently undergoing rapid growth in Sweden. 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 due to skin cancer.

The only study previously estimating costs of skin cancer in Sweden was limited to the Stockholm health-care region in 1999 (approximately 1.8 million inhabitants) [27]. If the results from this study (€ 17.4 million) are assumed to be representative for the whole country this would extrapolated indicate 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 health-care 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. Health-care costs and lost productivity accounted for 55.9% and

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

Type of cost	CMM	NMSC	MIS/CIS	MN	AK	Total
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 nevi; AK: actinic keratosis

44.1% of the total burden, respectively. The two main cost drivers were outpatient resource utilization and production lost caused by premature death, amounting to 42.2% and 37.4% of the total costs, respectively. Melanoma was found to be the diagnose contributing with 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. 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 can not 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 have full coverage of 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 underestimation due to a number of reasons. First, we relied on administrative systems which did not include cost related to visits where skin cancer was a secondary diagnose. 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. Second, 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 and long-term care provided municipalities and

transportations. Third, the consulted dermatologists found the number of skin cancer episodes reported in the primary care setting unreasonably low which makes us believe our estimates on incidence is a clear underestimation. However, it is unlikely that this underreporting 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 is suspected by the patient for instance seborrheic 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 indicate that the cost might well be in the same order of magnitude as for MN. Further it can be argued that extrapolating data on skin cancer prevalence and costs from the County of Östergötland to national level is 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 to 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 mainly can be explained 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 those elderly 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 in retirement age or older. Most of the other illnesses in Table VI strike individuals who are of working age, making the indirect cost considerably higher. When

Table VI. Cost of illness in Sweden presented in million € in 2005 prices⁶ (figures in parenthesis represent percentage of total cost for each illness)

Illness	Year	Indirect costs	Direct costs	Total Costs	Ref
Depression	2004	1 727 (65%)	946 (35%)	2 673	[29]
Stroke	1991	323 (24%)	1 042 (76%)	1 365	[30]
Diabetes mellitus	1994	399 (57%)	298 (42%)	697	[31]
Breast cancer	2002	233 (70%)	99 (30%)	332	[32]
Multiple sclerosis	1994	166 (79%)	45 (21%)	211	[33]
Brain tumours	1996	118 (74%)	41 (26%)	159	[34]
Skin cancer	2005	63 (44%)	80 (56%)	142	(This paper)

comparing only cost associated with medical consumption, skin cancer is, however, more costly than equivalent costs for both multiple sclerosis, brain tumours and close to the cost for 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, however, 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 programs 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 [35] and the simulation model focusing on melanoma screening in high-risk individuals in the United States [36]. 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 very cost-effective strategy compared to alternative treatments. In addition the study also concludes that screening every 2-year 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

⁶ This comparison is a development from Lidgren (2007) [27].

Swedish setting hence future studies should focus on assessing the cost-effectiveness of screening and other preventive programs in Sweden.

In conclusion, there is little doubt that skin cancer constitutes a major public health issue, and we hope that the results presented in this paper further motivate research and resources to address the rapidly increasing problem of skin cancer also from an economic and societal perspective.

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