The Finnish experience to save asthma costs by improving care in 1987-2013

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The Finnish National Asthma Program 1994-2004 markedly improved asthma care in the 1990s. We evaluated the changes in costs during 26 years from 1987 to 2013. Direct and indirect costs were calculated by using data from national registries. Costs from both the societal and patient perspectives were included. The costs were based on patients with persistent, physician-diagnosed asthma verified by lung function measurements. We constructed minimum and maximum scenarios to assess the effect of improved asthma care on total costs. The number of patients with persistent asthma in the national drug reimbursement register increased from 83,000 to 247,583. Improved asthma control reduced health care use and disability, resulting in major cost savings. Despite a 3-fold increase in patients, the total costs decreased by 14%, from €222 million to €191 million. Costs for medication and primary care visits increased, but overall annual costs per patient decreased by 72%, from €2656 to €749. The theoretical total cost savings for 2013, comparing actual with predicted costs, were between €120 and €475 million, depending on the scenario used. The Finnish Asthma Program resulted in significant cost savings at both the societal and patient levels during a 26-year period. (J Allergy Clin Immunol 2017;139:408-14.)

Key words: *Asthma, direct costs, indirect costs, national asthma program, public health*

Abbreviations used
ICS: Inhaled corticosteroid
LABA: Long-acting β_2-agonist
SII: Finnish Social Insurance Institution

In most countries the total costs of asthma treatment have gradually increased because of increased asthma prevalence and rapidly growing costs of newer drugs.[1] In Finland the prevalence of asthma in adults was approximately 6% in the 1990s[2,3] but has increased since then. In the Helsinki capital area population-based surveys indicated a prevalence of physician-diagnosed asthma of 6.8% in 1996 and 9.4% in 2007.[4] In adults aged 25 to 64 years, the age-adjusted prevalence of physician-diagnosed asthma increased from 6.1% to 9.5% in men and from 7.8% to 10.8% in women from 1997 to 2012.[5]

In 2013, the Finnish Social Insurance Institution (SII) listed 247,583 patients with physician-diagnosed asthma who were entitled to special reimbursement for drug costs because of their need for maintenance medication for persistent disease. This number was 3 times larger than the equivalent in 1987. The population of Finland has increased from 4,938,602 to 5,451,270 (10%) during the same period.

Significant advances in asthma care, especially in diagnostics and pharmacotherapy, have taken place since 1987. The main changes in pharmacotherapy have been the use of regular inhaled corticosteroids (ICSs) as first-line therapy in all asthmatic patients[6,7] and the introduction of new drugs, such as inhaled long-acting β_2-agonists (LABAs), combinations of LABAs and ICSs, and leukotriene receptor antagonists.

A 10-year national asthma program was established in Finland from 1994 to 2004 to lessen the burden of disease (Box 1).[8] As a result, overall asthma care improved, patients obtained better disease control, and costs decreased.[9,10] These changes were achieved through systematic planning, education, and networking to implement early detection and anti-inflammatory treatment (mainly ICSs) at all levels of asthma care. The local efforts improved cooperation between primary and secondary health care providers.

Encouraged by the good results, a new national allergy program from 2008 to 2018 was launched to take further steps to reduce the burden of all allergic conditions, including asthma.[11]

We have evaluated whether the systematic approach to improve asthma management in Finland has resulted in long-term cost savings. We used Finnish registry data from different sources for appraisal of the effectiveness of asthma care interventions during

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the 26-year period from 1987 to 2013. Comprehensive time-series analysis allowed detection of trends in costs and identification of relevant cost drivers.

DATA AND METHODS

The cost of illness calculations included the direct costs of care (outpatient visits, hospitalizations, and medication), as well as indirect costs (ie, sickness allowances and disability pensions). The data on both direct and indirect costs were based on national registries (see Table E1 in this article's Online Repository at www.jacionline.org).[12,13] The number of asthmatic patients was based on the SII registry. This registry includes all patients in Finland with persistent asthma entitled to special reimbursement for asthma drugs. The number of patients included in the SII registry is an underestimation of the true prevalence of asthma because patients are not registered if they only have intermittent or mild disease not requiring regular medication. However, the SII registry reliably reflects the number of patients with a persistent disease and can be used for comparison throughout the observation period. The diagnostic and reimbursement criteria have been validated and remained essentially the same.[14] The Finnish asthma reimbursement code (203) identifies patients with significant asthma with great accuracy because the diagnosis must be verified by objective lung function measurements.[15] The patients must also need regular medication, as judged and documented by their physicians.

Health care use and direct costs

All secondary care outpatient visits, emergency care, and hospital admissions during which asthma was the primary diagnosis in 1987-2013 were collected from national discharge registries maintained by the National Institute for Health and Welfare. During the observation period, primary care visits were not registered in Finland and not included in the calculations. Instead, we estimated primary care visits using the benchmarking database on asthma care in 10 Finnish cities in 2013 by the Nordic Healthcare Group and the prevalence of asthma. The national registry also is silent on visits to private health care providers. Moreover, benefits paid by private insurance companies were not available. However, private sector services have a negligible role in inpatient care, whereas they account for about 25% of the number of outpatient visits (mostly occupational care visits), as estimated by the Nordic Healthcare Group benchmarking.

The cost estimates were based on average unit costs of an outpatient visit (general practitioner or specialist) and inpatient hospital days in Finland in 2001.[12] All unit costs for other years were estimated by using the health care cost index available from Statistics Finland.[13] Finally, the annual nominal costs were converted to 2013 prices by using the general price level index.

The costs of medication were obtained from the annual statistics of the SII, which records the cost of medication bought by patients eligible for special reimbursement because of asthma. For patients with intermittent or mild asthma not included in the SII registry, medication costs were not available. Annual medication costs were also converted to 2013 price levels.

Indirect costs (lost productivity)

The study included transfer benefits (ie, sick-leave compensations and disability pensions caused by asthma) as indirect costs and for calculation of lost productivity.[16] Sick-leave data were obtained from the SII statistical yearbooks for 1989 to 2013; data for 1987 and 1988 were extrapolated with Constant Average Growth Rate because they were not available in the yearbooks. This estimate does not include shorter and noncompensated sickness leaves (<9 days). Data on disability pensions because of asthma were obtained from the SII statistical yearbooks for 1987-2013 and from the Finnish Centre for Pensions registries (2003-2013). The cost of lost productivity was based on the number of sick-leave days and pension days. The average monthly income of the working-age population was obtained from Statistics Finland.

Intangible elements, such as decreased working capacity at the workplace, value of lost life years because of premature death, and patients' quality of life,[17] could not be included in the analysis because no data were available.

Cost scenarios

We constructed "what if" scenarios to detect the important cost drivers for asthma care during the study period. The actual (realized) annual expenditures of asthma care were compared with the minimum and maximum scenarios of theoretic annual costs.

In the minimum scenario we assumed that in patients already in the register in 1987, the numbers of hospital days, sick-leave days, and disability pensions would decrease from that year onward according to the general trends in Finland.[18] Then we assumed that the 3-fold increase in prevalence, as reflected by the SII's registry, would be due to milder cases of the disease and therefore would not have an increasing effect on hospitalizations, sick leaves, and disability pensions. Thus in the minimum scenario the new patients with "mild" disease would only increase the medication cost.

In the maximum scenario we assumed that the prevalence of asthma increased, but the disease severity and care practices remained at the 1987 level. Thus the number of hospital and sick-leave days and disability pensions would decrease according to the general trend, but the increasing number of patients would result in an increase in absolute numbers.

The differences between the observed actual costs and the minimum and maximum scenarios would indicate the range of the theoretic savings because of improved care.

In this public register–based study, no ethics approval was necessary according to Finnish guidelines. The technical appendix, statistical codes, and data sets are available by request from Fredrik Herse at fredrik.herse@nhg.fi.

RESULTS

Patients

Table I characterizes Finnish persistent asthma prevalence according to age and sex at the beginning, middle, and end of the study period. In 1987, there were 83,000 asthmatic patients (1.6% of the entire population) entitled to special reimbursement for drug costs. By 2013, the number had increased to 247,583 (4.6%). The increase reflects mainly improved diagnostics and treatment coverage. The age profile of patients changed somewhat during the study period. The percentage of working-age asthmatic patients (16-64 years) decreased from 63% to 55%, whereas the share of those aged 65 years or older increased from 27% to 38%.[18]

Changes in health care use, disability, and mortality

The number of hospital days in secondary care decreased from 91,650 in 1987 to 12,050 in 2013 (87%), and those in primary care decreased from 45,300 to 13,300 (71%). In secondary care the decrease in hospital days per patient per year was 95% (from 1.10 to 0.05 days), and that in primary care was 90% (from 0.54 to 0.05 days). There was a shift of outpatient visits from secondary to primary care because secondary care visits decreased by 38% in

Box 1. Asthma program in Finland 1994-2004: Goals and main themes in 1994[8]

Goals for prevention, treatment, and rehabilitation
1. As many patients as possible with early asthma recover.
2. Asthmatic patients feel well, and their capacity corresponds with age.
3. Percentage of patients with severe and moderate asthma decreases from 40% to 20%.
4. Number of hospital days of asthmatic patients decreases by 50% by the year 2000.
5. Annual costs per patient decrease by 50% as a result of more effective prevention and treatment.

Main themes
- Early diagnosis and anti-inflammatory treatment: "hit early and hit hard"
- Guided self-management to stop exacerbations proactively
- Effective networking with general practitioners, nurses, and pharmacists (nomination of asthma-responsible health care workers)
- Smoking and tobacco smoke decreased by legislation
- Knowledge of asthma increased in key groups
- Scientific research promoted

TABLE I. Demographic data of the asthmatic patients in the Finnish drug reimbursement register: 1987, 2000, and 2013

	1987*	2000	2013
Finnish population (million)	4.9	5.2	5.4
No. of patients	83,000	190,383	247,583
Female sex (%)	Not available	53.9	53.2
Prevalence (%)	1.6	3.6	4.4
Age groups (%)			
0-15 y	10	14	7
16-64 y	63	56	55
≥65 y	27	30	38
Prevalence in the age group (%)			
0-15 y	0.8	2.9	2.0
16-64 y	1.6	3.1	3.8
≥65 y	3.5	7.3	8.9

*Prevalences denote those patients with the need for long-term regular maintenance medication for asthma control.

total (79% per patient, from 1.64 to 0.34 visits), whereas primary care visits increased by 98% in total. Sick leave days decreased by 70% in total (89% per patient, from 2.44 to 0.24 days). Disability pensions decreased by 79% in total (93% per patient, from 0.08 to 0.01 pensioners). There were 6,340 patients in 1987 and 1,310 patients in 2013 with disability pensions because of asthma.

There was also a 57% decrease in age-adjusted asthma-related death rates, from 3.5 to 1.5 per 100,000 per year. In 1987, there were 163 deaths caused by asthma, of which 11 were patients less than 45 years of age. In 2013, the total number was 82, and only 1 was less than 45 years of age.

Costs at the societal level

Although there was a 3-fold increase between 1987 and 2013 in the number of patients with persistent asthma (prescribed regular maintenance medication), total annual expenditures on asthma care decreased by 14% (from €222 million to €191 million) during the same period (Fig 1). The overall costs in the beginning and at the end of the study period are shown in Table II divided into direct and indirect costs.

Direct health care costs associated with asthma increased by 50% from €90 million in 1987 to €135 million in 2013. In the cost component analysis the costs of hospitalizations decreased by 73%, from €30 million to €8 million. The costs because of secondary care outpatient visits remained the same at €24 million per year, but the costs of outpatient drugs increased by 187%, from €33 million to €98 million. The costs because of primary care outpatient visits increased by 378%, from €1.1 million to €5.5 million.

Lost productivity measured as sickness allowances and disability pensions decreased significantly during the same period by 58%, from €131 million to €55 million. Sickness benefits represented constantly approximately 10% of these expenditures.

The most important single cost component at the beginning of the study period was lost productivity, but this changed to direct health care costs by 1994.

Costs at the patient level

In 2013, 247,583 patients were eligible for special reimbursement of their drug costs and were used for assessment. Between 1987 and 2013, the overall annual costs per patient decreased by 71%, from €2,670 to €771 (Fig 2 and Table II). Direct health care costs, including medication expenses, decreased by 55% (from €1,081 to €545 per patient). Costs of outpatient drugs decreased by 4%, from €409 to €394 per patient. Lost productivity dwindled by 86%, from €1,589 to €226 per patient, during the 26-year period.

Cost scenarios

Fig 3 shows the actual (realized) annual expenditures for asthma care in Finland and the minimum and maximum scenarios of theoretic development of annual costs. The change in service use and indirect costs in the scenarios are based on the general trends in health care in Finland.[18] All hospital (inpatient) days in secondary care (whole population) decreased by 58%, and those in primary care decreased by 35% from 1987 to 2013. Concomitantly, all secondary care outpatient visits (whole population) increased by 64%, and disability pensions (working-age population) decreased by 34%. The decreases for asthmatic patients were larger than these general trends, resulting in estimated cost savings of between €120 million (minimum) and €475 million (maximum) at the end of the observation period.

DISCUSSION

A systematic database search of the English literature from 1996 to 2008 showed that the costs of asthma are enormous,[19] and

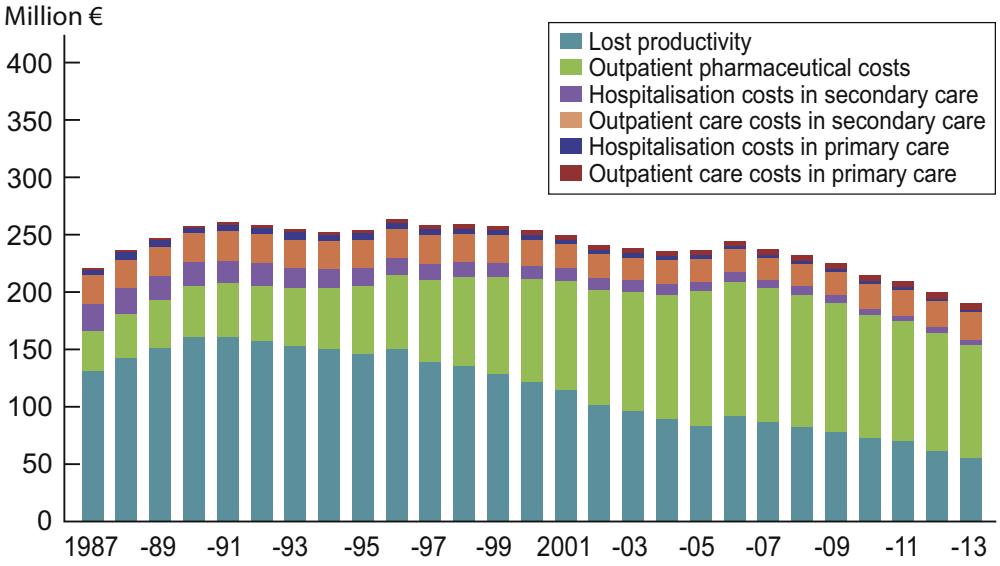

FIG 1. Overall annual costs of asthma care at the societal level in Finland from 1987 to 2013.

TABLE II. Total costs per patient and for the Finnish asthma population included in the Finnish drug reimbursement register (83,000 patients in 1987 and 247,583 patients in 2013)

	1987		2013	
	Per patient	Total	Per patient	Total
Total direct costs	€1,081	€89,698,974	€545	€134,985,376
Hospitalization				
Secondary care	€295	€24,477,526	€21	€5,209,985
Primary care	€69	€5,729,962	€11	€2,720,238
Outpatient care				
Secondary care	€293	€24,353,930	€97	€24,013,817
Primary care	€17	€1,152,583	€22	€5,472,336
Medication	€409	€33,984,973	€394	€97,569,000
Total indirect costs (lost productivity)	€1,589	€131,907,761	€226	€55,838,337
Total direct and indirect costs	€2,670	€221,606,735	€771	€190,823,713

despite effective therapies, these costs are increasing.[20,21] Improved asthma care ought to lessen the burden of disease at both the societal and individual patient level. This has happened in Finland, where asthma detection and control were improved. At the start of the Finnish asthma program in 1994, it was estimated that 20% of the patients had severe (or uncontrolled) disease.[8] This figure decreased to 10% in 2001 and 4% in 2010.[22] This led to a significant decrease in health care service use, sick leaves, and disability pensions. Although medication costs increased because of increased numbers of patients and higher costs of new drugs, it did not come anywhere close to offsetting the major cost savings derived from better disease control.

During a 26-year period, the total annual societal costs of asthma diminished by 14%, from €222 million to €191 million, while the number of patients receiving maintenance medication registered by the SII tripled. This increase in the number of patients reflects mainly better awareness and detection of disease and coverage of effective treatment. These factors might also have resulted in milder cases entering the register. However, the criteria for special reimbursement for drug costs have not changed during the study period. The cost decrease was remarkable at the patient level as well.

Cost savings were detected in all relevant paying sectors of society. In particular, reductions in sickness allowance days and disability pensions resulted in saved societal costs. An exception was the increase in outpatient drug costs, with the greatest relative growth in the latter half of the 1990s. This development was not surprising because the number of patients receiving an early diagnosis and effective medication increased.

The clinical efficacy of ICSs was shown already in the early 1970s, but generally, the drug was used with small doses and not as first-line treatment.[23] New pathophysiologic knowledge about asthma primarily as an inflammatory disease started to evolve from the mid-1980s.[24-26] Early and precise diagnosis, with the help of effective lung function measurements, was emphasized, and anti-inflammatory medication with ICSs was introduced as first-line treatment. The greatest benefit for society was attained in the 1990s, when this strategy became widespread and before the launch of fixed combinations of ICSs and LABAs in 1999-2001. Altogether, since 2000, the use of ICSs has increased only marginally (Fig 3).

One essential key for better patient care was improving treatment adherence by guided self-management. In 1998, it was confirmed that educating patients to prevent asthma exacerbations/attacks proactively was cost-effective compared with traditional treatment.[27] The result was repeated in subsequent studies, although at first, an intense education process was costly.[28]

The cost-effectiveness of the newer therapies cannot be reliably assessed by a societal cost analysis because the evaluation would need knowledge on individual or cohort quality of life for calculation of quality-adjusted life-years. Nevertheless, it is obvious that earlier and more effective use of the older and relatively cheap drugs made a real change for the better and

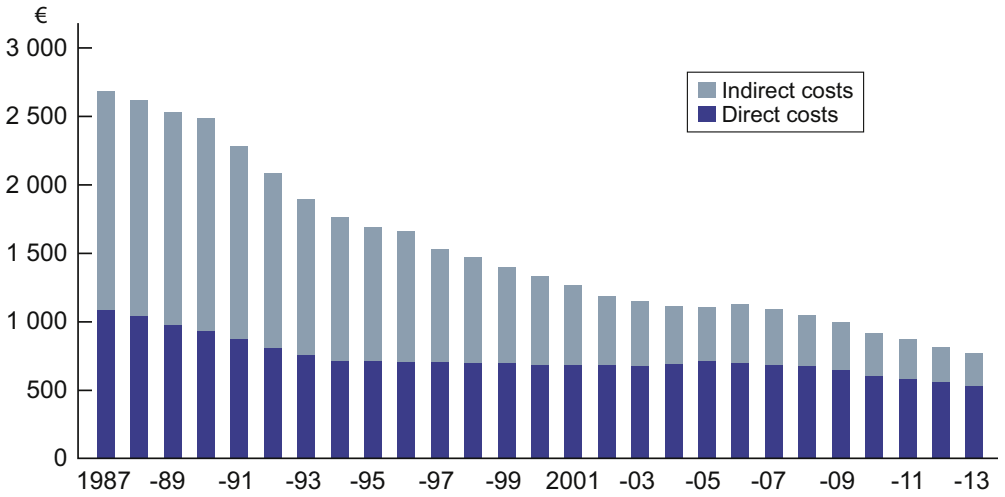

FIG 2. Overall annual costs of asthma care at the patient level in Finland from 1987 to 2013.

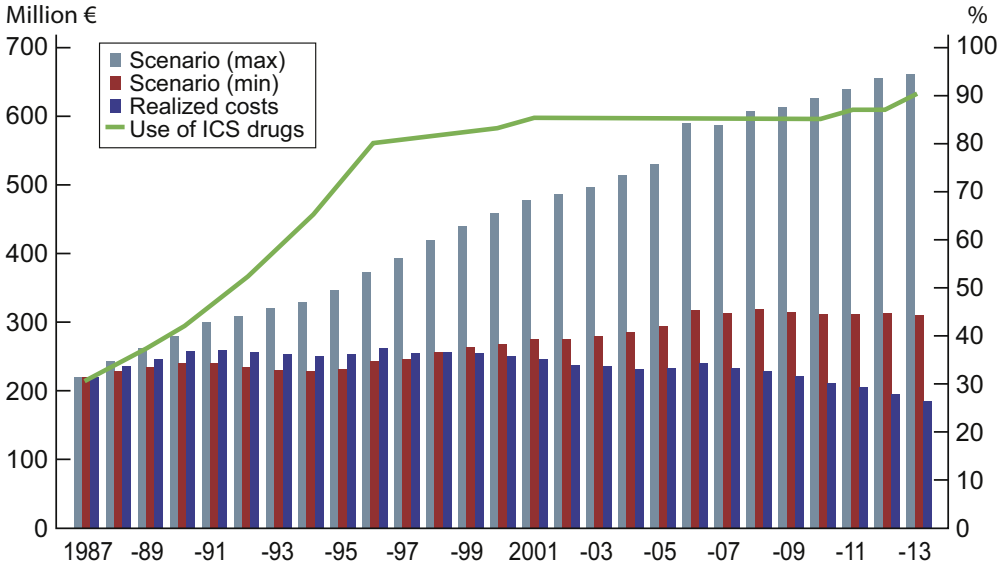

FIG 3. Actual (realized) annual expenditures of asthma care *(blue columns)* and minimum *(red columns)* and maximum *(gray columns)* scenarios of theoretic annual costs. The minimum scenario represents a theoretic annual expenditure if all of the 3-fold increase in prevalence was caused by patients with mild asthma. The maximum scenario assumes that the disease severity and standard of care remained at the 1987 level. The *green line* represents the percentage of patients receiving ICS medication.

yielded population-level benefits. This approach could also be applied in developing countries without jeopardizing their economies, thereby avoiding the substantial costs of emergency visits and hospitalizations.

The Finnish Asthma Program 1994-2004, supported by the Ministry of Health and Social Affairs, translated the new knowledge rapidly and consistently into clinical practice.[8] An implementation plan was outlined with strategic choices, defined goals, and measures, as well as activities, such as for capacity building and funding. Information, education, and effective networking with different stakeholders were the primary keys. Patients were taken into the program as active partners, mainly through nongovernmental patient organizations. Cooperation between asthma specialists, primary care physicians, nurses, pharmacists, and the pharmaceutical industry, with the last mentioned as producers of approved information material, resulted in rapid implementation of a program that could be achieved at low costs. A motivating factor was that many of the studies contributing to the new understanding of asthma originated from Finnish investigators in the international context.[29,30]

Improved asthma care in Finland is an example of how nationwide implementation of a successful strategy can decrease overall costs, despite increased numbers of patients needing treatment. Focused asthma programs have also been effective in other countries, with associated gains in quality-adjusted life-years[31,32] and improvements in quality of life, asthma symptoms, and lung function at lower direct costs compared with usual care.[33,34] Several European and other countries have similar experiences as Finland.[35-38] A group of experts, the

Advancing Asthma Care Network, discussed asthma projects and programs in Argentina, Australia, Brazil, China, Japan, Mexico, Philippines, Russia, South Africa, and Turkey.[39] The group concluded that the major barriers for successful programs are (1) low rates of dissemination and implementation of treatment guidelines, (2) low levels of continuing medical education and training of primary health care professionals, and (3) access and distribution of ICSs. In the less developed asthma programs, underrecognition and undertreatment further limited the success.

The Finnish financial system for providing care for chronic diseases, such as asthma, is complicated, as it is in most European Union countries, and divided into several sectors. The division of asthma costs in Finland between different stakeholders has changed considerably, with an increase in drug costs and costs for outpatient visits in primary care but significant decreases in hospital costs and indirect costs in terms of disability pensions and sickness allowances. A holistic view is warranted, and cooperation is needed among those who provide care and pay the costs.[40] Focusing on risk groups might provide further improvements.[41]

Our study has limitations, and the financial results are probably underestimated. Patients with mild or intermittent asthma not requiring daily maintenance treatment were excluded because they are not entitled to drug reimbursement and not included in the registry. The costs of outpatient visits to private health care providers are not known. Also, many of the components of productivity loss could not be calculated.

In Finland the number of patients receiving reimbursement for asthma drugs (ie, those receiving maintenance treatment) has almost tripled over the 26 years covered by this study. During the same period, the overall health care cost index increased by 37.5% in real terms.[13] Despite this, total costs for asthma in Finland at the end of the period were significantly less than 26 years before. In comparison, over the same period, the costs of breast cancer have increased by 140% while the number of patients has doubled.[42] From 2000 to 2007, the direct health care costs for diabetes increased by 60%, and costs for disability increased by 50%.[43]

In the United States evaluation methods have been developed that consider health care costs from the perspective of payers and society. However, it has been argued that an analysis of societal costs for a single disease is of little value and that cost-effectiveness analyses involving both costs and outcomes would be more feasible.[44] Nevertheless, cost of illness investigations are valuable in the planning, decision making, and allocation of resources within health care systems.[45] A broad societal approach that demonstrates real health care expenditures is important when discussing interventions in public health and medical care.[46] The present article estimates cost of illness changes over a long period of time, when systematic nationwide intervention has significantly reduced asthma burden.

CONCLUSIONS

Asthma needs public health solutions with implementation of best clinical practices. In Finland a nationwide management program based on a better understanding of disease pathophysiology resulted in improved care and significant cost savings over a 26-year period. Special focus on particular at-risk groups might provide further improvements.

The basis of the present report of asthma care costs in Finland is derived from the governmental, public health care asthma programme 1994-2004 (main results published in Thorax 2001 and 2006). The cost analyses were further developed in a project concerning several common diseases of public health concern commissioned by the Pharma Industry Finland (PIF) with the help of Nordic Healthcare Group (NHG). PIF published a report of the study findings of the selected chronic diseases, asthma among them. PIF did not participate in the design of the present, extended asthma study or in the collection, analysis, and interpretation of data. The final stage of this work was supported by the European Commission's 7th Framework Programme under grant agreement 261357 (MeDALL-project) and a Helsinki University Hospital grant.

Preliminary asthma data were published in the *Finnish Medical Journal* in Finnish (Reissell E, et al. The price of asthma in Finland 1987-2005—costs and financial benefits of treating a chronic disease. FMJ 2010;65:811-6). PIF had no part in the decision to submit the article for publication, and no funding was received. The researchers worked independent of PIF or other funders during the preparation of the present article.

Key messages

- **In many countries there have been major improvements in asthma care. The Finnish experience indicates that effective implementation of best practice results in significant cost savings. Emphasis on early diagnosis and anti-inflammatory treatment paved the way for improved care.**
- **Major societal cost savings can be achieved by reducing disability caused by asthma.**
- **Collaboration between all stakeholders is essential to tackle a public health problem, such as asthma.**

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TABLE E1. Finnish data sources registries and estimation methods for the present work

	Outcome/cost measure	Data source	Data extraction rule (method)	Cost estimation method	Generalizability (time/area)	Comments/data quality
Direct costs	Inpatient secondary care	National discharge register	Principal diagnosis ICD-9: 493 (1987-1995), ICD-10: J45, J46 (1996-2013) No. of bed days for each subject	Cost based on total number of bed days × standard unit price (national standard price list)[12]	Covers all admissions in the country during 1987-2013 Health care cost index[13] was used to estimate unit costs in other study years, and general price index[13] was used for deflating the costs for other study years in 2013 terms.	Widely used and audited register, data quality good according to validity studies
	Inpatient primary care	National discharge register	Principal diagnosis ICD-9: 493 (1987-1995), ICD-10: J45, J46 (1998-2013) No. of bed days for each subject	Cost based on total no. of bed days × standard unit price (national standard price list)[12]	Covers all admissions in the country during 1987-2013 Health care cost index[13] was used to estimate unit costs in other study years, and general price index[13] was used for deflating the costs for other study years in 2013 terms.	Widely used and audited register, data quality good according to validity studies
	Outpatient secondary care	National discharge register	Principal diagnosis ICD-10: J45, J46 (1996-2013) No. of visits for each subject	Cost based on total no. of visits × standard unit price (national standard price list)[12]	Covers all specialist level ambulatory visits in the country during 1996-2013 Visits in years 1987-1995 were extrapolated, assuming a constant growth rate based on average growth rate in 1996-2013 Health care cost index[13] was used to estimate unit costs in other study years, and general price index[13] was used for deflating the costs for other study years in 2013 terms.	Widely used and audited register, data quality good according to validity studies. Uncertainty related to estimated volumes for 1987-1995.
	Outpatient primary care	Nordic Healthcare Group benchmarking database (2013)	Diagnosis ICD-10: J45, J46, ICPC-2: R96 (2013) No. of visits for each subject	Average unit cost for ambulatory visit in public health centers[12]	Database contains a representative sample of Finnish municipalities The number of visits in the whole country was estimated by scaling	Data validated by the municipalities officials

(Continued)

TABLE E1. *(Continued)*

	Outcome/cost measure	Data source	Data extraction rule (method)	Cost estimation method	Generalizability (time/area)	Comments/data quality
					the no. of visits in the sample population to the whole population. The no. of other study years was obtained by assuming that visits per patient have remained constant (visits per patient × no. of patients). Health care cost index[13] was used to estimate unit costs in other study years, and general price index[13] was used for deflating the costs for other study years in 2013 terms.	
	Medication (outpatient)*	Finnish statistics on medicines, Finnish Medicines Agency (Fimea), Finnish Social Insurance Institution (SII)	SII reimbursement code 203 (asthma)	Costs directly from statistics	Covers medication reimbursements in the whole country (1987-2013) General price index[13] was used for deflating the costs for other study years in 2013 terms.	SII registry is reliable because it is based on paid reimbursements and match with accounting data.
Indirect costs (productivity)	Sick leaves	SII statistical yearbooks	Principal diagnosis ICD-9: 493 (1989-1995), ICD-10: J45, J46 (1996-2013) No. of sick-leave days for each subject	No. of sick-leave days transformed into lost work years × average annual income (national statistics)[13]	Covers sick leaves longer than 14 days in the whole country for 1989-2013 1987 and 1988 are assumed to be the same as 1989. General price index[13] was used for deflating the costs for other study years in 2013 terms.	SII registry is reliable because it is based on paid reimbursements and match with accounting data.
	Disability pensions	SII statistical yearbooks (national insurance pension) Finnish center for pensions registry (employee pension)		No. of disability pensions × average annual income (national statistics)[13]	Covers disability pensions (national insurance pension and employee pension) in the whole country for 1987-2013 General price index[13] was used for deflating the costs for other study years in 2013 terms.	SII registry and Finnish center for pensions registry are reliable because they are based on paid reimbursements and match with accounting data.

ICD-9, International Classification of Diseases, Ninth Revision; *ICD-10*, International Classification of Diseases, Tenth Revision.
*Inpatient medication included in inpatient care costs.