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## Original Research

## Costs of allergic diseases from birth to two years in Finland

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## SUMMARY

**Objectives:** Costing studies are needed to identify the resources used for treatment and inform payers of the costs incurred. The objectives were to determine the costs of diagnosing and treating atopic dermatitis, food allergy and asthma, and to compare the share of costs to society and to the family during the first two years of life.

**Study design:** The data were obtained from an ongoing mother-infant nutrition study. The sample comprised 60 infants who developed allergic disease by the age of 24 months and 56 healthy infants with no allergic disease.

**Methods:** The costs included diagnosis and treatment of the allergy, disability allowances, travel expenses and time spent by parents.

**Results:** The median costs per infant were €275 (range 94–1306) for atopic dermatitis, €1408 (163–5408) for asthma, €3182 (628–11195) for food allergy, and €10 (0–619) for the healthy infants due to the suspicion of allergic disease. The highest costs in atopic dermatitis were caused by primary care visits, topical treatments, travel costs and parents' time, and those for food allergy by hospital out-patient care, infant formulae for cow's milk allergy, disability allowances and travel costs. The families paid 43% of the costs arising from atopic dermatitis, 13.6% of those from food allergy and 16.5% of those from asthma.

**Conclusions:** Cow's milk allergy emerged as the most expensive allergic disease, especially for the society, and concurrent asthma in particular further increased the costs.

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## Introduction

Costing studies are needed to identify the resources used for treatment, to inform payers of the costs incurred and to provide data for cost-effectiveness studies. The reason for evaluating the costs related to allergic diseases in early

childhood lies in their prevalence, which varies from 15 to 30% for atopic dermatitis (AD),<sup>1</sup> from 3.1 to 4.5% for food allergy (FA)<sup>2,3</sup> and around 5% for asthma (AB).<sup>4</sup>

The total costs depend on the use made of the health services available, the unit costs of these services, how the provision of services is organised, national treatment

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practices and recommendations and many other societal factors. Disease-related costs can be approached from different perspectives,<sup>5</sup> the costs of treatment for AD, FA and AB having been evaluated from the perspective of society in general,<sup>6–11</sup> the health services,<sup>12</sup> third-party payers,<sup>13,14</sup> and the family.<sup>12,15–17</sup> Some follow-up studies are available on AD<sup>1,8,9,15</sup> and AB,<sup>13</sup> typically ones in which retrospective cost data have been gathered over a period of one year. Severity of AD<sup>8,15</sup> and AB<sup>13</sup> in early childhood have been shown to entail increased costs, while the incremental cost of diagnosing FA in an AD patient has been reported to be US\$257 (~€206 in 2005)<sup>18</sup> and the incremental cost of the diet €684.<sup>15</sup>

Valid data on costs are needed for policy making, evaluation of the adequacy and organisation of primary and secondary health care services and the evaluation of equality from the patient perspective. In Finland health care is mainly publicly financed and provided. Municipalities (local authorities) are responsible for organising all health care services (primary, secondary & tertiary) to their residents. Funding of health care services is based mainly on public funding (75%). Municipalities fund 35% of the total health care expenditure through local taxes, state 25% through partly progressive taxation, 15% is funded by national public health insurance scheme run by the Social Insurance Institution through compulsory insurance premiums. Private funding comprises funding by households, employers and private insurance. Households fund 19% of total health care expenditure by through user fees and co-payments, and the rest is financed by employers (3%), private insurance 2 (%) and sickness funds (1%). Households' out-of-pocket payments cover 44% of pharmaceutical expenditures, 15% of out-patient care and 4% of hospital expenditure.<sup>19</sup>

The largest share of health care is provided in the municipal health care system (71% of outpatient physician visits and 95% of inpatient care). Private health care provides only 16% of outpatient physician services.<sup>20</sup> Parents can pay private insurance for their children until the child age of 20 years. Within the public health care system, AB in young children is diagnosed and treated in specialized paediatric outpatient clinics, to which they are referred from primary health care. Allergies to milk and cereals are similarly diagnosed and treated in paediatric outpatient clinics. Mild to moderate AE may be treated in primary care, whereas the most severe cases are referred to specialized outpatient clinics. Private paediatricians also diagnose and treat allergic diseases.

The objective of this present work was to evaluate and compare the direct and indirect costs of diagnosing and treating AD, FA and AB in Finland, together with the costs to society and to the family during the first two years of life.

## Methods

### Subjects and study design

The data were collected in the context of an on-going prospective mother-infant study in Turku and neighbouring areas in South-West Finland<sup>21</sup> involving families with allergy in the mother, father or a sibling. Women were recruited at their first visit to maternal welfare clinics in the first trimester

of pregnancy, and the possible development of allergic disease in the infants was followed up from birth to 24 months by means of examinations by a nurse and physician at ages of 1, 6, 12 and 24 months. The criteria for the evaluation of allergy-related costs were a diagnosis of AD, FA (cow's milk and/or wheat allergy), doctor's diagnosed AB, a completed questionnaire concerning the child's diseases and medications between the ages of 12–24 months and the parents signed consent. An age and sex-matched group of healthy children were monitored in the same prospective manner and had no diagnosed allergic disease. The parents named their insurance company on the signed consent form. The protocol and declarations of informed consent were approved by the Ethics Committee of the Hospital District of South-West Finland.

AD was determined according to the criteria of Hanifin and Rajka<sup>22</sup> which requires that the patient fulfils at least 3 of the 4 major criteria and 3 of the 23 minor criteria for the establishment of the diagnosis of AD. The major criteria are pruritus, typical morphology and distribution of skin lesions, chronic or chronically relapsing dermatitis and personal or family history of atopy. The minor criteria includes issues related to facial features (e.g. facial pallor, infraorbital darkening, cheilitis), triggers of the dermatitis (e.g. foods, skin irritants), complications (e.g. susceptibility to skin infections), others (early age of onset, dry skin).

Cow's milk and wheat allergies were verified by means of open or double-blind placebo-controlled food challenges (DBPCFC).<sup>23</sup> In a DBPCFC, two challenges were carried out in a random order; one with placebo food which was known not to cause allergic symptoms to the patient and one with suspected food which was masked so that it could not be differentiated from placebo by taste or appearance. In both challenges, the food was administered to the patient in increasing doses. If skin symptoms (e.g. deterioration of atopic dermatitis) or intestinal symptoms (diarrhoea, vomitus, abdominal pain) occurred when the suspected food, but not placebo, was administered, the patient was diagnosed as having food allergy. Open food challenges were used especially when symptoms of immediate type (e.g. rash, urticaria) were expected.

Physician's diagnosed asthma was defined as qualification for a special reimbursement for asthma medication costs provided by the Finnish National Insurance Institute. This reimbursement requires at least four attacks of wheezing with respiratory distress within a year or three attacks in a year together with a positive asthma predictive index.<sup>24</sup> Asthma predictive index is positive if a child with recurrent wheezing during the first 3 years of life has 1 of 2 major criteria (physician-diagnosed eczema or parental asthma) or 2 of 3 minor criteria (physician-diagnosed allergic rhinitis, wheezing without colds or peripheral eosinophilia  $\geq 4\%$ ).

### Costing

The direct costs included the use of primary care and hospital care services, private services, examinations and treatment, medications, formulae for infants with cow's milk allergy, diets, disability allowances, and indirect costs included travel and the time spent by parents and time off work. For healthy infants all these were considered as aversion costs. The data

were collected from the national public insurance organisation, private insurance companies and health care providers, and also directly from the parents by means of a questionnaire and in connection with the examinations. The food costs and family part of infant formula for cow's milk allergic infants were evaluated from the infants' 3-day dietary records at ages of 6, 12 and 24 months.

The data obtained from the Social Insurance Institution, the national public insurance organisation which reimburses certain costs of private health care and medicines, included costs related to the services of a private specialist, examination and treatment charges, medications, reimbursed part of formulae for infants with cow's milk allergy (72%), disability allowances and travel costs in connection with public and private sector services. This was supplemented with data from private insurance companies in the case of infants who were insured privately. Private insurance covers those extra charges not reimbursed by public insurance. The health care providers were asked about in-patient and outpatient visits. Primary and secondary health care services are arranged and paid for by state and other legally authorized bodies.

Retail food prices were obtained from local supermarkets and the prices of vitamins, minerals and food supplements from the University Pharmacy. The baseline for the food-related costs including family part of formulae for cow's milk allergic infants and diet was set at the age of four months, when solid foods were introduced into the child's diet. When estimating family dietary costs up to the ages of 12 and 24 months the average daily costs (€/d) were multiplied by the number of days in the period concerned and the product multiplied by the difference in daily costs between the beginning and end point. Incremental family dietary costs were obtained by deducting the mean annual dietary costs for the healthy children in their first and second years from that of the allergic children. The parents' travelling times and times taken to reach sources of primary care, hospital care, private services and pharmaceutical services were estimated by counting the numbers of visits and multiplying these by the unit costs (Table 1). The parents' time off work due to the child's allergy was ascertained in the questionnaire

concerning the child's diseases and medications. The days lost (7.5 h/day) were multiplied with median wage per hour. Since the mothers were on a maternity allowance for the first 9–12 months of the infant's life, the questionnaire concerning the child's diseases and medications covered the ages from 12 to 24 months of age. The questionnaire was administered when the child was aged 24 months and included questions about the type and the amount of infections, prescriptions and the amounts of medication used, the use of over-the-counter medicines, emollients and cortisone or nutrition preparations and working days lost due to the child's allergy. Under the age of 12 months these were traced from the data collected at the 1, 6 and 12-month visits.

All prices were adjusted to the 2006 price level by reference to the cost-of-living index.<sup>25</sup> Unit prices, including those of blood tests and skin prick tests, were obtained from a standard price list (Table 1).<sup>26</sup> The costs were allocated to the family, the state or local authority, and public insurance or private insurance.

### Statistical analysis

The results are presented in the text as medians with the mean in brackets, as costs are naturally bounded by zero and have no upper bound.<sup>5</sup> The costs quoted in the tables include means, medians, standard deviations (SD) and ranges. Percentages are calculated from the means. Differences between groups were tested with the non-parametric Kruskal–Wallis test. The Chi Square test was used to evaluate the difference in the number of infections between the children with and without allergic disease. The data were analysed using SPSS for Windows (version 19.0; SPSS Inc., Chicago, IL, USA).

## Results

Data were obtained from 60 children (60% boys) who developed allergic disease by the age of 24 months and 56 ones who did not (60.7% boys). The allergic diseases and their combinations in the patients are presented in Fig. 1. The costs incurred by the healthy infants (for tests to exclude the possibility of allergies) were attributable to only 1.6% of them and amounted to a median of €10 (mean €50), (Table 2). These

**Table 1 – Unit costs, in € at 2006 prices.<sup>a</sup>**

|                                               | €/visit |
|-----------------------------------------------|---------|
| Primary care, GP visit                        | 61.9    |
| Outpatient visit, dermatologist               | 199.9   |
| Outpatient fee                                | 22.0    |
| Outpatient visit, paediatrician               | 197.4   |
| Dietician                                     | 85.2    |
| Rehabilitation instructor                     | 127.8   |
| Outpatient visit, food challenge <sup>b</sup> | 220.0   |
| Travelling costs for families:                |         |
| Primary care, pharmacy                        | 6.4     |
| Secondary care                                | 32.7    |
| Private consultations                         | 13.9    |
| Time cost                                     | 25.6    |
| Time off work (€/h) <sup>c</sup>              | 13.7    |

a Hujanen et al., 2008.

b Hospital District of Helsinki and Uusimaa.

c Statistics Finland.

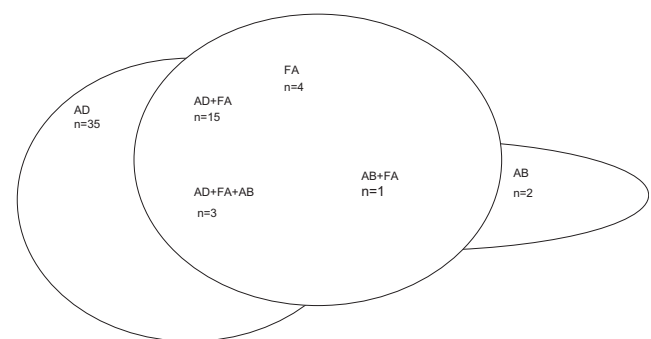


**Fig. 1 – Number of children with allergic diseases and their combinations, presented on Venn's diagram. (AD = atopic dermatitis, FA = food allergy, AB = asthma).**

**Table 2 – Costs of allergic diseases (€, at 2006 prices) during the first 24 months of life.**

| Costs (€) per child                   | First year  |             |             |                 | Second year |             |             |                 | From birth to two years |             |             |                  |
|---------------------------------------|-------------|-------------|-------------|-----------------|-------------|-------------|-------------|-----------------|-------------------------|-------------|-------------|------------------|
|                                       | Mean        | SD          | Median      | Range           | Mean        | SD          | Median      | Range           | Mean                    | SD          | Median      | Range            |
| <b>Healthy (n = 56)</b>               |             |             |             |                 |             |             |             |                 |                         |             |             |                  |
| Primary care consultations            | 4           | 16          | 0           | 0–62            | 1           | 8           | 0           | 0–62            | 6                       | 18          | 0           | 0–62             |
| Hospital out-patient care             | 11          | 45          | 0           | 0–197           | 0           | 0           | 0           | 0               | 11                      | 45          | 0           | 0–197            |
| Private specialists & examinations    | 1           | 9           | 0           | 0–68            | 2           | 11          | 0           | 0–65            | 3                       | 14          | 0           | 0–68             |
| Emollients                            | 1           | 7           | 0           | 0–54            | 10          | 20          | 3           | 0–123           | 11                      | 26          | 4           | 0–177            |
| Medications                           | 2           | 7           | 0           | 0–48            | 1           | 4           | 0           | 0–20            | 3                       | 8           | 0           | 0–48             |
| Travel expenses                       | 3           | 12          | 0           | 0–65            | 5           | 8           | 0           | 0–33            | 9                       | 15          | 3           | 0–84             |
| Time costs                            | 4           | 13          | 0           | 0–51            | 2           | 6           | 0           | 0–26            | 6                       | 14          | 0           | 0–51             |
| <b>Total</b>                          | <b>29</b>   | <b>99</b>   | <b>0</b>    | <b>0–477</b>    | <b>21</b>   | <b>39</b>   | <b>8</b>    | <b>0–158</b>    | <b>50</b>               | <b>118</b>  | <b>10</b>   | <b>0–619</b>     |
| <b>Atopic dermatitis (n = 35)</b>     |             |             |             |                 |             |             |             |                 |                         |             |             |                  |
| Primary care consultations            | 41          | 30          | 62          | 0–62            | 32          | 35          | 0           | 0–124           | 73                      | 28          | 62          | 62–124           |
| Hospital out-patient care             | 97          | 187         | 0           | 0–830           | 39          | 124         | 0           | 0–590           | 136                     | 243         | 0           | 0–830            |
| Private consultations & examinations  | 9           | 31          | 0           | 0–143           | 15          | 31          | 0           | 0–103           | 24                      | 45          | 0           | 0–165            |
| Emollients                            | 23          | 43          | 0           | 0–175           | 43          | 57          | 30          | 0–285           | 66                      | 90          | 40          | 0–456            |
| Medications                           | 9           | 23          | 0           | 0–125           | 6           | 12          | 0           | 0–54            | 15                      | 29          | 0           | 0–148            |
| Travel expenses                       | 29          | 37          | 13          | 0–156           | 28          | 26          | 20          | 0–124           | 56                      | 47          | 40          | 6–169            |
| Time costs                            | 32          | 32          | 26          | 0–128           | 23          | 20          | 26          | 0–77            | 56                      | 32          | 51          | 26–128           |
| <b>Total</b>                          | <b>239</b>  | <b>296</b>  | <b>111</b>  | <b>0–1277</b>   | <b>187</b>  | <b>179</b>  | <b>146</b>  | <b>0–874</b>    | <b>425</b>              | <b>364</b>  | <b>275</b>  | <b>94–1306</b>   |
| <b>Food allergy (n = 23)</b>          |             |             |             |                 |             |             |             |                 |                         |             |             |                  |
| Primary care consultations            | 62          | 32          | 62          | 0–186           | 5           | 18          | 0           | 0–62            | 67                      | 37          | 62          | 0–186            |
| Hospital out-patient care             | 424         | 394         | 393         | 0–1265          | 501         | 387         | 590         | 0–1203          | 925                     | 636         | 983         | 0–2465           |
| Private specialists & examinations    | 73          | 146         | 0           | 0–494           | 107         | 260         | 0           | 0–893           | 181                     | 365         | 0           | 0–1383           |
| Emollients                            | 45          | 64          | 18          | 0–219           | 65          | 73          | 43          | 0–254           | 110                     | 124         | 73          | 0–435            |
| Medications                           | 32          | 51          | 10          | 0–199           | 32          | 50          | 10          | 0–177           | 64                      | 92          | 26          | 0–290            |
| Diet, incremental cost                | 47          | 264         | 47          | –269–641        | 68          | 336         | 0           | –523–656        | 116                     | 564         | 14          | –783–2078        |
| Infant formulae                       | 768         | 1243        | 13          | 0–3877          | 1157        | 1652        | 369         | 0–5819          | 1925                    | 2668        | 731         | 0–8254           |
| Disability allowance                  | 161         | 258         | 0           | 0–714           | 465         | 604         | 79          | 0–2205          | 626                     | 660         | 714         | 0–2205           |
| Travelling costs                      | 125         | 71          | 110         | 6–228           | 127         | 62          | 124         | 14–238          | 252                     | 104         | 245         | 81–439           |
| Time costs                            | 101         | 55          | 102         | 0–230           | 96          | 52          | 77          | 0–179           | 197                     | 90          | 179         | 77–410           |
| <b>Total (n = 23, excluding diet)</b> | <b>1791</b> | <b>1494</b> | <b>1411</b> | <b>68–5778</b>  | <b>2556</b> | <b>2010</b> | <b>1978</b> | <b>213–7882</b> | <b>4348</b>             | <b>3225</b> | <b>3182</b> | <b>628–11195</b> |
| <b>Total (n = 20, including diet)</b> | <b>1881</b> | <b>1692</b> | <b>1373</b> | <b>126–6238</b> | <b>2562</b> | <b>1851</b> | <b>2131</b> | <b>143–6658</b> | <b>4445</b>             | <b>3292</b> | <b>3214</b> | <b>628–11560</b> |
| <b>Asthma (n = 6<sup>a</sup>)</b>     |             |             |             |                 |             |             |             |                 |                         |             |             |                  |
| Primary care consultations            | 0           | 0           | 0           | 0               | 21          | 32          | 0           | 0–62            | 21                      | 32          | 0           | 0–62             |
| Hospital outpatient care              | 140         | 345         | 0           | 0–845           | 249         | 399         | 0           | 0–907           | 389                     | 637         | 0           | 0–1568           |
| Hospital in-patient care              | 0           | 0           | 0           | 0               | 260         | 637         | 0           | 0–1560          | 260                     | 637         | 0           | 0–1560           |
| Private specialists & examinations    | 0           | 0           | 0           | 0               | 111         | 109         | 69          | 0–306           | 111                     | 109         | 69          | 0–306            |
| Medications                           | 75          | 140         | 15          | 0–356           | 208         | 138         | 167         | 46–432          | 283                     | 264         | 201         | 46–788           |
| Disability allowance                  | 134         | 289         | 0           | 0–720           | 282         | 456         | 0           | 0–1056          | 415                     | 725         | 0           | 0–1776           |
| Travelling costs                      | 33          | 75          | 3           | 0–186           | 85          | 68          | 57          | 20–176          | 119                     | 131         | 57          | 20–362           |
| Time costs                            | 21          | 52          | 0           | 0–128           | 68          | 42          | 64          | 26–128          | 90                      | 79          | 64          | 26–230           |
| Time off work                         | 0           | 0           | 0           | 0               | 169         | 415         | 0           | 0–1016          | 169                     | 415         | 0           | 0–1016           |
| <b>Total</b>                          | <b>404</b>  | <b>661</b>  | <b>21</b>   | <b>0–1596</b>   | <b>1454</b> | <b>1444</b> | <b>1022</b> | <b>164–3812</b> | <b>1858</b>             | <b>2024</b> | <b>1408</b> | <b>163–5408</b>  |

a 4/6 of infants had asthma, atopic dermatitis and food allergy.

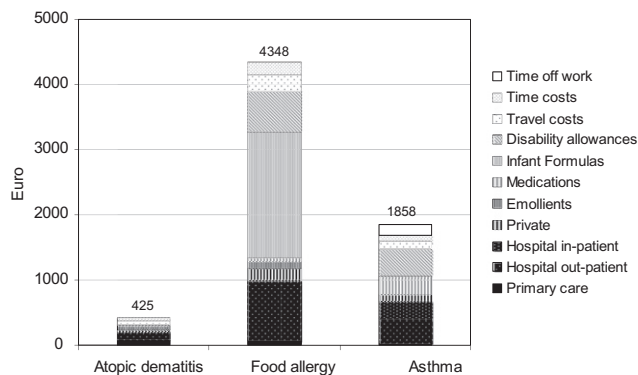


**Fig. 2 – Cost of atopic dermatitis, food allergy and asthma per infant during the first 24 months.**

costs were caused by the use of emollients, travel, hospital out-patient care and primary care (Fig. 2).

The median (total) cost in cases of AD was €275 (mean €425), with 56% of this occurring in the first year (Table 2). The largest direct cost components were primary care consultations, emollients, and indirect costs were travel costs and time costs. Topical corticosteroids combined with antimicrobials accounted for 49.5% of the (total) costs of the treatment of AD during the two-year period, while the percentages for topical calcineurin inhibitors, antihistamines, other medications and topical steroids alone were 20.2%, 13.8%, 8.8% and 7.7%, respectively.

FA caused a median cost of €3182€ (mean €4348) during the first two years, with 41% of this occurring in the first year (Table 2). The highest direct costs arose from hospital out-patient care, including food challenges, formulae for infants with cow's milk allergy, disability allowances and indirect costs from travel costs. Medications were needed to treat AD and food-related anaphylaxis. Topical calcineurin inhibitors comprised 38.5% of the treatment costs during the two-year period, topical steroids combined with antimicrobial substances 22.8%, topical steroids alone 20.7%, antihistamines 11.7% and other medications 6.2%.

The family dietary costs are shown in Table 3. The diet of the infants with FA for families was a median of €47 (mean €115) more expensive than that of the healthy children. The

additional cost of the diet of the infants with FA relative to the healthy infants was a median of €778€ (mean €2041) when reimbursed part of formulae by Social Insurance Institution for infants with cow's milk allergy were included.

The median cost of AB was €1408 (mean €1858), of which 75% occurred in the second year (Table 2). The proportions accounted for by bronchodilators and asthma control medications were 15% and 85% of the medication costs, respectively. Individual differences in this group of infants were large, and the costs mainly arose from cases requiring hospital care, disability allowances and medications. There were no statistically significant differences in the number of respiratory or gastrointestinal infections between the two groups.

### Cost per payer

The median costs to the family were €0 (mean €27) in the healthy cases, €131 (mean €183) in AD, €525 (mean €529) in FA and €235 (mean €300) in AB (Fig. 3), and those covered by the state and local authorities were €0 (mean €15) in the healthy cases, €62 (mean €194) in AD, €934 (mean €898) in FA and €62 (mean €629) in AB. The series included 32% infants who had no private insurance, and a further 16.4% ( $n = 14$ ) for whom no data were available. The proportion of the direct costs that was covered by private insurance was lowest in those who had the highest costs. Comparison of the costs per payer between the disease groups showed that in infants with private insurance it covered 9.3% of the costs for the healthy infants, 8.3% in AD and 7.6% in FA.

### Discussion

The results showed that the costs related to FA were 11 times higher than those related to AD, 3.5 times higher than those related to AB and 318 times higher than those required by the healthy infants for the exclusion of allergy during the first two years of life. The public insurance system paid a significant proportion of the costs in the cases of FA and AB, and thus succeeded in alleviating the cost burden to the families. FA, AD and AB comprise the spectrum of allergic diseases in early childhood and therefore the direct and indirect costs induced by them were the objective of this study.

| <b>Table 3 – Family dietary costs including part of infant formula for cow's milk allergic infants (€).</b> |            |             |          |
|-------------------------------------------------------------------------------------------------------------|------------|-------------|----------|
|                                                                                                             | First year | Second year | Total    |
| Healthy infants ( $n = 51$ )                                                                                |            |             |          |
| Mean                                                                                                        | 363        | 951         | 1314     |
| Median                                                                                                      | 349        | 949         | 1282     |
| Range                                                                                                       | 124–740    | 561–1457    | 685–2186 |
| Infants with atopic dermatitis ( $n = 35$ )                                                                 |            |             |          |
| Mean                                                                                                        | 391        | 922         | 1314     |
| Median                                                                                                      | 372        | 884         | 1290     |
| Range                                                                                                       | 116–779    | 476–1429    | 614–2095 |
| Infants with food allergy ( $n = 20$ )                                                                      |            |             |          |
| Mean                                                                                                        | 447        | 1019        | 1429     |
| Median                                                                                                      | 420        | 951         | 1327     |
| Range                                                                                                       | 94–1004    | 428–1607    | 530–2609 |

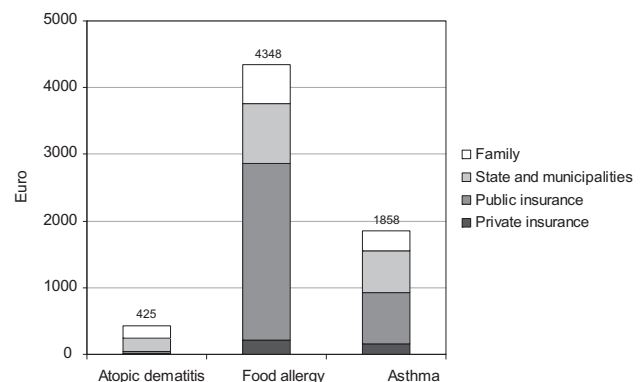


**Fig. 3 – Costs per payer in atopic dermatitis, food allergy and asthma during the first 24 months.**

The finding that the highest costs in FA arose from hospital out-patient visits, including consultations with a physician and food challenges, supports a previously presented model for the diagnosis and treatment of FA.<sup>27</sup> The second major cost category was treatment by means of an elimination diet and hydrolysed infant formulae. Other studies have reported on dietary costs occasioned by moderate eczema AUD81 (1996) (€52) and severe eczema AUD360 (1996) (€230)<sup>17</sup> and have stated the cost of food products to be €684,<sup>15</sup> which approaches our result of a median of €778 (mean €2041) over a two-year period. The dietary costs quoted in earlier studies have been based on crude measures compared with the dietary records including family part of formula costs and diet, and reimbursed part of formula by social insurance institution databases used here. Other studies also included pre-school and school-aged children.<sup>15,17</sup> Sladkevicius and Guest used decision analysis modelling to evaluate the economic impact of managing cow's milk allergy during the first year,<sup>28,29</sup> quoting an estimated cost of €2567 per patient in the Netherlands, where 72% of this was due to extensively hydrolysed formulae,<sup>28</sup> while the expected costs in South Africa were €3836 in the private sector and €2166 in the public sector.<sup>29</sup>

Only a few studies have reported the cost of AD/AE in early childhood together with the part borne by the family.<sup>9,12,15,18</sup> The median cost of AD was €275 (mean €425) during two years, which represents a medium level by comparison with previously quoted costs of £79.59 (€102)<sup>9</sup> and €1254.<sup>15</sup> In the first study 84% of children had mild AD and they were treated by physician in primary care where biggest estimated costs were caused by consultations (36%) and prescriptions (28%).<sup>9</sup> The major cost categories were the same as in Finland; primary care consultations, emollients, parents' travel and time costs. In an Italian study<sup>15</sup> the costs were accrued mainly by moisturizing (38–70%) and detergents (13–28%). These factors as, hospitalization,<sup>17</sup> primary care consultations,<sup>9,17</sup> time off work,<sup>17</sup> prescriptions<sup>9</sup> and changes in the home environment,<sup>9,17</sup> made up of a significant proportion of the costs generally. In one study 50% of the infants under the age of two years had no expenditure, so that the family median cost was £0 and cost to the state £112 (€151).<sup>12</sup> The prognosis for childhood eczema has been shown to be usually good, and the majority of infants have a mild AD.<sup>30,31</sup> In the studies of Ricci<sup>15</sup> and Su<sup>17</sup> the children were recruited from hospital out-patient care to represent the costs of moderate to severe AD, and may give a distorted impression of the cost level if the results are extrapolated to produce national estimates. Cost increase with increasing disease severity in AD<sup>13,15,17</sup> when hospital in-patient care is needed. The payer proportions of the estimated costs have varied from 47% to 64% to the state and from 36% to 53% to the family, which were close to the figures presented here.<sup>9,17</sup>

The median cost of AB, €1408, is comparable with the annual cost of CAD1386 (€900) to society reported earlier for children under the age of four years,<sup>16</sup> and again the main sources of expenditure were the same as reported previously: hospital admissions and medications.<sup>13,16</sup> Hospital in-patient care has been shown to be more expensive for younger children than for older ones.<sup>32</sup> Because of the differences in health care delivery and financing systems, and variations in disease severity and the costs included between the patients, large

variations between countries can be found in the estimated treatment costs associated with AD.

The median was chosen to describe the costs at the group level, as the mean was affected by resource use in infants with severe disease, but in any case a significant proportion of the costs is often attributable to children with severe disease. Weinmann *et al.*<sup>13</sup> reported that 20% of their children with asthma incurred 76% of the health care costs and 20% of those with atopic eczema incurred 85% of the costs. The fact that our data were obtained from families at risk of contracting infant allergy means that the series may be self-selected. The costs are nevertheless related to the illness per se and the selection of the families during the pregnancy doesn't change the cost figures obtained. These figures may represent underestimates, as telephone calls to the health services were not included, nor was the extra time required for parents to prepare special food or the effects of differences in diet at ages from four to six months. The use of emollients was not asked about until after the age of 12 months, and instead was traced from the diaries and public and private insurance claims, so that their use may be underestimated. The regular follow-ups were aimed at early diagnosis and treatment, and the changes made by the researchers to some of the children's treatment paths may have distorted the costs in this instance. Also, household items and lost productivity were not included. Parents were asked about time off work on account of their infant's allergy, but as only one family reported having been off work for about same days, this factor was related to AB. Elsewhere it has accounted for almost 50% of the total burden on the parents of young children,<sup>7</sup> but only 5% of the costs in another connection,<sup>9</sup> where this aspect was included in a parents' questionnaire, as in the present case.

## Conclusion

The present study gives an estimate of the direct and indirect costs related to AD, FA and AB during the first two years of life, identifying FA involving cow's milk allergy as the most expensive allergic disease. From the family perspective public insurance covers the major part of the costs related to FA and asthma. Further studies are needed to find out how the costs alter as the children grow up and how the costs per payer change.

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## Ethical approval

The protocol and declarations of informed consent were approved by the Ethics Committee of the Hospital District of South-West Finland.

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### Contributions

All authors have contributed significantly to the study design, data collection, analysis and manuscript preparation.

### Competing interests

None.

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