

# Impact of tonsillotomy versus tonsillectomy on health-related quality of life and healthcare costs in children with sleep-disordered breathing

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## Main Article

Dr A J Sakki takes responsibility for the integrity of the content of the paper

**Cite this article:** Sakki AJ, Roine RP, Mäkinen LK, Sintonen H, Nokso-Koivisto J. Impact of tonsillotomy versus tonsillectomy on health-related quality of life and healthcare costs in children with sleep-disordered breathing. *J Laryngol Otol* 2022;**136**:454–460. <https://doi.org/10.1017/S0022215121003832>

Accepted: 12 May 2021  
First published online: 25 November 2021

### Key words:

Tonsil Surgery; Health Related Costs; Quality Of Life; Child; Sleep-Disordered Breathing

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## Abstract

**Objective.** This study aimed to explore health-related quality of life and use of healthcare services and ensuing costs before and after tonsillotomy in children with sleep-disordered breathing and to compare the results to an earlier cohort of children who had undergone tonsillectomy.

**Method.** Children undergoing tonsillotomy answered the 17-dimensional, standardised health-related quality of life instrument questionnaire and a questionnaire on use of healthcare services and sick leave before and after surgery. Costs of specialist care were obtained pre- and post-operatively. The data were compared with similar data collected previously from children with tonsillectomy.

**Results.** Tonsillotomy improved mean total health-related quality of life score significantly at 6 and 12 months. Healthcare costs and number of sick-leave days diminished significantly from 3 months pre-operatively to 12 months after surgery. Tonsillotomy had similar positive effects compared with tonsillectomy regarding health-related quality of life and healthcare costs.

**Conclusion.** Tonsillotomy improves health-related quality of life in children with sleep-disordered breathing and reduces healthcare service needs and sick leave similarly to tonsillectomy.

## Introduction

Sleep-disordered breathing is currently the most common indication for tonsil surgery in children.<sup>1,2</sup> Sleep-disordered breathing is caused by tonsillar hypertrophy and represents a spectrum of upper-airway disorders ranging in severity from primary snoring to obstructive sleep apnoea syndrome.<sup>3</sup> In recent years, tonsillotomy, intracapsular (partial) tonsillectomy, has become the recommended surgical method for tonsillar hypertrophy.<sup>1,4</sup> Compared with tonsillectomy, tonsillotomy is associated with less morbidity and faster post-operative recovery.<sup>5–7</sup> However, tonsillectomy is still the preferred method for chronic or recurrent tonsillitis.<sup>1</sup>

Patients with tonsillar hypertrophy, recurrent throat infections or both may have varying symptoms that impact their health-related quality of life (QoL). Throat infections and sleep-related problems (snoring, frequent awakenings, failure to thrive and behavioural disturbances) result in increased healthcare visits and health-related costs.<sup>8–11</sup> Tonsillectomy has a positive impact on health-related QoL in children and adolescents,<sup>12,13</sup> and it reduces healthcare costs.<sup>13</sup> Tonsillotomy has also been shown to improve health-related QoL in small children (4–5 years) and young adults (16–25 years).<sup>14–18</sup> However, there are only a few studies that have compared the effect of tonsillotomy and tonsillectomy in the treatment of sleep-disordered breathing on health-related QoL in children,<sup>14,19</sup> and there are no studies that compare the use of healthcare services, ensuing costs and sick leave after tonsillotomy and tonsillectomy.

The objective of this study was to compare the self-reported health-related QoL in children of 5 to 11 years of age before and after tonsillotomy by using a generic 17-dimensional, standardised health-related QoL instrument. In addition, the use of healthcare services, ensuing costs and sick leave after tonsillotomy were analysed in the same study population. The second aim was to compare the results to an earlier cohort of children who had undergone tonsillectomy.

## Materials and methods

The patients were children (5–11 years) who were scheduled for tonsillotomy through normal clinical practice. Patients were recruited at the Department of Otorhinolaryngology or at the New Children's Hospital of Helsinki University Hospital, Finland, between June 2013 and September 2019. The indication for

tonsillotomy was tonsil-related sleep-disordered breathing. In accordance with Finnish practice, no polysomnography was performed on these otherwise healthy children. All tonsil surgical procedures were performed in an ambulatory surgery (day case procedure) except for one because of hereditary increased risk of post-operative bleeding which needed observation overnight. The children, with the assistance of their parents, were asked to complete a health-related QoL questionnaire and a questionnaire inquiring about the use of healthcare services and sick leave during the pre-operative three months. At 6 and 12 months after the operation, follow-up questionnaires were mailed to families who had returned the first questionnaire and the informed consent form. One reminder was sent to the patients who had not returned the follow-up questionnaire.

Health-related QoL was measured by a generic 17-dimensional, standardised health-related QoL instrument.<sup>20</sup> The 17-dimensional, standardised health-related QoL instrument can be used both as a profile and as a single index utility score measure. The dimensions of the 17-dimensional, standardised health-related QoL instrument questionnaire comprise mobility, vision, hearing, breathing, sleeping, eating, speech, excretion, school and hobbies, learning and memory, discomfort and symptoms, depression, distress, vitality, appearance, friends, and concentration. For each dimension, the respondents chose the level (on a scale of 1–5, with 1 indicating the best and 5 the worst level) to best describe their current state of health.

The single index score (17-dimensional, standardised health-related QoL instrument score), representing the overall health-related QoL on a 0–1 scale (with 0 being dead and 1 full health) and the dimension level values, reflecting the goodness of the levels relative to no problems on the dimension (1) and to being dead (0), were calculated from the health state descriptive system by using a set of preference or utility weights elicited from parents of 8 to 11-year-old schoolchildren. The valuation methodology is similar to that used for the adult version of the health-related QoL instrument (15 dimensional) and is based on an application of the multi-attribute utility theory (<http://www.15d-instrument.net/15d>).<sup>20</sup> Mean dimension level values were used to draw 17-dimensional, standardised health-related QoL instrument profiles for the groups.

Costs related to the use of primary healthcare services (both public and private), hospital treatment and laboratory services during the preceding 3 months and 6 and 12 months after surgery were collected by a self-report questionnaire. The same questionnaire also included a question concerning the number of days spent on sick leave because of oropharyngeal symptoms. The use of services was converted into monetary units using Finnish data on the unit costs of healthcare-related services from the year 2006.<sup>21</sup> In order to bring the costs to the 2017 level, the year in which most of the costs were incurred, costs were multiplied by 1.235 to correspond to the price inflation of basic services over the years. The data on price inflation were obtained from the Association of Finnish Municipalities.<sup>22</sup>

Hospital costs incurred in the Helsinki University Hospital because of tonsillotomy and related to oropharyngeal problems during a time span from 3 months preceding the operation to 12 months after the operation were obtained from the Ecomed<sup>®</sup> clinical patient administration system, where data on hospital treatment costs of individual patients were stored. Visits concerning tonsil-related oropharyngeal problems, tonsillotomy or its complications, and visits to other medical specialties if they

were deemed to be related to tonsil-related otorhinolaryngology problems were included.

The same data before and after tonsillectomy in children aged 7 to 11 years were collected from 2008–2012 and published previously.<sup>13</sup> For that study, the data of children having undergone tonsillectomy because of sleep-disordered breathing were analysed. The hospital costs reported in that article (median year, 2010) were multiplied by 1.082 to bring them to the 2017 level (median year of the new data).

### Surgical technique for tonsil surgery

The technique for tonsillotomy was adopted from Hultcrantz and Ericsson.<sup>23</sup> They used a radiofrequency generator BM-780 II (Sutter Medizintechnik, Freiburg, Germany). A small amount of lidocaine-adrenaline was injected into the tonsillar tissue. With a bent needle electrode (ARROWtip Re-Usable, Sutter Medizintechnik, Freiburg, Germany) and 80 W effect, the protruding part of the tonsil was cut off in the plane of the pillars. Tonsillectomy was performed with a cold knife or scissors and blunt dissection. On both occasions, haemostasis was obtained with compression or bipolar diathermia.

### Statistics

Data analysis was performed using SPSS<sup>®</sup> statistical software (version 25). The results are presented as mean and 95 per cent confidence interval (CI). The significance of the difference between the tonsillectomy and tonsillotomy groups was analysed with independent samples *t*-test, the difference between baseline and follow-up health-related QoL scores with paired samples *t*-test, and the distribution of categorical variables between the groups with chi-squared test. *P*-values less than 0.05 were considered statistically significant.

### Ethics

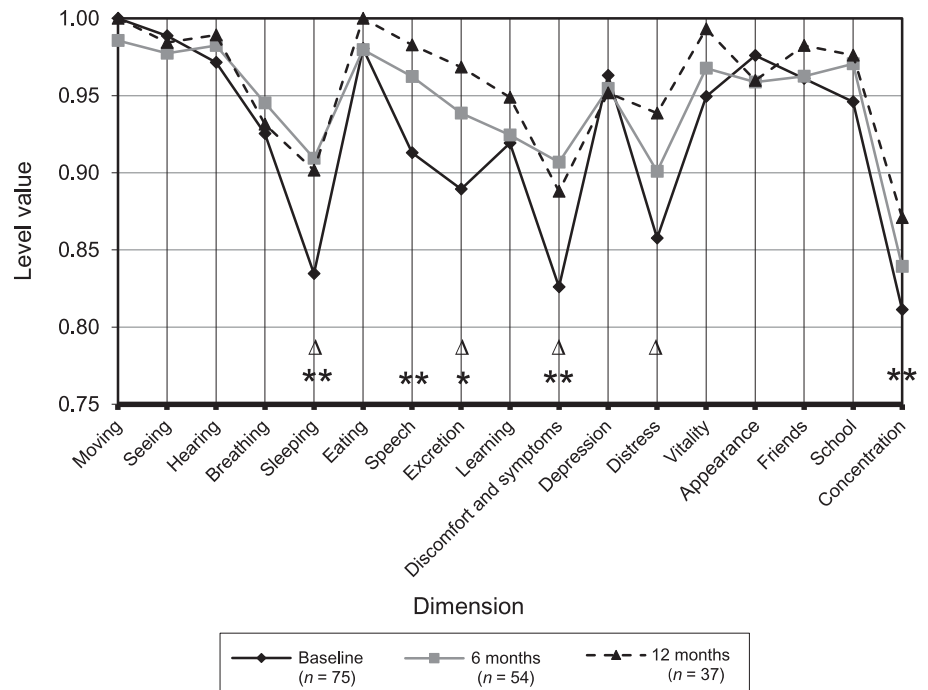
The study protocol was approved by the Ethics Committee of the Helsinki and Uusimaa Hospital District. Institutional research permission was granted by the Helsinki University Hospital, Helsinki, Finland. Written informed consent was obtained from the parents of all participants. All patients received scheduled routine treatment.

### Results

The families of 75 children returned an adequately completed baseline questionnaire and were included in the study. Of the families that answered the baseline questionnaire, 37 (49 per cent) returned all three questionnaires. The mean age of the children at the time of the first questionnaire was 6.7 years (range, 5–11) and 45 per cent were female. The indication for tonsillotomy was sleep-disordered breathing in all patients.

The mean baseline and follow-up 17-dimensional, standardised health-related QoL instrument profiles of all (tonsillotomy) patients are presented in [Figure 1](#). The most marked improvements in health-related QoL were seen for the dimensions of sleeping, speech, discomfort and symptoms, and concentration.

For the children who returned all the health-related QoL questionnaires ( $n = 37$ , mean age 6.9 years, 50 per cent female), the mean total health-related QoL score improved from 0.933 (95 per cent CI = 0.931 to 0.953) to 0.956 (95



**Fig. 1.** Graph showing mean 17-dimensional, standardised health-related quality of life instrument profiles during 1-year follow up for children who had undergone tonsillotomy. Mean 17-dimensional score: baseline, 0.925; 6 months, 0.946; and 12 months, 0.957. Baseline versus 6 months,  $p=0.002$ ; baseline versus 12 months,  $p=0.002$ . Baseline versus 6 months: \* $p < 0.05$ , \*\* $p < 0.01$ . Baseline versus 12 months:  $\Delta p < 0.05$ .

per cent CI = 0.942 to 0.970) at 6 months ( $p=0.001$ ) and remained at the same higher level at 12 months.

The baseline questionnaires concerning the use of healthcare services and days on sick leave during the pre-operative 3 months were returned by 76 patients. Ten patients had left 1 or 2 of the 12 cost item questions unanswered. These were interpreted as if there were no costs in that specific item. Where more than three items were unanswered, the patient was excluded from the analysis. Adequately completed self-reported data from all three questionnaires were available for 33 children. The mean costs related to the use of healthcare services during the preceding 3 months diminished from €570 (95 per cent CI = 302 to 838) at baseline to €269 (95 per cent CI = -99 to 636) at 6 months ( $p=0.209$ ) and to €132 (95 per cent CI = 27 to 236) at 12 months ( $p < 0.001$ ). The mean number of sick-leave days as a result of oropharyngeal problems during the pre-operative 3 months compared with post-operative months 10–12 decreased significantly from 2.8 days (95 per cent CI = 1.2 to 4.4) to 0.5 days (95 per cent CI = -0.3 to 1.0) ( $p=0.001$ ).

### Hospital costs

Valid cost data on the use of specialist services related to tonsillar problems at the Helsinki University Hospital were available for 75 patients. The mean total cost of specialist care from 3 months before the operation to 12 months after the operation was €1371 (range, €971 to €5501). Of the total costs, 88 per cent were attributable to operation costs, 11 per cent to pre- and post-operative out-patient visits, and less than 1 per cent were attributable to in-patient ward treatment. One patient needed an out-patient visit within two weeks of the operation because of a complication. Other post-operative

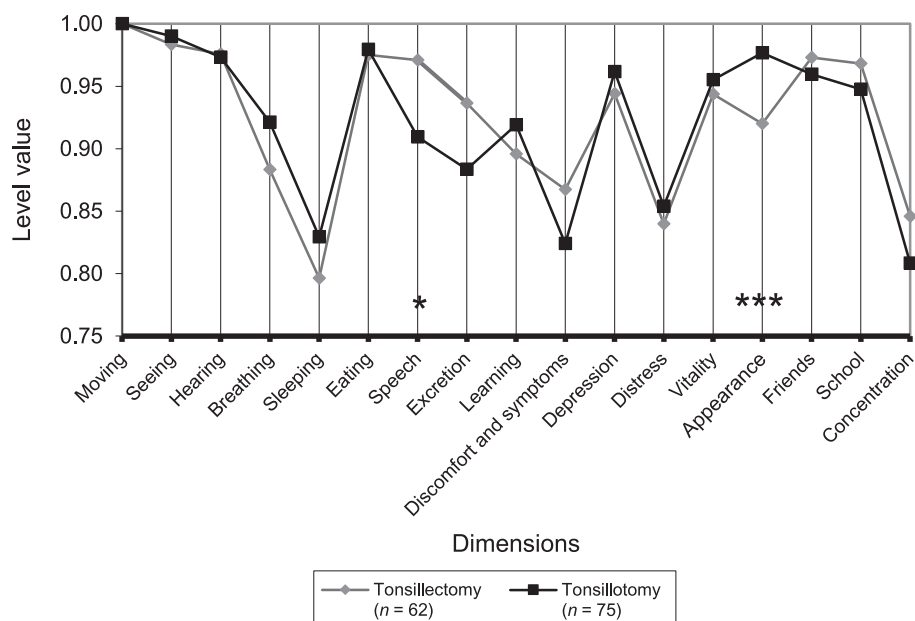
costs (2.3 per cent) consisted of out-patient visits during the year following the surgery. None of the patients needed a re-operation during the 12-month follow-up period.

### Comparisons of QoL and costs

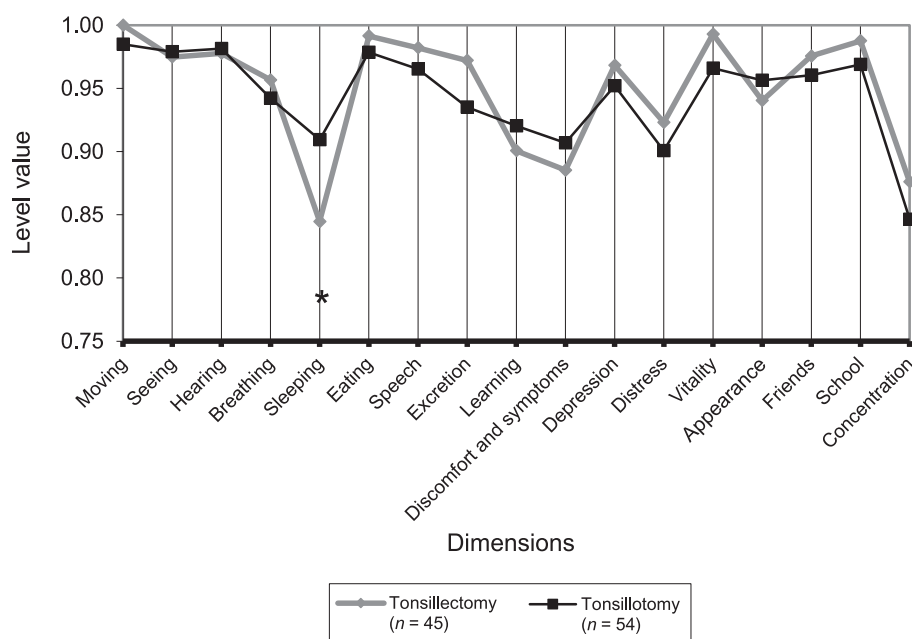
Health-related QoL and healthcare-related costs before and after tonsillectomy in children and adolescents have been reported previously.<sup>13</sup> The data on paediatric tonsillectomy undertaken because of sleep-disordered breathing ( $n=62$ ) were re-examined for the comparison. The children with tonsillectomy were younger than tonsillotomy patients (mean, 6.7 vs 9.3 years), but the gender distribution did not differ significantly; 45 per cent were female in the tonsillotomy group and 53 per cent were female in the tonsillectomy group. The indication for surgery was sleep-disordered breathing for all children included in the study.

The baseline 17-dimensional, standardised health-related QoL instrument profiles of tonsillotomy and tonsillectomy children are shown in Figure 2. At baseline, tonsillotomy patients had a lower mean score on the dimension of speech compared with the tonsillectomy group (0.909 vs 0.971,  $p < 0.05$ ), whereas on the dimension of appearance, tonsillotomy group patients had a higher mean score (0.977 vs 0.921,  $p < 0.01$ ). There was no significant difference between the groups in the mean total health-related QoL score ( $p=0.713$ ).

At 6 months, tonsillotomy group patients had significantly higher scores on the dimension of sleeping compared with tonsillectomy group patients (0.909 vs 0.844,  $p < 0.05$ ) (Figure 3); however, the difference had disappeared at 12 months. The total 17-dimensional, standardised health-related QoL instrument score improved in both groups during follow up with no significant difference between groups. The changes



**Fig. 2.** Graph showing mean 17-dimensional, standardised health-related quality of life instrument profiles of children who had undergone tonsillectomy or tonsillotomy at baseline, before the intervention. 17-dimensional score: tonsillectomy, 0.929; tonsillotomy, 0.925;  $p = 0.713$ . \* $p < 0.05$ , \*\*\* $p < 0.01$ .



**Fig. 3.** Graph showing mean 17-dimensional, standardised health-related quality of life instrument profiles of children who had undergone tonsillectomy or tonsillotomy and who returned the questionnaire 6 months after the intervention. 17-dimensional score: tonsillectomy, 0.952; tonsillotomy, 0.946;  $p = 0.615$ . \* $p < 0.05$ .

in the total 17-dimensional, standardised health-related QoL instrument scores from baseline to 6 months and 12 months are shown in Figure 4.

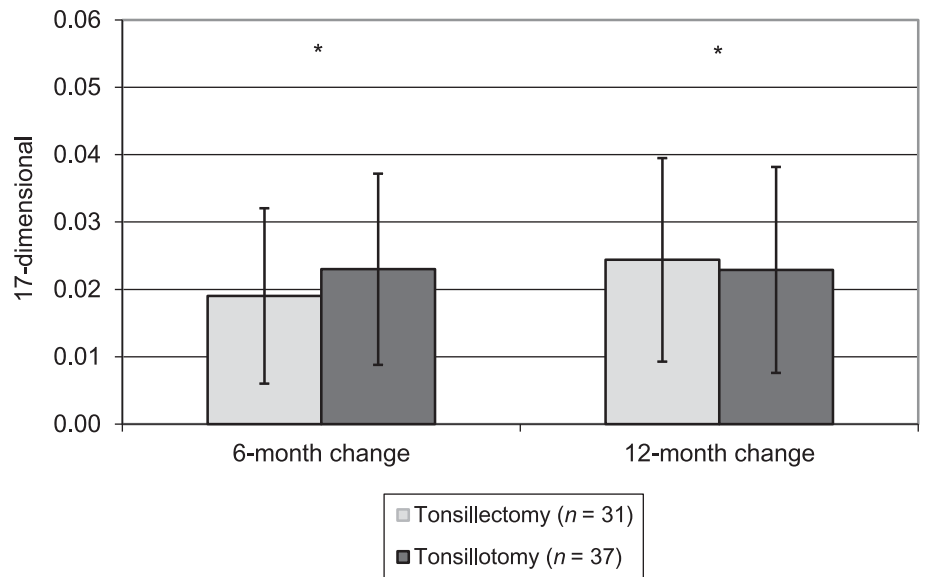
The mean costs related to the use of healthcare services (self-reported) diminished in both groups from the pre-operative 3 months to the end of the follow-up period. A statistically significant decrease in costs was achieved later in the tonsillotomy group compared with the tonsillectomy group (Figure 5). There was no significant difference between the groups regarding the number of sick-leave days.

The mean costs of specialist care of tonsillotomy and tonsillectomy are shown in Figure 6. The total costs of operations (taking account of visits 3 months preceding the surgery and 12 months post-operatively) were at the same level ( $p = 0.368$ ). The costs related to post-operative visits

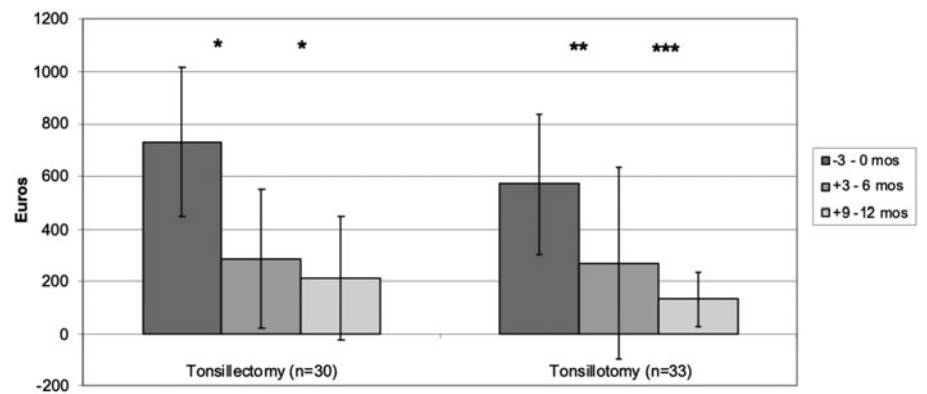
were divided into primary costs (less than 2 weeks after the surgery) and secondary costs (more than 2 weeks to 1 year after the surgery). Primary costs were mainly because of post-operative complications; in both the tonsillotomy and tonsillectomy group, one patient with post-operative haemorrhage was treated in the operating room and re-admitted to the ward for one night. The secondary costs, consisting of outpatient visits during the year following the surgery, were significantly higher after tonsillotomy compared with tonsillectomy ( $p < 0.01$ ).

### Discussion

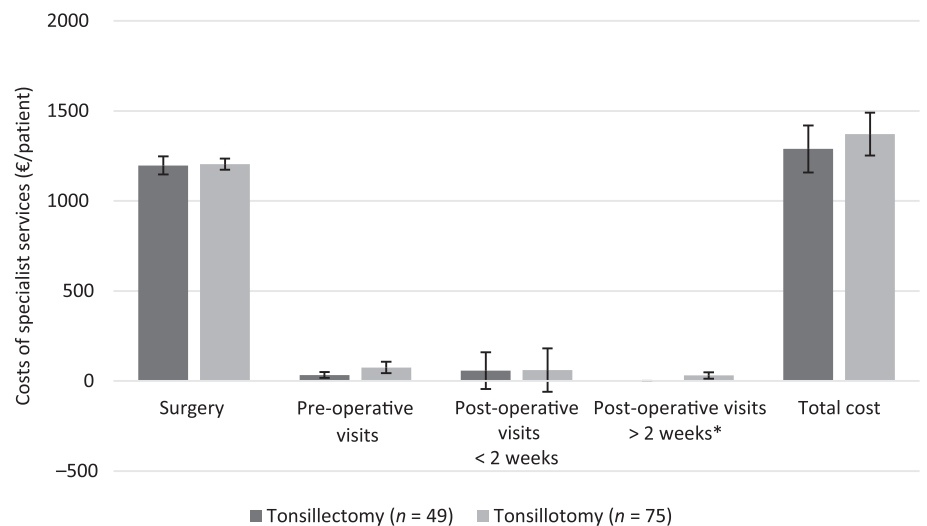
The aim of this prospective study was to compare the self-reported health-related QoL in children before and after



**Fig. 4.** Graph showing mean total 17-dimensional, standardised health-related quality of life instrument score change in children who had undergone tonsillectomy or tonsillotomy (patients that answered at all follow-up points). \*No significant difference between the groups. Error bar shows 95% confidence interval.



**Fig. 5.** Graph showing mean self-reported healthcare costs in children who had undergone tonsillectomy or tonsillotomy (patients that answered at all follow-up points). \* $p < 0.05$ , \*\* $p = 0.209$ , \*\*\* $p < 0.001$  (change compared to baseline). Error bar shows 95% confidence interval.



**Fig. 6.** Graph showing mean costs of the use of public sector otorhinolaryngology specialist services in the Helsinki University Hospital region, taking account visits 3 months preceding the tonsil surgery and 12 months post-operatively. \* $p < 0.01$ . Error bar shows 95% confidence interval.

tonsillotomy and to examine the use of healthcare services and ensuing costs and sick leave after tonsillotomy. In addition, the results were compared with those retrieved from a previous study on children with sleep-disordered breathing having undergone traditional tonsillectomy.<sup>13</sup>

Tonsillotomy improved the mean total health-related QoL score significantly in children aged 5 to 11 years. In addition, the healthcare costs and the number of sick-leave days

diminished significantly from the preceding 3 months to 12 months after surgery. Compared with children in the tonsillectomy group, those in the tonsillotomy group had similar positive effects regarding health-related QoL and healthcare costs at 12 months post-operatively.

Tonsillotomy operations were started at our department in 2009, and from 2012 onwards tonsillotomy has been more common than tonsillectomy in the treatment of airway obstruction in



children.<sup>2</sup> This change was initiated by studies establishing the safety and efficiency of tonsillotomy;<sup>24,25</sup> however, there are only a few studies comparing the effect of tonsillotomy and tonsillectomy on health-related QoL in children with sleep-disordered breathing.<sup>14,19</sup> These studies have shown that tonsillotomy and tonsillectomy have an equally positive effect on health-related QoL. In the retrospective analysis by Koltai *et al.*,<sup>26</sup> in which caregivers were asked to classify post-operative improvement in quality of life as mild, moderate or marked, the improvement was significant in the total and partial tonsillectomy groups without significant intergroup differences. As the method for tonsil surgery has changed, it is essential to evaluate the impact of the change on children's quality of life and on healthcare costs.

Tonsil-related sleep-disordered breathing has become the most common indication for tonsil surgery in recent decades.<sup>2,27</sup> The change has been influenced by increased awareness of sleep-disordered breathing. At worst, untreated sleep-disordered breathing may cause problems such as anti-social and aggressive behaviour and learning difficulties at school age. Several studies have shown great improvements in behaviour and quality of life after tonsil surgery.<sup>28,29</sup> However, it has been suggested that sleep-disordered breathing in children is still underdiagnosed and that there is a need for increased awareness of sleep-disordered breathing symptoms in children among caregivers and healthcare providers.<sup>30</sup> In the present study, children with tonsillotomy showed significant improvement on the dimensions of distress and concentration, and children with tonsillectomy showed significant improvement on the dimension of distress,<sup>13</sup> which may reflect an improvement in behavioural and learning problems. In addition to problems with sleeping, tonsillar hypertrophy can cause dysphagia, dysphonia and secondary enuresis.<sup>16,31,32</sup> In the present study, there was a clear improvement on the dimensions of speech and excretion after tonsillotomy.

The use of healthcare services was reduced in both groups, and consequently, the costs of healthcare diminished. Furthermore, sick-leave days because of oropharyngeal problems diminished equally after tonsillotomy and tonsillectomy. The mean total costs of specialist care of tonsillotomy were at the same level as the costs after tonsillectomy. The proportions of the immediate post-operative costs would have been expected to be smaller after tonsillotomy compared to tonsillectomy, as the incidence of complications after tonsillotomy has shown to be lower compared with tonsillectomy.<sup>2,6,7</sup> The proportion of costs which were related to out-patient visits during the year following the surgery were significantly higher after tonsillotomy compared with tonsillectomy which may reflect a tendency of the tonsils to regrow and cause obstructive symptoms needing new assessment. However, none of our tonsillotomy group patients needed a reoperation during the follow-up period. That is important, as a known disadvantage of tonsillotomy is that the operated tonsils may regrow and obstructive symptoms may reappear, leading to a need for reoperation. In the previous studies,<sup>9,33</sup> the time from the first surgery to a reoperation was on average 1.6–2.0 years. Because of the study design, the follow-up period in the present study was only one year after surgery, which may be insufficient to show symptoms of regrowth.

For paediatric sleep-disordered breathing, the most widely used QoL survey is the obstructive sleep apnoea-18 survey.<sup>3</sup> Other questionnaires used in previous studies have been the Child Behavior Checklist,<sup>14</sup> the 36-Item Short Form Health Survey, the EuroQoL Visual Analogue Scale and a questionnaire with questions about snoring, infection and health.<sup>17</sup> We

measured health-related QoL with the 17-dimensional, standardised health-related QoL instrument, which has been validated for Finnish children. As a generic health-related QoL instrument, it provides the possibility to compare health-related QoL in different diseases. The 15-dimensional version, which is the corresponding instrument for adults, is widely used to study health-related QoL, and its properties have been shown to be equally good or even better than those of many other generally used comparable instruments.<sup>34,35</sup>

Although analogous comparisons have not been performed in children, we have no reason to believe that the 17-dimensional, standardised health-related QoL instrument would be less suitable than other instruments to study health-related QoL in children. However, it would have been interesting to compare the health-related QoL results obtained with the 17-dimensional, standardised health-related QoL instrument to those obtained with the obstructive sleep apnoea-18 survey (or other comparable instruments).

The small number of patients may be seen as a limitation of our study. This seems to be common in studies with children, and low response rates have been observed in other child health-related QoL study groups. This is not surprising, as QoL questionnaires are relatively lengthy and traditional paper questionnaires can be seen as troublesome to complete compared with online questionnaires. In the present study, the 12-month follow-up period was long and follow-up visits during that time could have motivated the families to complete the questionnaires more adequately.

- Many children are known to suffer from sleep-disordered breathing, and it is the most common indication for tonsil surgery
- This cohort study assessed the impact of tonsillotomy on the health-related quality of life (QoL) of children with sleep-disordered breathing
- The results of this study were compared with the results of an earlier cohort of children who had undergone tonsillectomy
- Tonsillotomy improved the health-related QoL of children with sleep-disordered breathing and reduced the healthcare costs including the costs of sick-leave days
- The impact of tonsillotomy and tonsillectomy was equal in terms of the health-related QoL and healthcare costs

The results of our study confirmed that the indications for tonsillar surgery are appropriate in our practice and the patients benefit from the surgery; tonsillotomy had a positive effect on health-related QoL in children and the effect of tonsillotomy seemed to be equivalent to that of tonsillectomy.

## Conclusion

Both tonsillotomy and tonsillectomy improve health-related QoL in children with sleep-disordered breathing and reduce healthcare service needs and sick-leave days.

**Acknowledgements.** This study was funded by The Helsinki University Hospital Research Fund (no role in the study).

**Competing interests.** None declared

## References

- 1 Borgstrom A, Nerfeldt P, Friberg D, Sunnergren O, Stalfors J. Trends and changes in paediatric tonsil surgery in Sweden 1987-2013: a population-based cohort study. *BMJ Open* 2017;7:e013346
- 2 Sakki A, Makinen LK, Roine RP, Nokso-Koivisto J. Changing trends in pediatric tonsil surgery. *Int J Pediatr Otorhinolaryngol* 2018;118:84-9

- 3 Baldassari CM, Mitchell RB, Schubert C, Rudnick EF. Pediatric obstructive sleep apnea and quality of life: a meta-analysis. *Otolaryngol Head Neck Surg* 2008;**138**:265–73
- 4 Koempel JA, Solares CA, Koltai PJ. The evolution of tonsil surgery and rethinking the surgical approach to obstructive sleep-disordered breathing in children. *J Laryngol Otol* 2006;**120**:993–1000
- 5 Eriksson M, Nilsson U, Bramhagen AC, Idvall E, Ericsson E. Self-reported postoperative recovery in children after tonsillectomy compared to tonsillotomy. *Int J Pediatr Otorhinolaryngol* 2017;**96**:47–54
- 6 Walton J, Ebner Y, Stewart MG, April MM. Systematic review of randomized controlled trials comparing intracapsular tonsillectomy with total tonsillectomy in a pediatric population. *Arch Otolaryngol Head Neck Surg* 2012;**138**:243–9
- 7 Acevedo JL, Shah RK, Brietzke SE. Systematic review of complications of tonsillotomy versus tonsillectomy. *Otolaryngol Head Neck Surg* 2012;**146**:871–9
- 8 Aronen ET, Liukkonen K, Simola P, Virkkula P, Uschakoff A, Korkman M *et al.* Mood is associated with snoring in preschool-aged children. *J Dev Behav Pediatr* 2009;**30**:107–14
- 9 Leiberman A, Stiller-Timor L, Tarasiuk A, Tal A. The effect of adenotonsillectomy on children suffering from obstructive sleep apnea syndrome (OSAS): the Negev perspective. *Int J Pediatr Otorhinolaryngol* 2006;**70**:1675–82
- 10 Tarasiuk A, Greenberg-Dotan S, Simon-Tuval T, Freidman B, Goldbart AD, Tal A *et al.* Elevated morbidity and health care use in children with obstructive sleep apnea syndrome. *Am J Respir Crit Care Med* 2007;**175**:55–61
- 11 Gudnadottir G, Tennvall GR, Stalfors J, Hellgren J. Indirect costs related to caregivers' absence from work after paediatric tonsil surgery. *Eur Arch Otorhinolaryngol* 2017;**274**:2629–36
- 12 Escarra F, Vidaurreta SM. Assessment of quality of life before and after an adenotonsillectomy among children with hypertrophic tonsils and/or adenoids. *Arch Argent Pediatr* 2015;**113**:21–7
- 13 Nokso-Koivisto J, Blomgren K, Roine RP, Sintonen H, Pitkaranta A. Impact of tonsillectomy on health-related quality of life and healthcare costs in children and adolescents. *Int J Pediatr Otorhinolaryngol* 2014;**78**:1508–12
- 14 Ericsson E, Graf J, Lundeborg-Hammarstrom I, Hultcrantz E. Tonsillotomy versus tonsillectomy on young children: 2 year post surgery follow-up. *J Otolaryngol Head Neck Surg* 2014;**43**:26
- 15 Ericsson E, Ledin T, Hultcrantz E. Long-term improvement of quality of life as a result of tonsillotomy (with radiofrequency technique) and tonsillectomy in youths. *Laryngoscope* 2007;**117**:1272–9
- 16 Ericsson E, Lundeborg I, Hultcrantz E. Child behavior and quality of life before and after tonsillotomy versus tonsillectomy. *Int J Pediatr Otorhinolaryngol* 2009;**73**:1254–62
- 17 Wireklint S, Ericsson E. Health-related quality of life after tonsillotomy versus tonsillectomy in young adults: 6 years postsurgery follow-up. *Eur Arch Otorhinolaryngol* 2012;**269**:1951–8
- 18 Colen TY, Seidman C, Weedon J, Goldstein NA. Effect of intracapsular tonsillectomy on quality of life for children with obstructive sleep-disordered breathing. *Arch Otolaryngol Head Neck Surg* 2008;**134**:124–7
- 19 Vicini C, Eesa M, Hendawy E, Pari M, D'Agostino G, AlGhamdi S, Meccariello G. Powered intracapsular tonsillotomy vs. conventional extracapsular tonsillectomy for pediatric OSA: a retrospective study about efficacy, complications and quality of life. *Int J Pediatr Otorhinolaryngol* 2015;**79**:1106–10
- 20 Apajasalo M, Rautonen J, Holmberg C, Sinkkonen J, Aalberg V, Pihko H *et al.* Quality of life in pre-adolescence: a 17-dimensional health-related measure (17D). *Qual Life Res* 1996;**5**:532–8
- 21 Hujanen T, Kapiainen S, Tuominen U, Pekurinen M. *Terveystalouden yksikkökustannukset Suomessa vuonna 2006 (The unit costs of health care in Finland 2006)*. Helsinki: Stakes, 2008
- 22 The Association of Finnish Municipalities. In: <http://www.localfinland.fi> [13 March 2020]
- 23 Hultcrantz E, Ericsson E. Pediatric tonsillotomy with the radiofrequency technique: less morbidity and pain. *Laryngoscope* 2004;**114**:871–7
- 24 Hultcrantz E, Linder A, Markström A. Long-term effects of intracapsular partial tonsillectomy (tonsillotomy) compared with full tonsillectomy. *Int J Pediatr Otorhinolaryngol* 2005;**69**:463–9
- 25 de la Chaux R, Klemens C, Patscheider M, Reichel O, Dreher A. Tonsillotomy in the treatment of obstructive sleep apnea syndrome in children: polysomnographic results. *Int J Pediatr Otorhinolaryngol* 2008;**72**:1411–7
- 26 Koltai PJ, Solares CA, Koempel JA, Hirose K, Abelson TI, Krakovitz PR *et al.* Intracapsular tonsillar reduction (partial tonsillectomy): reviving a historical procedure for obstructive sleep disordered breathing in children. *Otolaryngol Head Neck Surg* 2003;**129**:532–8
- 27 Parker NP, Walner DL. Trends in the indications for pediatric tonsillectomy or adenotonsillectomy. *Int J Pediatr Otorhinolaryngol* 201;**75**:282–5
- 28 Landau YE, Bar-Yishay O, Greenberg-Dotan S, Goldbart AD, Tarasiuk A, Tal A. Impaired behavioral and neurocognitive function in preschool children with obstructive sleep apnea. *Pediatr Pulmonol* 2012;**47**:180–8
- 29 Stewart MG, Glaze DG, Friedman EM, Smith EO, Bautista M. Quality of life and sleep study findings after adenotonsillectomy in children with obstructive sleep apnea. *Arch Otolaryngol Head Neck Surg* 2005;**131**:308–14
- 30 Gudnadottir G, Ehnhage A, Bende M, Andersson M, Cervin A, Cardell LO *et al.* Healthcare provider contact for children with symptoms of sleep-disordered breathing: a population survey. *J Laryngol Otol* 2016;**130**:296–301
- 31 Ahlqvist-Rastad J, Hultcrantz E, Svanholm H. Children with tonsillar obstruction: indications for and efficacy of tonsillectomy. *Acta Paediatr Scand* 1988;**77**:831–5
- 32 Basha S, Bialowas C, Ende K, Szeremeta W. Effectiveness of adenotonsillectomy in the resolution of nocturnal enuresis secondary to obstructive sleep apnea. *Laryngoscope* 2005;**115**:1101–3
- 33 Odhagen E, Sunnergren O, Hemlin C, Hessen Soderman AC, Ericsson E, Stalfors J. Risk of reoperation after tonsillotomy versus tonsillectomy: a population-based cohort study. *Eur Arch Otorhinolaryngol* 2016;**273**:3263–8
- 34 Sintonen H. The 15D instrument of health-related quality of life: properties and applications. *Ann Med* 2001;**33**:328–36
- 35 Richardson J, Iezzi A, Khan MA, Chen G, Maxwell A. Measuring the sensitivity and construct validity of 6 utility instruments in 7 disease areas. *Med Decis Making* 2016;**36**:147–59