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REVIEW ARTICLE

Short-term weight gain after adenotonsillectomy in children with obstructive sleep apnoea: systematic review

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Abstract

Background: Children with obstructive sleep apnoea commonly undergo adenotonsillectomy as first-line surgical treatment. This paper aimed to investigate whether this intervention was associated with weight gain after surgery in the paediatric population with obstructive sleep apnoea.

Method: Two independent researchers systematically reviewed the literature from 1995 to 2014 for studies on patients who underwent adenotonsillectomy with weight-based measurements before and after surgery. The databases used were Ovid Medline, Embase and PubMed.

Results: Six papers satisfied all inclusion criteria. Four of these papers showed a significant weight increase and the others did not. The only high quality, randomised, controlled trial showed a significant increase of weight gain at seven months follow up, even in patients who were already overweight before their surgery.

Conclusion: The current evidence points towards an association between adenotonsillectomy and weight gain in patients with obstructive sleep apnoea in the short term.

Key words: Adenoidectomy; Tonsillectomy; Weight Gain; Obesity; Obstructive Sleep Apnea; Review, Systematic

Introduction

Obstructive sleep apnoea (OSA) is a common childhood condition caused by a spectrum of factors which lead to upper airway obstruction during sleep.[1] Adenotonsillar hypertrophy is a common cause and adenotonsillectomy is one of the most commonly performed surgical interventions for treatment of OSA in children.[2] Previous studies have reported growth failure to be more common in children with OSA.[3,4] In addition, recent literature has indicated an association between adenotonsillectomy and post-operative weight gain, but so far no review articles have specifically investigated this phenomenon in children with OSA.[5]

Childhood obesity has increased on a worldwide scale for the past three decades, and current figures show that 28 per cent of children aged 2–15 years in Britain are either overweight or obese.[6,7] Established health complications as a result of childhood obesity are significantly detrimental, and include cardiovascular risks and type II diabetes. It is therefore important to ascertain whether adenotonsillectomy in this cohort puts patients at risk of further obesity.

This review aimed to evaluate the current evidence for weight gain in a paediatric population following adenotonsillectomy performed for OSA.

Materials and methods

A systematic literature search was conducted by two independent researchers using PubMed, Embase and Ovid databases. Articles published between 1995 and December 2014 that included the following key search terms were screened and selected: 'growth' or 'weight', 'adenoidectomy' or 'adenotonsillectomy', and 'OSA'. In total, 784 articles were retrieved; the abstracts were reviewed after removal of duplicate articles. The full text of suitable papers was analysed and the references were screened for further articles missed in the primary search.

The inclusion criteria were: children with OSA, aged 0–14 years, who underwent adenotonsillectomy. The exclusion criteria were: studies with less than 30 patients; articles in a language other than English; animal studies; and investigations of children with craniofacial, cardiac, pulmonary or neurological disorders. The final articles selected were divided up and analysed

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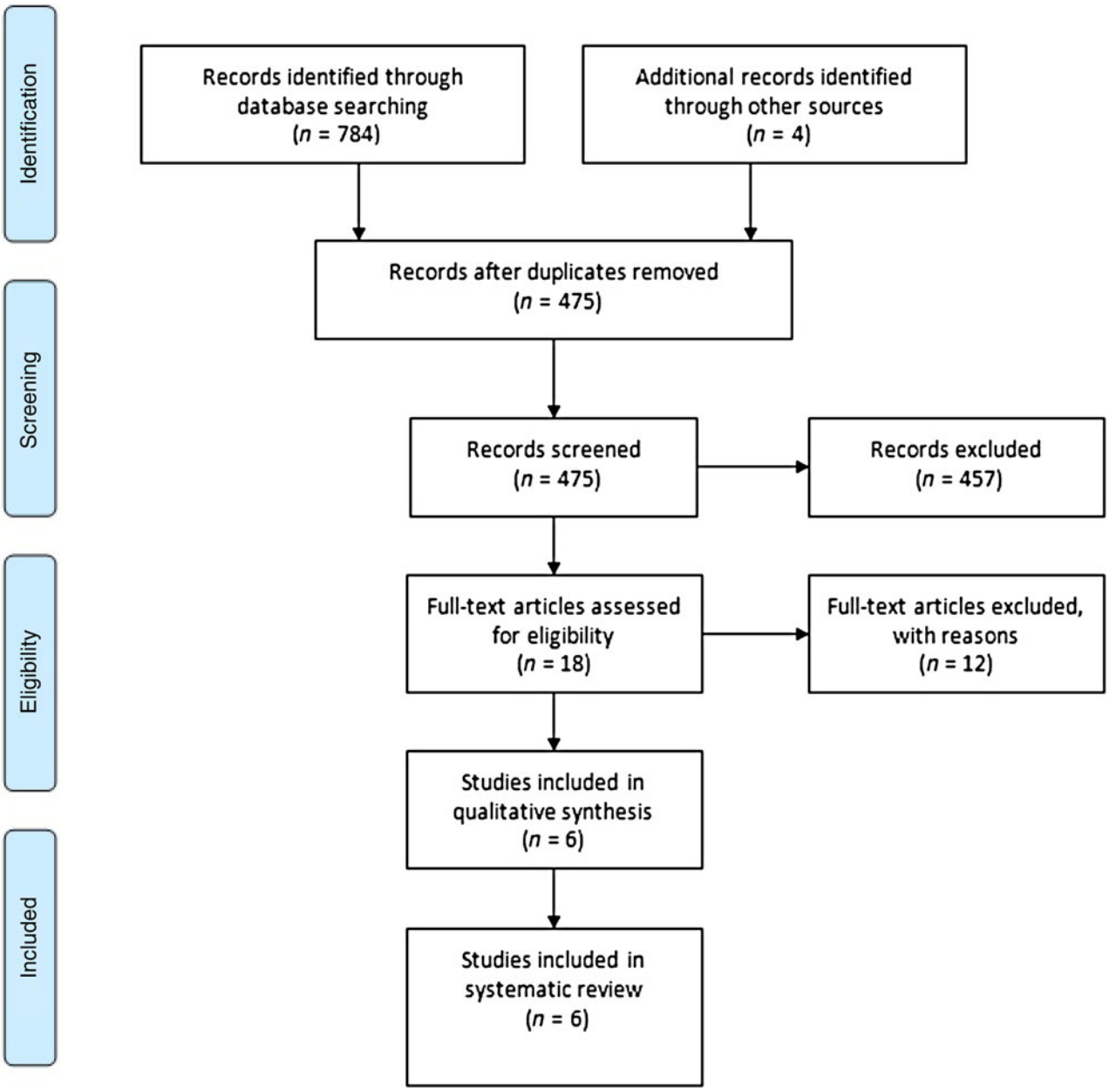

FIG. 1
Preferred Reporting Items for Systematic Reviews and Meta-Analyses ('PRISMA') flow diagram for reviewing papers.

in separate groups depending on the reported weight outcomes. No ethical approval was required for this study.

Results

An initial search yielded 475 unique articles; after the primary screening, this was narrowed down to 18 papers that fitted the inclusion criteria (Figure 1). Further screening of the full text articles led to the exclusion of 12 further articles as a result of: the inability to extract details regarding the effect of the intervention on weight ($n = 1$), fewer than 30 participants in the intervention arm ($n = 1$), the inclusion of children older than 14 years ($n = 2$), and the inclusion of patients who had either undergone tonsillectomy only or who had undergone surgery for indications other than OSA (mostly for recurrent tonsillitis) ($n = 8$).[4,8–18] The 6 remaining studies included a total of 729 children.[19–24] The demographics of the articles are summarised in Table I.

Given the variation in weight outcome measures and follow-up times recorded in the various papers, a meta-analysis was not conducted. Five papers utilised pre- and post-operative body mass index (BMI) z scores as the outcome measure, and one paper recorded standardised percentile weight.

Five papers involving 675 patients measured the pre- and post-operative change in BMI z scores. The BMI z score allows for the correction of height and gender according to age. A z score of 0 denotes the mean BMI of the population and the z values either side of this represent the standard deviation from the mean.

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TABLE I
RESEARCH ARTICLES AND STUDY DEMOGRAPHICS

Study	Year	Patients (*n*)	OSA diagnosis method	Follow-up duration	Outcome measure	Quality assessment
Roemmich *et al.*[24]	2006	54	PSG	12 months	Weight percentiles	Level 4
Huang *et al.*[21]	2014	88	PSG	3 years	BMI z score	Level 4
Jabbari Moghaddam *et al.*[22]	2013	40	Clinical	12 months	BMI z score	Level 4
Kang *et al.*[23]	2008	52	Clinical	5 years	BMI z score	Level 4
Karalok *et al.*[20]	2014	59	Clinical	12 months	BMI z score	Level 4
Katz *et al.*[19]	2014	464	PSG	7 months	BMI z score	Level 1

OSA = obstructive sleep apnoea; PSG = polysomnography; BMI = body mass index

In these five studies, the patients were followed up for seven months to five years. Four of them were prospective studies and one was a randomised, controlled trial.[19–23] The prospective studies had relatively few participants, ranging from 40 to 88 patients. The randomised, controlled trial, conducted by Katz *et al.*, comprised 464 patients, who all had OSA and were eligible for adenotonsillectomy.[19] The patients were randomly assigned to either the intervention arm, which consisted of early adenotonsillectomy (performed within four weeks), or the control arm, where the patients were managed by watchful waiting. In that study, post-operative BMI z scores were significantly greater than the pre-operative z scores, even those for children who were already overweight prior to surgery compared to the control group.

Although all five studies saw an increase in BMI z scores, the difference was only statistically significant for the studies performed by Kang *et al.*,[23] Jabbari Moghaddam *et al.*[22] and Katz *et al.*[19] (Figure 2). The populations varied between the studies. For instance, Jabbari Moghaddam *et al.* studied an underweight cohort with an average BMI z score of less than −1 pre-operatively,[22] whereas the other studies were all within 1 standard deviation pre-operatively. After surgical intervention, the mean BMI of the children had increased in four of the studies to fall into the normal range.[20–23] The study performed by Katz *et al.* saw an increase in the BMI z score that exceeded 1 after surgery, shifting the mean BMI to the overweight category post-operatively.[19]

Roemmich *et al.* recorded weight outcomes in terms of standardised weight percentiles and showed a statistically significant increase in weight on follow up at 12 months (Figure 3).[24]

Three studies confirmed OSA with the help of polysomnography[19,21,24] and the other three studies established the diagnosis on clinical grounds (Table I).[20,22,23]

Discussion

Our review paper shows evidence for weight gain in the short term following adenotonsillectomy in children with OSA, regardless of their initial weight status. Most of the studies included in the review were observational studies, with relatively few patients. However, although a meta-analysis could not be performed, the study with the highest level of evidence – the randomised, controlled trial performed by Katz *et al.* – confirms weight gain, as reflected by an increase in BMI z score (of 0.31) post-operatively at seven months follow up.[19] There was also an increase in BMI z score in the control group (0.13), but the increase was significantly greater in the intervention group. In addition, subgroup analyses

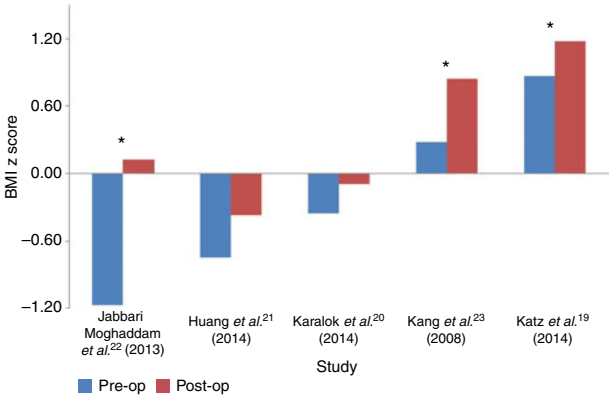

FIG. 2
Pre- and post-operative body mass index (BMI) z scores (*$p < 0.001$). Pre-op = pre-operative; post-op = post-operative

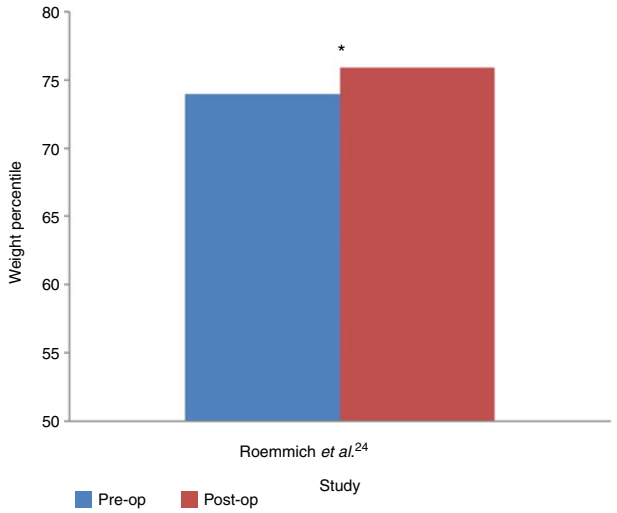

FIG. 3
Pre- and post-operative standardised weight percentiles (*$p < 0.001$). Pre-op = pre-operative; post-op = post-operative

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showed a statistically significant BMI z score increase in the intervention group children who were underweight and overweight at baseline compared to the control group. In contrast, the studies conducted by Karalok *et al.*[20] and Huang *et al.*,[21] which had longer follow-up times, of 12 months and 3 years respectively, did not show a significant weight gain; therefore, we do not know if this effect is sustained in the long term.

Czechowicz *et al*. conducted a retrospective study of 815 patients who underwent adenotonsillectomy for OSA.[11] They found a significant increase in weight percentile at 18 months' follow up compared to baseline (6.3 weight percentiles, $p < 0.001$). However, they did not detect an increase in obesity rate among their cohort. Instead, they found that mainly underweight and younger children gained weight, which accounted for the overall increase in weight percentiles. The study by Czechowicz *et al*. was retrospective, with no randomisation. In addition, the follow-up times varied, from 12 to 27 months, making direct comparison less reliable as the time factor was not consistent. This paper was excluded from the review as they included patients over the age of 14 years.

Further randomised, controlled trials with longer follow-up times are needed to ascertain whether the weight gain is only a transient phenomenon. Another limitation was the lack of standardised outcome measures. Many of the studies used their own national growth charts to calculate the BMI z scores, which could affect direct comparisons of results depending on when they were updated for their respective populations. None of the studies reported using the most recent World Health Organization growth charts from 2007, which represent projected healthy growth potential in children.[25] Body mass index z score measurement enables reliable comparisons across studies; however, this measurement is subject to a ceiling effect. This means that children with higher BMIs who gain weight will show a smaller increase in BMI z score because of the smaller population distribution at the extremes of the bell curve.

There are several proposed explanations as to why adenotonsillectomy results in post-operative weight gain. The intermittent upper airway obstruction during sleep has been thought to increase the work of breathing in children with OSA, and therefore increase energy expenditure at night. However, a study by Bland *et al*. did not find a significant difference in the pre- and post-operative energy expenditure of children with OSA who were treated with adenotonsillectomy.[26] Enlarged adenoids and/or tonsils could lead to more frequent infections, swallowing problems and pain, which could reduce appetite and in turn reduce overall calorific intake.[27,28] Several studies have also shown a hormonal dysregulation in children with OSA, particularly those investigating insulin-like growth factor 1 (which reduces growth potential), and an increase in growth hormone secretion after adenotonsillectomy.[14,15,22,23] This can be explained by the fact that OSA causes sleep fragmentation and reduces the amount of slow-wave sleep, which is the phase when the growth hormone is primarily released.[29,30]

The reasons for post-operative weight gain seem to be multifactorial. Nevertheless, regardless of the aetiology, current evidence shows that there is a significant quantifiable increase in weight gain for children who undergo adenotonsillectomy to treat OSA. When considering children who are underweight at the outset, this may be a positive result, allowing them to regain their normal weight potential. However, in the case of normal weight, overweight or obese children, we might consider weight monitoring and referral to appropriate pathways for nutritional counselling and obesity management. We might want to factor this into our pre- and post-operative consultations in order to manage these patients holistically.

Conclusion

The current body of evidence points towards a significant weight gain in the short term following adenotonsillectomy in children with OSA. Although this effect might be beneficial in children who are underweight at baseline, there may be a need to raise awareness of the likely effect of surgery in the pre-operative consultation, and to consider weight monitoring and nutritional counselling post-operatively for children who are at risk of further obesity.

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