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Impact of allergic rhinitis on the day-to-day lives of children: insights from an Australian cross-sectional study

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ABSTRACT

Study design and objective Cross-sectional, observational survey to describe the impact of allergic rhinitis (AR) on Australian children (2 to 15 years).

Methods Participants (n=1541), parents of children aged 2 to 15 years, provided information on behalf of themselves and one eligible child in their household using a custom-built online questionnaire. Children were allocated to case (AR) or control (No AR) analysis groups based on a validated screening questionnaire.

Statistical methods The study sample was stratified on age: primary analysis population (6 to 15 years, n=1111; AR=797, No AR=314); exploratory population (2 to 5 years). The primary endpoint, parent-perceived burden, was quantified using a validated measure of health status and analysed via comparison of means.

Results The majority of AR cases were treated (730/797; 90.3%) and classified as having moderate-severe, intermittent AR (549/797; 68.9%). Half reported adequate symptom control in the prior 2 weeks (389/797; 48.8%; OR=4.04; 95% CI (CI) 2.24 to 7.31). Having AR was associated with worse overall health status (7.4 vs 8.4, mean difference (least squares mean difference (LSMD))=−0.99; 95% CI −1.18 to −0.79), fewer days being happy (22.2 vs 25.9, LSMD=−3.68; 95% CI −4.82 to −2.54) and more days of poor physical (2.82 vs 0.78, LSMD=2.04; 95% CI 1.61 to 2.47) and emotional (2.14 vs 0.67, LSMD=1.47; 95% CI 1.02 to −1.92) health compared with not having AR. All of these outcomes were significantly ($p<0.05$) worse in children who reported inadequate symptom control. Having AR negatively impacted on schoolwork, sleep and other activities, and increased the likelihood of having comorbidities.

Conclusion The parent-perceived burden of AR in Australian children is high and it impacts many areas of day-to-day living. Inadequate symptom control is a key driver of the extent of this impact. Opportunities to optimise the management of AR in children include the adoption of self-assessment tools to gauge and monitor adequacy of symptom control.

Strengths and limitations of this study

- This study used objective measures to quantify the negative impact of paediatric allergic rhinitis on health status, emotional well-being, physical health, school and sleep.
- All data were parent-reported and were collected using a customised online survey questionnaire, which included relevant validated tools.
- The International Study of Asthma and Allergies in Childhood questionnaire provided the basis for screening participants and was used to allocate children to case or control groups for analysis.
- The data revealed some interesting findings, notably the significant role of adequacy of symptom control, and raised questions about the level of parental knowledge regarding the medication their child is taking.
- The validity of the data was limited due to methodological constrains, including online sampling, inability to verify sample representativeness and collection of parent-reported data rather than those of the child directly.

INTRODUCTION

Allergic rhinitis (AR), an IgE-mediated, chronic inflammatory disorder affecting the nasal mucosa, is characterised by episodes of repeated sneezing, rhinorrhoea and nasal congestion, often accompanied by itching of the eyes, nose and palate.[1] Pharmacological treatment aims to achieve symptom control, but current Allergic Rhinitis and its Impact on Asthma (ARIA) guidelines suggest the need to take account of multiple factors beyond efficacy, speed of onset and safety when selecting pharmacotherapy for patients to encompass patient preferences, symptom severity, prior treatments, self-management strategies and the effects of AR on sleep and work productivity.[2] This reflects an increasing recognition that the interlinked concepts of disease severity and control are complex in AR. Rather than equating severity directly with physiological function, patients with AR tend to equate severity with the negative impact that the allergies have on their lives.[3] Understanding what drives this negative impact of AR is important; and is further heightened where treatments for this condition are available in the pharmacy setting where patients often self-select.

Health-related quality of life (HR-QoL) is a complex and multidimensional concept used as a marker of disease impact beyond clinical impact, morbidity or mortality. It is often used to capture subjective perceptions and objective assessment of a patient's health and well-being.[4] HR-QoL in children with AR is an important and emerging area of interest, primarily due to the fact that the impact of AR on the day-to-day lives of individuals can be felt beyond the severity of symptoms experienced. In their review of 27 studies of children with AR, aged 10 to 19 years, Blaiss *et al*[5] highlighted the negative impact of AR on several aspects of day-to-day living including: daily functioning, sleep, absenteeism, school productivity and academic performance. Adolescents with AR have high rates of somatisation, anxiety and depression, less resistance to stressful situations, and exhibit more hostility, impulsivity and rapid changes in interest. Parental assessment of the impact of AR on the day-to-day lives of children with AR indicates that AR makes their child unhappy, upset, angry and embarrassed.[6] In practical terms, HR-QoL can be used to describe the way in which health status affects quality of life.[7] Some of the most important research exploring the impact of AR on the day-to-day lives of children in the USA have used the concept of 'health status' as a means of determining the burden of AR.[8] It is in recognition of this research, and the high prevalence of AR, that we focus on AR in children.

Previous Australian data reported a prevalence of AR of approximately 12.9% in children aged 6 to 7 years and 19.3% in children aged 13 to 14 years.[9] More recent data suggest a higher, and rising,[10] prevalence: 15.1% to 37.8% in adolescents aged 12 to 15 years in Europe[11] and 24.8% among children aged 14 to 17 years in the USA.[12] Data from an Australian longitudinal birth cohort study (Perth Infant Asthma Follow-up (PIAF) study) demonstrated a rapid increase in the development of AR over childhood (7% at age 6 years, 18% at age 11 years and increasing to 24% by age 18 years).[13] However, despite this high prevalence, published Australian data on the impact and management of AR in children are minimal and outdated.[14]

To address this gap, we conducted a national, online survey to generate contemporary data describing the burden of AR on the day-to-day lives of Australian children (2 to 15 years), with the aim of identifying gaps and opportunities for optimising care in the future. Inherent difficulties in properly identifying AR in young children (2 to 5 years) were addressed by the study sample being stratified on age with the primary analysis population encompassing children 6 to 15 years and an exploratory population encompassing the younger children (2 to 5 years). We report here the primary study results.

METHODS

The survey was conducted between 15 October 2018 and 12 November 2018. The study sample was derived from three ISO-accredited research-only panels of respondents for online consumer research in Australia (Ipsos i-Say 180 000 members, Research Now/Survey Sampling International 400 000 members and Pure Profile 250 000 members). Panel members completed a series of screening questions, including inclusion and exclusion criteria, and eligible respondents provided informed consent prior to accessing the survey. Eligible participants were aged 21 years or over, currently residing in Australia and the parent/guardian of at least one child aged 2 to 15 years. Participants provided information on behalf of themselves and one eligible child in their household. Participants with multiple eligible children were randomly allocated a specific child on which to answer questions.

Data collection and cohort description

All data were parent-reported, and collected using a customised online survey questionnaire, which was self-administered once. The questionnaire (online supplemental file 1) comprised a series of closed-answer questions, incorporating relevant validated tools and other questions developed empirically through review of the AR literature and other health surveys.

The questionnaire explored 11 domains: (1) screening (International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire),[15] (2) family medical history, (3) parent-perceived burden (as assessed by the validated single health status question;[16] and the validated Healthy Days questionnaire[17] and impact of AR on day-to-day living (adapted from Pediatric Allergies in America Survey)),[18] (4) beliefs about medicines (Beliefs about Medicines questionnaire),[19] (5) knowledge and beliefs about allergies (knowledge, attitude and practice questions in AR and asthma),[20–22] (6) AR classification (ARIA criteria),[1 23] (7) AR diagnosis, (8) AR triggers and testing, (9) AR symptoms (Contre les MAladies Chroniques pour un VIeillissement Actif (MACVIA)-ARIA validated visual analogue scales (VAS)[3 24 25]), (10) symptom control (Control of Allergic Rhinitis and Asthma Test for Children)[26] and (11) AR management strategies. The length of the questionnaire was a key consideration; to minimise bias resulting from questionnaire fatigue, data collected about the survey respondents (parents/guardians) were minimal, with the majority of data relating to the specified child on whose behalf the questionnaire was being completed.

The ISAAC questionnaire[15] provided the basis for screening participants and was used to allocate respondents' children to case or control groups for analysis. Cases (AR) were defined as children with symptoms of AR that were not associated with a cold/influenza, and controls (No AR) were defined as children without symptoms of AR. Within the AR group, a subgroup was defined based on information provided that the child was currently using an allergy medication, where 'treated AR' had selected one or more types of medicines from a list, while those allocated to 'untreated AR' had selected either 'none' or 'don't know'.

Burden of AR was determined based on four questions: a single validated question, 'In general, how would you describe your child's health?' to provide a measure of health status, and three questions to assess the number of healthy days per month, as reflected in the number of the number of days in the last month the child could be described as being (a) healthy (happy and full of energy), (b) had poor physical health or (c) had poor emotional health. These four questions were derived from the validated Centers for Disease Control and Prevention (CDC) Healthy Days Core Module[17] and the Pediatric Allergies in America Survey.[18] The original, validated, health status question was answered using a 5-point Likert scale (excellent, very good, good, fair or poor).[17] To provide a quantitative value for statistical analyses, it was administered using a 10 cm VAS (0= poor; 10= excellent). To determine the impact of AR on day-to-day living, questions used in the Pediatric Allergies in America Survey[18] were modified in order to capture data relating to performance at school and in other activities, sleep duration, sleep quality, absenteeism and presenteeism. Taking into consideration the lower target age of the children in the survey was 2 years, for pragmatic reasons the questionnaire was answered by an adult on behalf of the child, hence all findings are reported as being parent-perceived.

Patient and public involvement

The research question and outcomes measures were informed by the results of prior published research in paediatric AR patients. However, at the time of protocol development, a review had identified a number of important data gaps, noting few recent data on the impact of AR in adolescents and questioned the relevance of available evaluations of HR-QoL in the current social landscape.[5] Patients were not involved in the design of the survey questionnaire, the conduct of the study or reporting of the results.

Sample size

The primary endpoint was parent-perceived burden (health status) in children aged 6 to 15 years in case (AR) versus control groups (no AR). It was determined that the study would require a sample of at least 1000 children for univariate logistic regression and 1100 children for multivariable logistic regression, assuming the sample was children aged 6 to 15 years, with an expected symptom prevalence of 4% (4.45%,[27] an OR of 1.5 (1.5 among children aged 6 to 17 years[5]), an alpha of 5% (95% CI), a power of 80% and a 30% multiple correlation with other covariates. To allow for the exploratory analysis in young children, the sample was extended proportionately to the age range 2 to 5 to maintain the same power. Sample selection quotas were stratified based on the child's age, gender, geographical location and meeting case/control criteria. Children meeting case criteria were also stratified based on AR classification, management and management type.

Statistical analysis

Variables included prevalence, family history, parent-perceived burden[16 17] and impact,[18] symptoms, diagnosis, triggers and management. Baseline demographic variables (child's age and gender) were used as criteria to test for differences. All information was summarised using descriptive statistics for continuous data and frequency tables for categorical data. Summaries were provided based on relevant analysis samples: controls (No AR), all cases (AR), AR cases treated and AR cases not treated. Observations with missing values were excluded and answers of 'Don't Know' were replaced with missing values.

Data were analysed using the χ^2 test for two-way tables and by binary logistic or multinomial models for variables with more than two levels. All statistical analyses were performed at the 5% significance level using two-sided tests or two-sided CIs. For two-way tables, OR with 95% CI and p values were created to quantify any associations. Additional analyses were conducted to understand the relationships, multi-level associations and interactions and control for potentially confounding factors. The analysis was built progressively through phases, by first understanding the univariate relationships (for continuous variables) or associations (for categorical variables), and then incorporating analysis and modelling which brought in more than one variable to account for interactions or potentially confounding factors. The variables incorporated in the secondary modelling included variables identified in the initial analysis with a cut-off of $p<0.05$.

The level of parent-perceived burden was determined via comparison of means, 95% CI for the means and their differences and t or z tests for the following groups: cases (AR) versus controls (No AR), cases (AR) treated versus not treated, and cases (AR) with good versus poor symptom control. Where there were more than two groups, analysis of variance was applied to test for a significant difference between groups. Depending on the group, analyses conducted were: distribution and comparison of means (least squares means (LSM)), generalised linear models (GLM), contingency tables and OR, and GLM model with interactions. This analysis was applied to each of the four questions used to determine burden: health status, the number of healthy days in the last 30 days and the number of unhealthy days in the last 30 days (a combined mean of physically unhealthy days and emotionally unhealthy days).[17] Covariates identified based on the outcome of the baseline variables analyses were then included as independent variables along with group allocation (AR or No AR) and treatment type in multiple linear regression of the above mean parent-perceived burden measures. Summaries and statistical analyses were generated using Q-research software (V.5.3.2, Displayr, Chicago, Illinois) and SAS (V.9.4, SAS Institute, Cary, North Carolina).

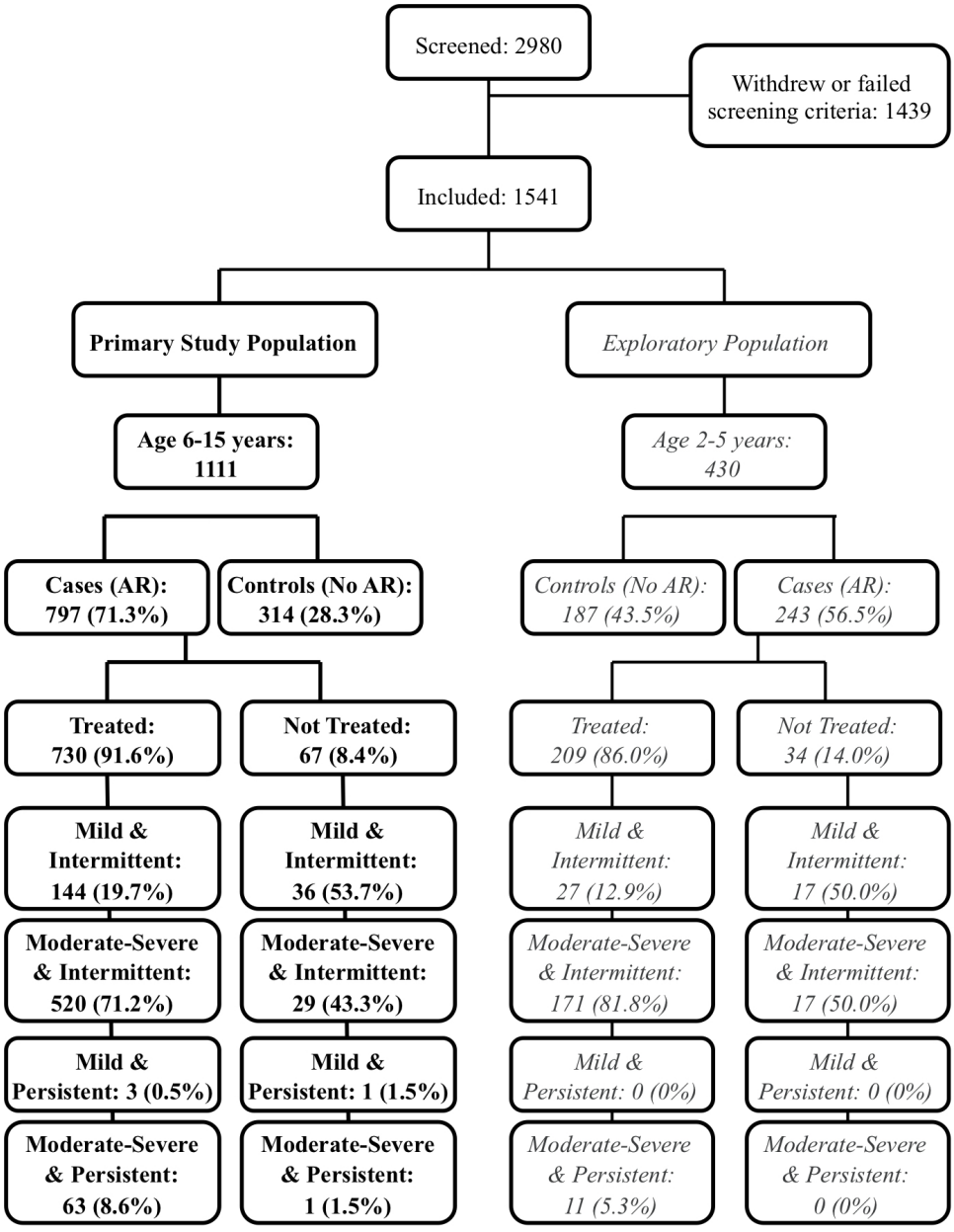

Figure 1 STROBE flowchart of participants, group allocation: AR/No AR based on the International Study of Asthma and Allergies in Childhood questionnaire;[15] mild/moderate-severe and intermittent/persistent based on the Allergic Rhinitis and its Impact on Asthma Criteria;[1 23] and treated/not-treated based on parental report of current allergy medicine use. AR, allergic rhinitis.

RESULTS

Of the 2980 potential participants screened, 1541 met the inclusion criteria and completed the survey. Approximately two-thirds of respondent were female and their mean age was 42 years (online supplemental table 1). The primary analysis sample comprised 1111 children, aged 6 to 15 years (figure 1); the majority of AR cases were being treated (730/797; 90.3%) and were classified as having moderate-severe, intermittent AR based on the ARIA criteria (549/797; 68.9%).

Demographics

There was no statistically significant difference between the mean ages of AR case and control children. Children treated for AR, were older than those not treated (11.5 vs 10.1 years, 95% CI −2.12 to −0.53). Parental AR was associated with significantly increased odds of AR in their offspring (OR 5.21, 95% CI 3.78 to 7.18) and there were statistically significant relationships between having AR and sinusitis, asthma, cough, recurrent wheezing, hives, nasal polyps or food allergy. Children with AR were significantly more likely to have undergone ear, nose and throat procedures than those without AR (table 1). In the past 12 months, doctor visits were reported significantly more frequently in children with AR than those without (3.2 vs 1.4 visits, p<0.001). After hay fever, the three most common reasons for seeking a doctor's advice in children

Table 1 Medical history and doctor visits. Data presented as N (%)

Medical procedures	Cases (AR) n=797	Controls (No AR) n=314	Cases (AR) treated n=730	Cases (AR) not treated n=67
Tonsils removed	127 (15.9%)*	19 (6.1%)	118 (16.2%)	9 (13.4%)
Adenoids removed	104 (13.0%)*	19 (6.1%)	98 (13.4%)*	6 (9.0%)
Tubes put in his/her ears	69 (8.7%)*	12 (3.8%)	67 (9.2%)*	2 (3.0%)
Nasal or sinus surgery	63 (7.9%)*	3 (1.0%)	59 (8.1%)	4 (6.0%)
Required braces for their teeth	195 (24.5%)*	50 (15.9%)	182 (24.9%)*	13 (19.4%)
None of the above	446 (56.0%)	240 (76.4%)*	400 (54.8%)	46 (68.7%)*
Reasons for visits to the doctor	**Cases (AR) n=729†**	**Controls (No AR) n=190†**	**Cases (AR) treated n=672†**	**Cases (AR) not treated n=57†**
Asthma	38 (18.9%)*	18 (9.5%)	127 (18.9%)	11 (19.3%)
Sinusitis	84 (11.5%)*	3 (1.6%)	81 (12.1%)	3 (5.3%)
Hay fever/AR (nasal and/or eye allergy symptoms)	324 (44.4%)*	1 (0.5%)	311 (46.3%)*	13 (22.8%)
Sleep disturbances	45 (6.2%)*	2 (1.1%)	42 (6.3%)	3 (5.3%)
Adenoids/tonsils hypertrophy	50 (6.9%)*	2 (1.1%)	48 (7.1%)	2 (3.5%)
Eczema (atopic dermatitis)	72 (9.9%)*	6 (3.2%)	67 (10.0%)	5 (8.8%)
Vaccinations	121 (16.6%)*	17 (8.9%)	116 (17.3%)*	5 (8.8%)
Cough	322 (44.2%)*	62 (32.6%)	295 (43.9%)	27 (47.4%)
Nasal polyps	26 (3.6%)*	1 (0.5%)	26 (3.9%)*	0 (0.0%)
Hives (urticaria)	21 (2.9%)*	1 (0.5%)	20 (3.0%)	1 (1.8%)
Respiratory tract infection	139 (19.1%)*	18 (9.5%)	134 (19.9%)*	5 (8.8%)
Urinary tract infection	24 (3.3%)	4 (2.1%)	20 (3.0%)	4 (7.0%)
Acne	39 (5.3%)	5 (2.6%)	37 (5.5%)	2 (3.5%)
Other	183 (25.1%)	114 (60.0%)*	161 (24.0%)	22 (38.6%)*

*Statistically significant difference between groups (cases versus controls; cases treated versus not treated) at 95% CI. The list of reasons was prespecified in the survey questionnaire.
†Sample size smaller than the total population due to missing data.
AR, allergic rhinitis.

with AR were cough, respiratory tract infections and asthma, all of which were significantly higher than in children without AR (table 1).

AR symptoms and adequacy of control

The average age at symptom onset was 6.7 years (treated AR) and 6.2 years (untreated AR). Parents of children with AR reported that runny nose, nasal congestion, itchy eyes and repeated sneezing were the four most bothersome symptoms (online supplemental table 2). When the level of bother from each symptom was reported using a 10 cm VAS, facial pain, difficulty getting to sleep, disturbed sleep, distractibility and irritability were the most frequently reported moderate-severely bothersome symptoms (figure 2).

Overall, half of the children with AR were reported to have adequate symptom control (VAS score of ≤5 on a 10 cm scale) over the past 2 weeks (389/797; 48.8%). The majority of children currently treating their AR were using tablets/liquids (453/730, 62%), half were using nasal sprays (365/730, 50%) and one in three were using eye drops (211/730, 29%). The majority of children who were treating their AR had been advised to do so by a healthcare professional (general practitioner: 372/730 (51%), pharmacist: 175/730 (24%) and specialist: 80/730 (11%)). However 10% (73/730) of children were being managed based on the decisions of their parents.

Irrespective of the medication class, the majority of children began using their medication either at the onset of symptoms or the onset of the allergy season (online supplemental table 3). Over one-third of children (263/730, 36%) who had been identified as treating their AR had taken medication on the day of the survey. The mean bother score was higher in these children (6.14±2.04) than in those who had not taken their medication that day (3.20±2.68).

Burden and impact of AR

Based on the single validated question, 'In general how would you describe your child's health?' to determine health status, children with AR had significantly higher parent-perceived burden than did those without AR (figure 3). Subgroup analyses showed that these differences remained statistically significant for comparisons of

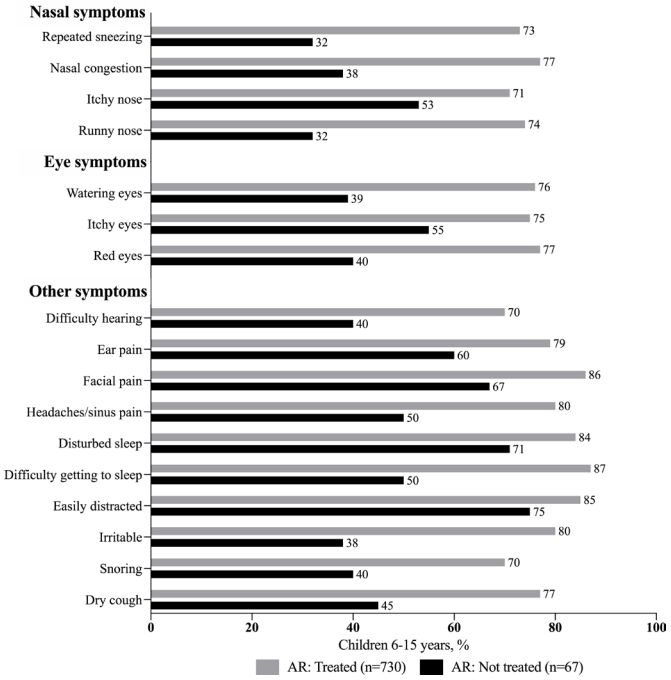

Figure 2 Proportion of children with AR in whom symptoms were moderate-severely bothersome*. *Defined as a score between 6 and 10 on a 10 cm visual analogue scale (0 cm= not at all bothersome and 10 cm= extremely bothersome (as bad as they can get)).[34] AR, allergic rhinitis.

children with inadequate symptom control versus good symptom control and of children with moderate-severe versus mild AR, but not for treated versus untreated cases (figure 3). Having AR, poor symptom control and moderate-to-severe disease were also associated with fewer

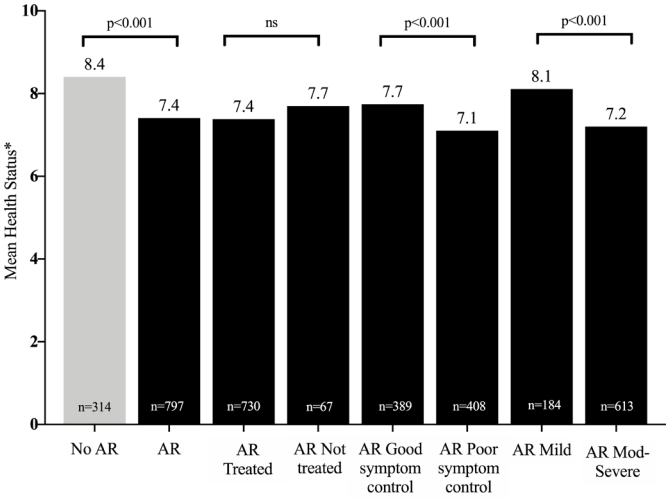

Figure 3 Parent-perceived burden: health status in children aged 6 to 15 years.*Health status was based on the single question, 'In general, how would you describe your child's health?',[16 18] adapted to be answered on a 10 cm VAS (0= poor health and 10= good health). Mean score was derived from the cut-off criteria: VAS<2= very poor; 2≤VAS<4= poor, 4≤VAS<6= good, 6≤VAS<8= very good and 8≤VAS≤10= excellent). AR, allergic rhinitis; ns, not significant; VAS, visual analogue scale.

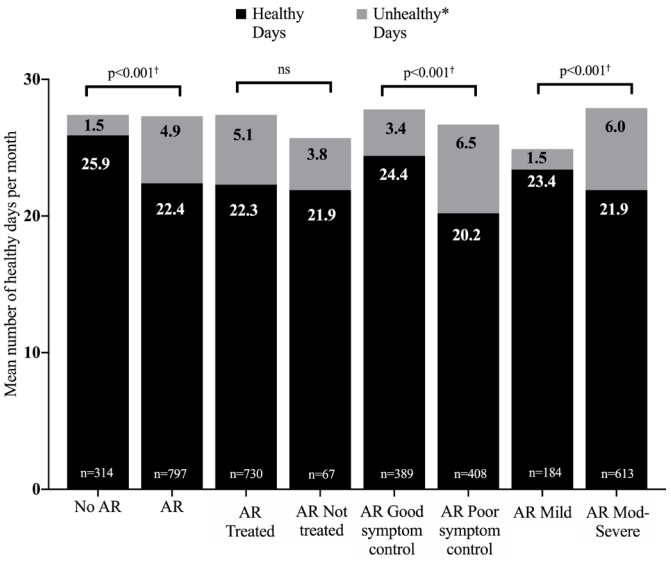

Figure 4 Parent-perceived burden: healthy and unhealthy days per month in children aged 6 to 15 years. The number of days in the last month the child was either healthy (happy and full of energy), had poor physical health or had poor emotional health were measured based on questions derived from the Centers for Disease Control and Prevention's Healthy Days Core Module[17] and the Pediatric Allergies in America Survey.[18] *Unhealthy days= number of days of poor emotional health and number of days of poor physical health combined. †Statistically significant difference between groups for each metric (healthy days and unhealthy days). AR, allergic rhinitis.

healthy days and more unhealthy days (poor emotional and physical health) per month (figure 4). There was a significant association between AR classification, treatment and adequacy of symptom control (figure 5). Based on health status, parent-perceived burden was least in untreated children who had mild AR and good symptom control (LSM health score: 8.24; 95% CI 7.68 to 8.80) and greatest in untreated children who had moderate-severe AR and inadequate symptom control (LSM health score: 6.58; 95% CI 5.72 to 7.44).

The burden of AR was greatest in children with co-morbidities (figure 6A). Parent-perceived burden was lowest in children with AR who also had other conditions (LSM 7.27; 95% CI 7.07 to 7.47), but was not significantly lower than in children with AR and no other conditions (LSM 7.47; 95% CI 7.32 to 7.62). Parent-perceived burden was significantly lower in children with AR, either with or without comorbidities, than in those without AR with (LSM 8.03; 95% CI 7.78 to 8.53) or without (LSM 8.58; 95% CI 8.38 to 8.78) comorbidities. This trend was also seen in the number of healthy days (figure 6B), days of poor physical health and days of poor emotional health per month (figure 6C).

Having AR versus not having it was associated with significantly reduced ability to perform schoolwork and other activities. Children accomplished less than they would usually have done at school or in other activities, and a reduced level of care was taken when performing

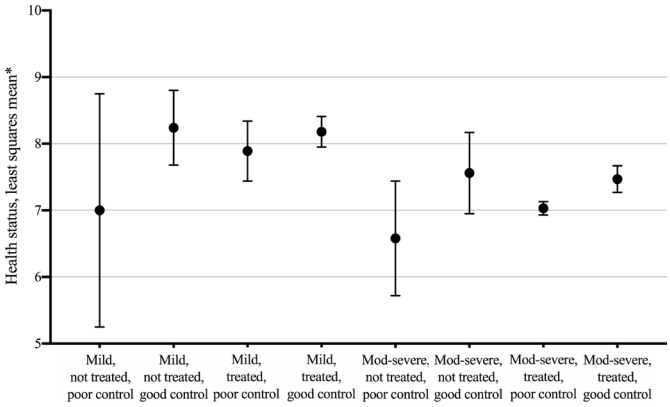

Figure 5 Parent-perceived burden: interaction between AR classification, receipt of treatment and adequacy of symptom control in children with AR aged 6 to 15 years. *Health status was based on the single question, 'In general, how would you describe your child's health?',[16 18] adapted to be answered on a 10 cm VAS (0= poor health and 10= good health). Mean score was derived from the cut-off criteria: VAS<2= very poor; 2≤VAS<4= poor, 4≤VAS<6= good, 6≤VAS<8= very good, 8≤VAS≤10= excellent. Statistically significant differences in health status between seven comparisons: treated and mild AR and good control versus treated and moderate-severe AR and good control (p=0.0008), treated and mild AR and good control versus treated and moderate-severe AR and poor control (p<0.0001), treated and mild AR and good control versus not-treated and moderate-severe AR and poor control (p=0.0081), treated and mild AR and poor control versus treated and moderate-severe AR and poor control (p=0.0126), not-treated and mild AR and good control versus treated and moderate-severe AR and poor control (p=0.001), not-treated and mild AR and good control versus not-treated and moderate-severe AR and poor control (p=0.0181), treated and moderate-severe AR and good control versus treated and moderate-severe AR and poor control (p=0.0095). AR, allergic rhinitis; Mod, moderate; VAS, visual analogue scale.

schoolwork and other activities (table 2). Between-group comparisons showed that, among all children with AR, these activities were affected in significantly more children who had poor symptom control (versus good symptom control), in those with moderate-to-severe symptoms (versus mild symptoms) and those who were currently treating their AR (versus not currently treating) (table 2). Having AR was also associated with a reduced duration of sleep (8 hours or less per night: AR 494/797 (62%) vs No AR 126/314 (40%), p<0.05), poorer sleep quality and higher rates of absenteeism (table 2).

Parents' knowledge and beliefs about AR

As part of the survey, parents were asked if their child ever had hay fever. These data were then compared with children classified as having AR (AR cases) based on the answers that the parents gave to the ISAAC questions[15] later in the survey. AR was not always recognised by the parents: overall, a history of AR was not reported in 118/797 (15%) of the children who were classified as having AR based on the ISAAC questions. Most parents (669/797; 84%) believed that AR could significantly impair well-being, but their understanding of causes was poor; 375/797 (47%) believed it could only be caused by a reaction to something in the air outdoors, 128/797 (16%) believed that it was caused by a virus and 112/7979 (14%) believed that it was contagious. Parents who had sought advice from a healthcare professional had primarily received written or verbal information about available treatment options (274/797; 34%), administration approaches (dosing regimen (169/797, 21%), how to use (191/797, 24%) and side effects (191/797, 24%)). Few received information about the condition itself (117/797, 15%), and two-third (509/797, 64%) of parents indicated that they would benefit from having more information about AR.

DISCUSSION

This study has confirmed that having AR significantly impacts a child's life as reported by parents. Among Australian children, aged 6 to 15 years, having AR was associated with greater parent-perceived burden, lower health status, fewer days of being healthy and more days of being unhealthy (poor physical or emotional health). It significantly reduced the child's ability to perform schoolwork and other activities, was associated with children accomplishing less than they would usually have done at school or in other activities, and reduced the level of care taken when performing schoolwork and other activities. Absenteeism and the likelihood of having comorbidities were increased, while sleep duration and quality were reduced.

Parent-perceived burden was highest in children who were not treated, who also had moderate-severe AR and reported inadequate symptom control. Statistical modelling, undertaken to help better define what was contributing to this parent-reported burden, found the most important overall factor leading to a lower health status was inadequate symptom control. Despite the majority of children being treated, half had inadequate symptom control (VAS score of >5 on a 10 cm scale). Parents reported that a large proportion of children used their medication only after their symptoms had started or when symptoms were very bothersome. While this may reflect that the majority of treated children were classified as having intermittent AR (mild: 19.7%, moderate-severe: 71.2%), and reflects on-demand treatment approaches observed in adults with AR,[28] it does not account for optimal pharmacology. For example, oral antihistamines have a rapid onset of action (1 to 2 hours), while for intranasal corticosteroids (INCS) the onset of action is 7 to 12 hours and it can take up to 2 weeks for maximum benefit to be achieved.[29] Established guidelines support that use of INCS on an as-needed basis is less effective than continuous use.[30]

In an attempt to determine the relationship between treatment and impact of AR, participants were asked to report on whether their child had used their allergy medication that day, while also reporting on how bothersome

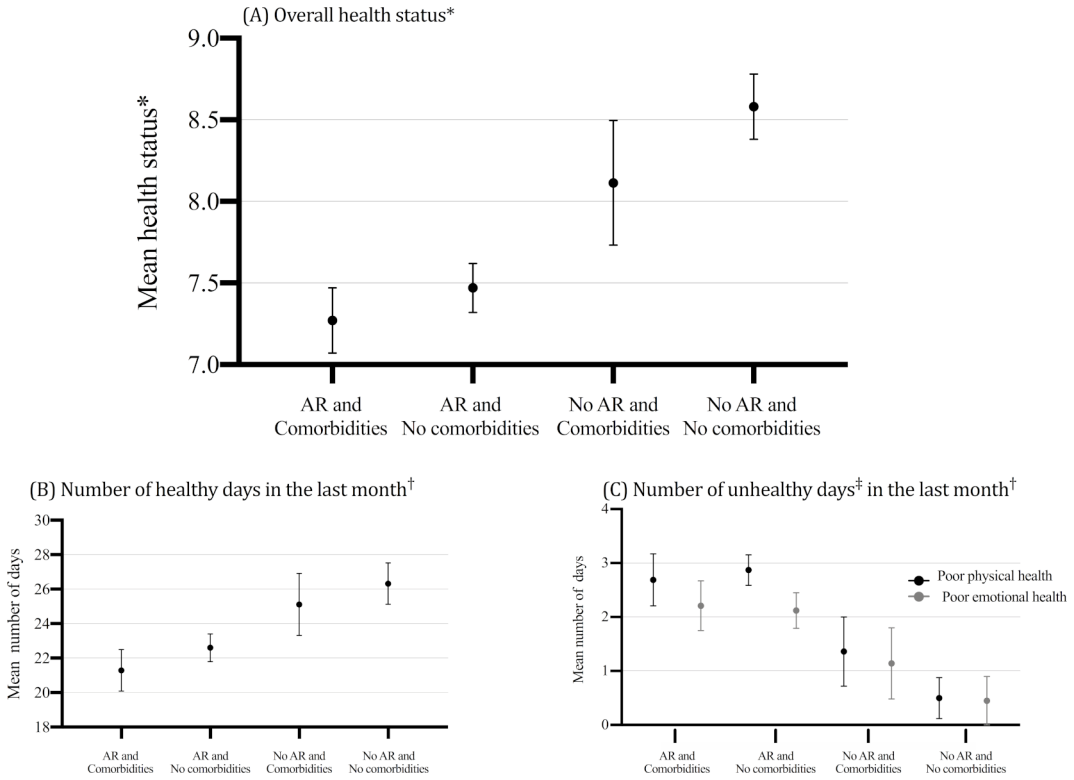

Figure 6 Parent-perceived burden: interaction between AR and comorbidities in children aged 6 to 15 years.*Health status was based on the single question, 'In general, how would you describe your child's health?',[16 18] adapted to be answered on a 10 cm VAS (0= poor health and 10= good health). Mean score was derived from the cut-off criteria: VAS<2= very poor, 2≤VAS<4= poor, 4≤VAS<6= good, 6≤VAS<8= very good, and 8≤VAS≤10= excellent. †The number of days in the last month the child was healthy (happy and full of energy), had poor physical health and had poor emotional health were measured based on questions derived from the Centers for Disease Control and Prevention's Healthy Days Core Module[17] and the Pediatric Allergies in America Survey[18]. ‡Unhealthy days=number of days of poor emotional health and number of days of poor physical health combined. (A) overall health status* (B) number of healthy days in the last month† (C) number of unhealthy days‡ in the last month†. AR, allergic rhinitis; VAS, visual analogue scale.

the AR symptoms were that day. The results were counter-intuitive to what would have been expected. AR symptoms were reported as being more bothersome in those children who had taken their medication that day compared with those who had not. While these data could be interpreted to mean that the medication taken had not worked, it is more likely (based on the order of the questions) that the children had been given medication because their symptoms had been bothersome that day. This is consistent with an approach of treating to alleviate the impact of AR, rather than based on disease severity. Community pharmacy research, conducted among Australian adults with AR has demonstrated that the majority (70%) self-select over-the-counter medications, but only 15% select an appropriate medication for their condition based on symptom severity.[31 32] Symptom severity was found not to be a driving factor in medication choice, with patients reporting that they only sought advice from the pharmacist when they perceived their symptoms to be sufficiently bothersome to impact on their day-to-day lives.[33]

This study has a number of limitations. The survey questionnaire was custom-designed for this research activity and was not validated in its entirety prior to use. However, it drew on a combination of validated tools and questions previously used in similar surveys in paediatric AR. The term 'burden' was used to discuss the effect of AR on health and 'impact' to discuss its effect on activities of day-to-day living, such as schooling and sleep. The measures of burden are determined based largely on the CDC Healthy Days questionnaire[17] and the measures of impact on questions in the Pediatric Allergies in America Study.[18] Validity of the use of the single question to measure health status is supported in the literature[16] and has previously been adapted and used in the AR setting to enable an adult to answer on behalf of a child in their care[18] Where possible, the survey questionnaire used VAS scales; thereby conforming to established, quantitative methods in other areas of AR research as a valid measure.[34–36] The representativeness of the sample to that of the Australian population has been difficult to verify given the limited amount of participant demographic data collected. Based on the available data, the sample was slightly older, had a higher level of education and a higher household income than average Australians. This may have occurred due to the online nature of the survey methodology and may have introduced some bias, given that we found a higher household income was associated with an increased propensity to treat AR. The study was set up to collect parental perceptions rather than the

Table 2 Impact of AR on schoolwork and sleep quality in the past 4 weeks and absenteeism in the past 12 months

	Cases (AR) versus Controls (No AR)		Cases (AR) treated versus not treated		Cases (AR) Good versus poor symptom control		Cases (AR) Mild versus moderate-severe	
	Cases	Controls	Treated	Not treated	Poor control	Good control	Mild	Moderate-severe
N	797	314	730	67	408	389	184	613
Proportion of children who had difficulty performing schoolwork and other activities	445 (56%)*	53 (17%)	420 (58%)*	22 (33%)	297 (71%)*	152 (39%)	37 (20%)	405 (66%)*
Proportion of children who accomplished less than they would usually have done at school or in other activities	419 (53%)*	44 (14%)	396 (54%)*	25 (37%)	286 (70%)*	136 (35%)	38 (21%)	383 (62%)*
Proportion of children who took less care than usual when performing schoolwork and other activities	388 (47%)*	35 (11%)	368 (50%)*	23 (34%)	269 (66%)*	121 (31%)	31 (17%)	360 (59%)*
Sleep quality: Proportion of children who:								
Woke up tired	367 (46%)*	72 (23%)	350 (48%)*	21 (31%)	212 (52%)*	156 (40%)	44 (24%)	325 (53%)*
Had restless sleep	247 (31%)*	28 (9%)	226 (31%)	19 (28%)	159 (39%)*	89 (23%)	18 (10%)	233 (38%)*
Had difficulty falling asleep	247 (31%)*	57 (18%)	234 (32%)	14 (21%)	135 (33%)	113 (29%)	39 (21%)	208 (34%)*
Slept badly	151 (19%)*	19 (6%)	146 (20%)	5 (7%)	98 (24%)*	55 (14%)	8 (4%)	141 (23%)*
Proportion of children who were absent from school at least once per month because they were unwell	255 (32%)*	35 (11%)	234 (32%)	17 (25%)	180 (44%)*	78 (20%)	18 (10%)	239 (39%)*

*Between-group difference was statistically significant at 95% CI.
AR, allergic rhinitis.

views of children, this may have posed some limitations on the validity reliability of the data, due to proxy reporting bias, particularly in adolescents who were not given the opportunity to answer for themselves.

The PIAF study demonstrated the impact of parental asthma, eczema and AR on the odds of their offspring developing these conditions.[13] Similarly, in our study, children with AR were significantly more likely to report a range of medical conditions (eg, asthma, cough, eczema, sinusitis and food allergy) in the family (parents/siblings and proband children) relative to children without AR. However, the survey questionnaire listed conditions for the respondents to select from, potentially introducing reporting bias, and there were no clinical examinations or objective tests to verify a diagnosis of AR, both of which limit the interpretation of the data.

In moving forward with the findings of this research, it is important to consider the implications in context with available AR management guidelines. ARIA guidelines developed over the past 20 years have incorporated evidence-based, integrated care approaches to AR management. Increased understanding of the importance of impact and adequacy of control to sufferers has lead to a paradigm shift.[37] In recent years, the MACVIA-ARIA Sentinel NetworK has developed and validated VAS scales to evaluate the extent of AR symptom control.[3 25] Well-controlled AR has previously been defined as a VAS of score of 2 or less.[38] The new ARIA guidelines for adults and adolescents recommend a step-up/step-down algorithm based on patient-report of symptom control assessed via a VAS, with a step-down if the score is <2, continuing as is for scores of ≥2 to<5, and stepping up if the score is ≥5.[2] The rationale being that better reflecting patients' needs and preferences will improve overall patient satisfaction and adherence, thereby optimising management. Given the availability of over-the-counter allergy medicines, and high levels of self-diagnosis and self-management of AR, the principles behind these guidelines and the use of VAS scales for self-assessment have been incorporated into care pathways, algorithms and shared decision support systems for use in the community pharmacy setting.[37 39] A recent review of AR adds to this, supporting the view that shared decision-making can help to better equip patients to make appropriate decisions for optimal disease control.[40]

Prior research has demonstrated that children with AR as young as 8 years of age are able to use self-assessment questionnaires, including VAS scales to report measures of disease severity and impact.[41] The availability of app-based self-assessment tools, such as the MASK-Air Allergy Diary, opens up the concept that some children may be able to take a more active role in documenting the impact of the AR, providing opportunities to enhance shared decision making.

CONCLUSION

The parent-perceived burden of AR in Australian children aged 6 to 15 years is high and impacts many areas of day-to-day living, including emotional well-being, physical health, school and sleep. Inadequate symptom control is a key driver of the extent of that impact. Parents have many misconceptions about AR and its management. Opportunities to optimise the management of AR in children include parental education, regular review and adoption of self-assessment tools to gauge and monitor adequacy of symptom control.

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