

REGULAR ARTICLE

Population-based study shows that teenage girls with asthma had impaired health-related quality of life

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Keywords

Asthma control, Health-related quality of life, Physical activity, Smoking, Teenagers

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Received

27 September 2016; revised 24 January 2017; accepted 22 March 2017.

DOI:10.1111/apa.13847

ABSTRACT

Aim: This study examined the health-related quality of life (HRQoL) of teenagers with and without asthma, including the impact of their sex, allergic conditions, smoking, living conditions and physical activity.

Methods: The Obstructive Lung Disease in Northern Sweden (OLIN) studies recruited a cohort of schoolchildren in 2006. The parents of all children aged seven to eight years in three municipalities were invited to complete a questionnaire and 2585 (96%) participated. The cohort was followed up at the ages of 11–12 years and 14–15 years with high participation rates. At 14–15 years, the HRQoL questionnaire KIDSCREEN-10 and Asthma Control Test were added.

Results: Girls with current asthma at 14–15 years had a lower mean HRQoL score than girls without asthma (46.4 versus 49.3, $p < 0.001$), but this was not seen among boys (53.8 versus 52.8, $p = 0.373$). Poor HRQoL was related to current asthma, uncontrolled asthma and teenage onset of asthma. It was also related to eczema, living in a single-parent household, maternal smoking, daily smoking and inversely related to physical activity.

Conclusion: Teenage girls with asthma had lower HRQoL than girls without asthma. Possible interventions to improve HRQoL among teenagers with asthma were identified as follows: increasing asthma control, preventing smoking and promoting physical activity.

INTRODUCTION

Asthma is common among children, teenagers and adults and constitutes a considerable public health problem. In young children, both the prevalence and incidence of asthma are higher among boys than girls, while the association is reversed in adults (1). This is partly because of a higher incidence of asthma among girls (2,3) and higher remission among boys during their teenage years (4). Thus, the natural history of asthma differs between boys and girls and this may imply differences in health-related quality of life (HRQoL) between girls and boys with asthma. Furthermore, during this time the teenagers assume more responsibility for their asthma management. Adherence to asthma treatment is low among teenagers (5), which may lead to poor asthma control with increased risk for exacerbations and lower HRQoL (6,7).

Having asthma may affect daily life and decrease the HRQoL among teenagers (8). Children with severe asthma have been reported to have worse HRQoL than those with mild asthma in some studies (9), but not in others (10). One

explanation for this inconsistency may be that HRQoL among adolescents with asthma depends on individual factors, such as personality traits (11) or social factors such as family functioning (9), as well as on the intensity or frequency of symptoms. Furthermore, whether the asthma cohort is hospital or population based may also have an impact on the results, as participants in a population-based study include the whole spectrum of disease severity, while a hospital-based study may include more severe asthmatics and those with more severe comorbid conditions. Asthma is a heterogeneous condition, and different phenotypes have been defined by age at onset, allergic or nonallergic asthma and disease severity (12). There are a lack of

Abbreviations

BMI, Body mass index; CI, Confidence interval; HRQoL, Health-related quality of life; OR, Odds ratio; SD, Standard deviation; SPT, Skin prick test.

Key notes

- We examined the health-related quality of life (HRQoL) of a population-based cohort of more than 2000 teenagers with and without asthma.
- Girls, but not boys, with current asthma at 14–15 years had a lower mean HRQoL than those without asthma.
- Factors related to poor HRQoL included current, uncontrolled and teenage onset asthma, eczema, single-parent families and preventable factors such as maternal smoking, daily smoking and physical activity.

population-based studies on HRQoL, in relation to different asthma phenotypes, that take other demographic factors into account, such as the subject's sex, lifestyle factors such as smoking and physical activity and social factors such as family structure. Furthermore, there are few studies on HRQoL in population-based samples that include both teenagers with and without asthma.

In this population-based study, we studied HRQoL in relation to asthma, asthma phenotypes and asthma control among teenagers and analysed the impact of the subject's sex, allergic sensitisation, rhinitis, eczema, lifestyle factors, living conditions and physical activity.

METHODS

Study population

A population-based paediatric cohort was recruited in 2006 as part of the Obstructive Lung Disease in Northern Sweden (OLIN) studies (13). The parents of all children in the first and second grades, aged seven to eight years, in the three municipalities of Luleå, Piteå and Kiruna in northern Sweden were invited to complete a questionnaire. Of these, 2585 (96%) participated (13). A follow-up survey was performed when the children were 11–12 years of age, with 2378 parents participating, which equated to 92% of the participants at seven to eight years. A second follow-up survey was carried out at 14–15 years and that questionnaire was completed by 2217 of the subjects themselves, which equated to 86% of the participants at seven to eight years (Fig. 1). The study was approved by the Regional Ethical Review Board at Umeå University, Sweden.

Questionnaires

The study questionnaire included the International Study of Asthma and Allergies in Childhood core questionnaire, which asked questions about asthma, wheezing, rhinitis and eczema (14). It was expanded with additional questions about asthma and allergic diseases, including physician diagnoses, symptoms, medicine use and heredity. Other questions included possible risk factors, such as living conditions, physical activity, parental smoking and socioeconomic status (13). When the children were seven to eight and 11–12 years of age, the questionnaire was completed by the parents. At the age of 14–15 years, the questionnaire was completed by the teenagers, instead of

their parents, and questions about tobacco use, HRQoL and asthma control were added.

HRQoL was self-reported at 14–15 years and assessed by the validated generic KIDSCREEN-10 questionnaire (15), which consists of 10 items, with each item being answered by using a five-point ordinal scale. The KIDSCREEN-10 is a short version of the KIDSCREEN-52 questionnaire, which was developed and tested in large representative samples in several European countries. It provides a valid measure of general HRQoL in children and adolescents (15). In accordance with the KIDSCREEN manual, the crude responses were transformed into a single HRQoL score with a mean of approximately 50 and a standard deviation (SD) of approximately 10 (16). The manual states that a normal score is the mean of the total study population ± 0.5 SD. Based on this formula, HRQoL was categorised into two groups: poor <46.02 and normal ≥ 46.02 .

Asthma control was assessed by the Asthma Control Test, which contains five questions with responses on a five-point ordinal scale. The responses are summed into a score that ranges from 5 to 25. A cut-off point of ≤ 19 indicates uncontrolled asthma, 20–24 indicates partly controlled asthma and 25 indicates controlled asthma (17).

Skin prick tests

All children in Luleå and Kiruna were invited to skin prick tests (SPT) with a panel of 10 standard airborne allergens at the age of seven to eight years and 92% of those invited or 1443 children participated (13). At the follow-up at 11–12 years 88% of those invited or 1356 children participated. The SPTs were performed by the same trained staff on both occasions. The specific allergens were birch, timothy, mugwort, dog, cat, horse, *Dermatophagoides farinae*, *Dermatophagoides pteronyssinus*, cladosporium and alternaria using extracts from Soluprick (ALK, Hørsholm, Denmark).

Definitions

The variables of asthma and wheeze were defined based on the questionnaire reports at the age of 14–15 years. Physician-diagnosed asthma was defined as answering yes to the question 'Have you been diagnosed by a physician as having asthma?' (13). Current wheeze was defined as answering yes to the question 'Have you had wheezing or whistling in the chest in the last 12 months?' (14). Current asthma was defined as physician-diagnosed asthma and either current wheeze or use of asthma medication during the last

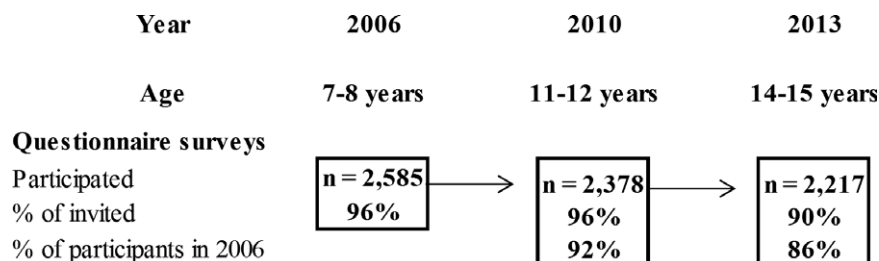


Figure 1 Study design and participation in the Obstructive Lung Disease in Northern Sweden paediatric study.

12 months. Allergic sensitisation was based on the SPT results and defined as a mean wheal diameter of ≥ 3 mm to any of the tested allergens at the age of seven to eight years or 11–12 years of age.

Those who reported current asthma at the age of 14–15 years were categorised based on the age at onset, asthma control and the presence of allergic sensitisation. Early onset included those who reported having physician-diagnosed asthma at the age of seven to eight years. School age onset included those who reported having physician-diagnosed asthma at the age of 11–12 years but not at seven to eight years. Teenage onset included those who reported having physician-diagnosed asthma at the age of 14–15 years but not in any of the previous surveys. Nonallergic asthma included those with current asthma at the age of 14–15 years without allergic sensitisation. Allergic asthma included those with current asthma at the age of 14–15 years and allergic sensitisation.

Statistical analyses

The analyses were carried out using the computer software IBM SPSS Statistics, version 22.0 (IBM Corp, New York, NY, USA). As the KIDSCREEN-10 single score was normally distributed, the differences in means between groups were analysed by t-tests and the differences in proportions by chi-square tests. Additionally, the ten single items included in the KIDSCREEN-10 were analysed in relation to the level of asthma control. Because the responses were skewed, and the differences across the groups were analysed by the nonparametric Kruskal–Wallis test. A p-value of <0.05 was considered to be statistically significant. Factors that were significantly associated with poor HRQoL in the bivariate analyses were included in multiple logistic regression analyses. The association between poor HRQoL and the different asthma variables, namely current asthma, level of asthma control and age at onset were analysed in three separate multivariate models. Associations are expressed as odds ratios (OR) with 95% confidence intervals (95% CI). Some of the demographic factors, namely living in a single-parent household and maternal tobacco use, were strongly related to one another. Therefore, we only included one of these variables at a time in the multivariate analyses.

RESULTS

The prevalence of asthma

At the age of 14–15 years, the prevalence of current asthma was 11.1%, with no significant difference by sex (Table 1). Most of the girls with current asthma reported teenage onset of asthma, whereas early onset was most common among the boys. Among those with current asthma, 15% were classified as having a controlled asthma, 54% partly controlled asthma and 32% uncontrolled asthma. There was a difference by sex, as significantly more girls than boys reported uncontrolled asthma (39% versus 25%, $p = 0.03$). Among those with current asthma, 69% had allergic asthma, with no difference by sex.

HRQoL in relation to asthma

Of the study population at 14–15 years ($n = 2217$), 2181 completed the KIDSCREEN-10 questionnaire. In the analyses of the ten single items of KIDSCREEN-10, there were significant differences in the HRQoL score distribution between teenagers with and without asthma and by the level of asthma control, with the lowest scores among those with uncontrolled asthma (Table 2). Post hoc tests showed significantly lower scores among those with uncontrolled asthma than the other categories, for all items except the questions about fairness and having fun with friends. Furthermore, the scores were similar between no asthma versus controlled asthma, except for three items – fit and well, full of energy and doing things in free time – where there were higher scores in controlled asthma.

The overall mean of the single score was 51.0 (SD 9.9), with a lower mean score among girls than boys (49.0 versus 52.9, $p < 0.001$). Girls with current asthma had a lower HRQoL than girls without asthma (46.4 versus 49.3, $p < 0.001$), but this was not seen among boys (53.8 versus 52.8, $p = 0.373$).

Overall, one-third of the cohort were classified as having poor HRQoL, and significantly more girls than boys had poor HRQoL (43% versus 24%, $p < 0.001$). Among those with current asthma, 41% had poor HRQoL compared to 33% of those without asthma ($p = 0.006$) (Fig. 2). There was a significant association between HRQoL and asthma control: poor HRQoL was most prevalent among those with uncontrolled asthma (59.2%) and least prevalent among those with controlled asthma (15.2%, test for trend $p < 0.001$). Among girls, poor HRQoL was more common among those with than without current asthma (55.8% versus 41.8%, $p = 0.004$) and associated with asthma control (test for trend $p < 0.001$) (Fig. 2). A similar trend was seen among the boys, but the differences were not significant.

Factors related to poor HRQoL

The risk of having poor HRQoL was significantly higher among those with current asthma, uncontrolled asthma and teenage onset of asthma than teenagers without asthma. Other factors related to poor HRQoL were female sex, living in a single-parent household, living in an apartment, maternal smoking, parental snus use – moist smokeless tobacco that is placed under the upper lip – the subjects' daily smoking, hypersensitivity to basic food and current eczema. Poor HRQoL was also inversely related to physical activity (Table 3).

Multivariate analyses

The association between poor HRQoL and the different asthma variables current asthma, level of asthma control and age at onset were analysed in three separate multivariate models (Table S1). Poor HRQoL was significantly related to current asthma, uncontrolled asthma and teenage onset of asthma, respectively (Fig. 3). Regarding the other covariates included in these analyses, poor HRQoL for current asthma was significantly related to female sex (OR

Table 1 The prevalence (%) of asthma and the level of asthma control, age at onset and allergic sensitisation among girls and boys with asthma, respectively, at the age of 14–15 years

	Girls		Boys		All		Difference by sex p-value
	n	%	n	%	n	%	
Current asthma	123/1080	11.4	122/1137	10.7	245/2217	11.1	0.621
Asthma control*							
Controlled	14/115	12.2	19/113	16.8	33/228	14.5	0.030
Partly controlled	56/115	48.7	66/113	58.4	122/228	53.5	
Uncontrolled	45/115	39.1	28/113	24.8	73/228	32.0	
Age at onset							
Early onset	32/123	26.0	51/122	41.8	83/245	33.9	0.015
School age onset	34/123	27.6	28/122	23.0	62/245	25.3	
Teenage onset	57/123	46.3	43/122	35.2	100/245	40.8	
Allergic sensitisation†							
Nonallergic asthma	32/88	36.4	19/76	25.0	51/164	31.1	0.117
Allergic asthma	56/88	63.6	57/76	75.0	113/164	68.9	

*Among the n = 245 with current asthma, n = 228 completed the asthma control test (ACT) questionnaire.

†Among the n = 245 with current asthma, n = 164 participated in skin prick tests at the age of 7–8 or 11–12 years.

Table 2 Median and interquartile range (IQR) of the ten items in the health-related quality of life (HRQL) questionnaire KIDSCREEN-10, comparing no asthma with current asthma and level of asthma control, respectively, at age 14–15 years. A higher score indicate better HRQL

	Asthma control											
	No current asthma		Current asthma		p-value*	Controlled		Partly controlled		Uncontrolled		p-value**
						Md	IQR	Md	IQR	Md	IQR	
	Md	IQR	Md	IQR								
Have you felt fit and well?	4	3–5	4	3–4	<0.001	5	4–5	4	3–5	3	3–4	<0.001
Have you felt full of energy?	4	3–4	4	3–4	0.012	4	4–5	4	3–4	3	3–4	<0.001
Have you felt sad?	4	3–5	4	3–5	0.243	5	4–5	4	3–5	4	3–4	<0.001
Have you felt lonely?	5	4–5	4	4–5	0.250	5	4–5	5	4–5	4	3–5	0.036
Have you had enough time for yourself?	4	3–5	4	3–4	0.078	4	3–5	4	3–4.5	4	3–4	0.011
Have you been able to do the things that you want to do in your free time?	4	4–5	4	3–5	0.547	5	4–5	4	3–5	4	3–4	<0.001
Have your parent(s) treated you fairly?	5	4–5	5	4–5	0.301	5	4.5–5	5	4–5	5	4–5	0.249
Have you had fun with your friends?	5	4–5	5	4–5	0.684	5	5–5	5	4–5	5	4–5	0.040
Have you got on well at school?	4	3–4	4	3–4	0.015	4	4–5	4	3–4.5	3	3–4	<0.001
Have you been able to pay attention?	4	3–4	4	3–4	0.036	4	4–5	4	3–4	4	3–4	<0.001

*Mann–Whitney, comparing no current asthma with current asthma.

**Kruskal–Wallis, comparing no current asthma with level of asthma control.

2.4, 95% CI 2.0–2.9), single-parent household (OR 1.3, 95% CI 1.0–1.7), daily smoking (OR 2.9, 95% CI 1.7–4.9), current eczema (OR 1.5, 95% CI 1.1–2.0) and inversely related to physical activity (OR 0.5, 95% CI 0.4–0.7). The effect of the subject's sex, single-parent household, maternal smoking, daily smoking, current eczema and physical activity remained almost identical independently of what asthma variable was included in the model (Table S1).

When the multivariate analyses were stratified by sex, poor HRQoL was significantly related to current asthma (OR 1.7, 95% CI 1.1–2.6), uncontrolled asthma (OR 4.0, 95% CI 2.1–7.8) and school age onset of asthma (OR 2.8, 95% CI 1.4–5.5), respectively, among girls. Furthermore, poor HRQoL was significantly related to living in a

single-parent household, maternal smoking, daily smoking and current eczema and inversely related to physical activity in all three of the multivariate models (data not shown). Among boys, none of the asthma variables were significantly related to poor HRQoL, whereas daily smoking (OR 2.4, 95% CI 1.1–5.2) and physical activity (OR 0.5, 95% CI 0.4–0.7) were.

DISCUSSION

In this population-based study, girls with current asthma at the age of 14–15 years had significantly lower HRQoL than girls without asthma, but this was not seen among boys. Poor HRQoL was associated with having current,

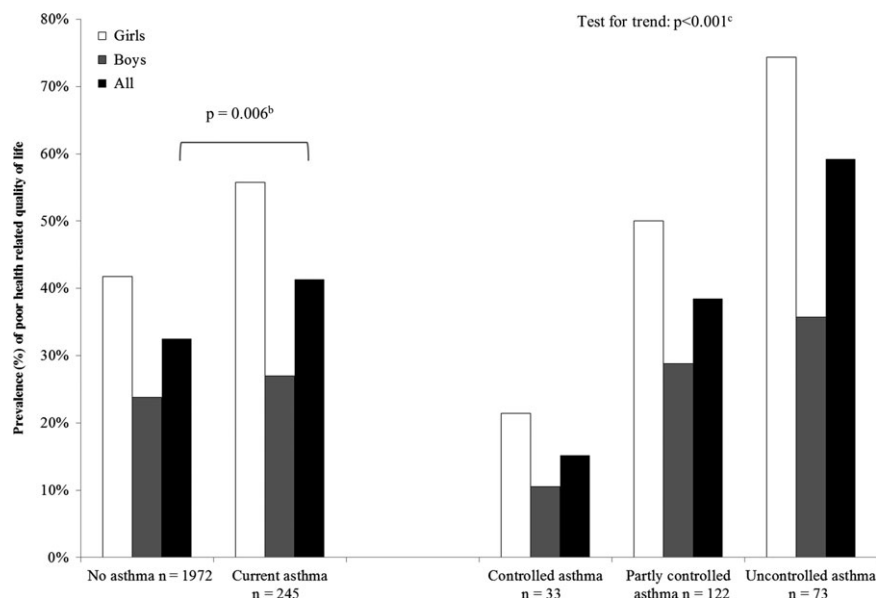


Figure 2 The prevalence (%) of poor health-related quality of life in relation to current asthma and asthma control^a at the age of 14–15 years. ^aOf the 245 with current asthma, 228 completed the Asthma Control Test questionnaire. ^bComparison between no asthma and current asthma among all subjects. $p = 0.004$ among girls and $p = 0.432$ among boys. ^cComparison between no asthma and level of asthma control. $p < 0.001$ among girls and $p = 0.163$ among boys.

uncontrolled and teenage onset of asthma. In addition to asthma and female sex, poor HRQoL was also related to having eczema, living in a single-parent household, maternal smoking and daily smoking and inversely related to physical activity.

We found an association between asthma control and HRQoL in accordance with other studies (6,7). Uncontrolled asthma affects families and society as well as individuals as it is related to increased school absenteeism, a low HRQoL in both asthmatic children and in their families (7), higher healthcare use (18) and consequently higher healthcare costs (6). Furthermore, under treatment and poor adherence to asthma treatment have been shown to increase asthma mortality among Swedish children and young adults (19). Identifying ways of achieving asthma control are therefore a multilayered and important public health objective. Interestingly, those with controlled asthma had better HRQoL than those without asthma. One explanation for why teenagers with controlled asthma reported a better HRQoL may be that these people's daily life had previously been affected or restricted by their asthma and that they now received the correct treatment and had achieved good compliance to that treatment.

Girls had poorer HRQoL than boys, a result consistent with other studies (20). In a large multicentre study about age and sex differences in HRQoL in European children, HRQoL was similar among boys and girls at a younger age, but it decreased more in girls than boys as they got older (20). One explanation for this may be that girls actually have a higher risk of poor overall health, as it has been shown that they reported a higher frequency of symptoms, such as headaches, stomach aches and feeling low or nervous, than boys (21). Another explanation may be that

the timing of puberty differed between the girls and boys and may have contributed to the observed sex differences in HRQoL. Furthermore, the effect of puberty may affect boys and girls differently. In particular, girls who mature early seem to have a higher risk of emotional and behavioural problems, such as depression, eating disorders and risk-taking behaviour, including an earlier initiation of drinking alcohol, smoking and sexual activity (22). Thus, adolescence is a difficult time in life due to significant personal, physiological and social changes, which seem to affect girls more than boys. To improve adolescent health, efforts such as educational or prevention programmes may be more effective if they are sex-specific.

In our study, those who were physically active reported better HRQoL. It is well known that physical activity improves well-being and reduces depression and anxiety. It has been shown that increased physical activity improved HRQoL in asthmatics (23) and that physical exercise can reduce the frequency of wheeze, number of hospitalisations and school absenteeism (24). However, it has also been reported that adolescents with asthma were less active than their nonasthmatic peers (25). Some asthmatics may avoid physical activity because they are afraid of exercise-induced symptoms or because limited activity is seen as a natural part of having asthma (25). Nevertheless, because the benefits of physical activity are well established, it should be further promoted for teenagers in general and among teenagers with asthma in particular, by their parents, their schools and in healthcare settings.

As suggested in other studies, living in a single-parent household (9) and daily smoking (26) were related to poor HRQoL. In our study, living in an apartment, living in a single-parent household and parental smoking, which were

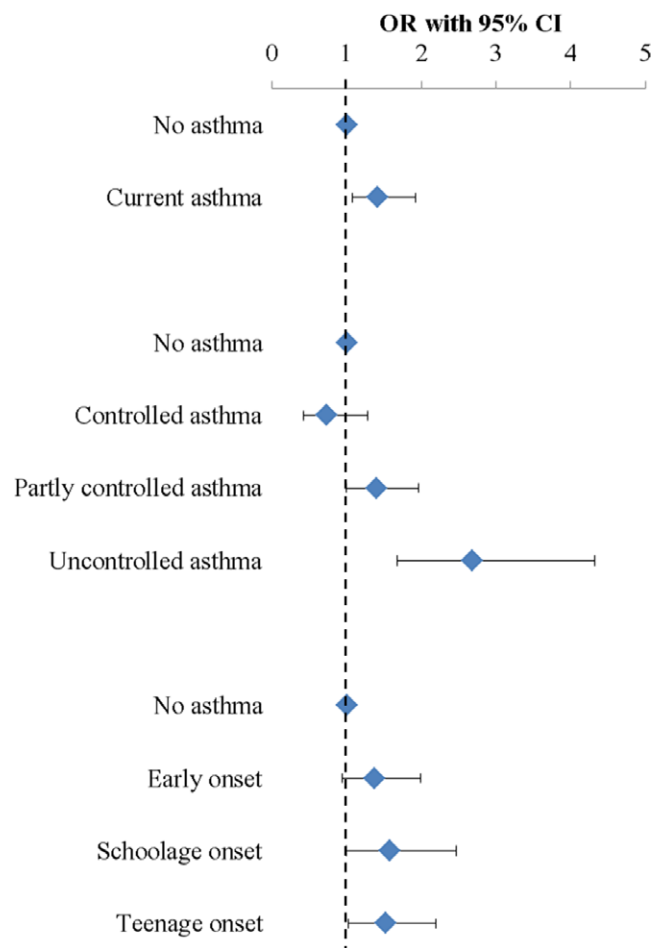
Table 3 Factors related to poor health-related quality of life, bivariate analyses expressed as odds ratios with 95% confidence intervals.

	Bivariate analyses	
	OR	95% CI
Female sex	2.41	2.00–2.89
Living conditions		
Urban living (vs. Rural)	1.05	0.86–1.28
Living in an apartment (vs. House)	1.46	1.15–1.85
Single-parent household	1.46	1.13–1.90
Mother smoking	1.46	1.12–1.90
Mother using snus	1.34	0.99–1.79
Father smoking	1.20	0.91–1.58
Father using snus	1.34	1.11–1.62
Lifestyle factors		
Daily smoking	3.59	2.19–5.86
Daily use of snus	1.24	0.75–2.03
Physical activity	0.52	0.43–0.63
Body mass index*	1.02	0.99–1.05
Allergic conditions		
Allergic sensitisation*	0.80	0.65–1.00
Current rhinitis	1.03	0.74–1.43
Current eczema	1.62	1.19–2.20
Current asthma	1.46	1.11–1.92
Food hypersensitivity to basic food	1.46	1.13–1.88
Asthma control		
No current asthma	1.00	
Controlled	0.37	0.14–0.96
Partly controlled	1.30	0.89–1.89
Uncontrolled	3.00	1.85–4.87
Age at onset		
No current asthma	1.00	
Early onset*	1.22	0.86–1.73
School age onset*	1.48	0.97–2.27
Teenage onset	1.53	1.07–2.19

*All covariates were based on questionnaire reports at age 14–15 years except BMI (11–12 years), allergic sensitisation (7–8 years or 11–12 years), early onset (7–8 years) and school age onset (11–12 years).

all associated with poor HRQoL in the bivariate analyses, were strongly related to one another. These factors reoccur as risk factors with regard to many outcomes in adolescence, for instance poor school performance, poor overall health and morbidity of asthma. In a randomised controlled trial of children with asthma from families of low-socio-economic status, HRQoL improved among those who participated in an asthma education programme and problem-solving skills training, compared to those who received standard asthma care (27). Improving HRQoL among adolescents is therefore an important way of reducing social inequalities in asthma.

We found no association between rhinitis and poor HRQoL, in contrast to other studies (28). One explanation may be that the questionnaire survey was performed during the winter in Northern Sweden, when the average temperature is below freezing, and there is no pollen. As the questions in the KIDSCEEN-10 HRQoL questionnaire only take the previous week into account, teenagers who only

**Figure 3** Poor health-related quality of life in relation to current asthma, asthma control and age at onset, respectively, expressed as odds ratios with 95% confidence intervals. Analysed in three separate multiple logistic regression analyses adjusted for the subject's sex, daily smoking, physical activity, single-parent household and current eczema.

experienced rhinitis during the pollen season would be expected to report normal HRQoL outside the pollen season. Having eczema was related to poor HRQoL in accordance with other studies (29). As eczema is a visible disease, it may affect an individual's social life and have a strong impact on HRQoL, particularly among teenagers who often are sensitive about their appearance.

Strengths and limitations

The strengths of this study included the large sample size, with high response rates, and the low number of subjects lost to follow-up, the use of validated questionnaires and the study design, which included both questionnaire data and clinical examinations. The skin prick tests were performed by the same trained staff when the children were seven to eight and 11–12 years of age. A limitation was that the questionnaire mainly focused on asthma and allergic diseases and, therefore, we lack information on other diseases that may have affected the HRQoL of teenagers with and without asthma. For instance, we did

not include questions about physical disabilities, depression or anxiety, which may decrease HRQoL among those without asthma and affect both asthma control and HRQoL among those with asthma (30). However, the KIDSCREEN-10 includes items about sadness and loneliness, which may be markers for mental health status, but teenagers with and without asthma reported similar high scores for both of these items. Other studies have found significant associations between BMI and HRQoL, which we did not find in our study. Unfortunately, BMI was based on measurements from the clinical examination at the age of 11–12 years, three years before HRQoL was measured.

CONCLUSION

Teenage girls with current asthma had lower HRQoL than girls without asthma, but this was not seen among boys. Poor HRQoL was related to having current asthma, uncontrolled asthma and teenage onset of asthma. Poor HRQoL was also related to preventable factors, such as smoking, and inversely related to physical activity. Thus, there are possible targets for interventions to improve the quality of life among teenagers with asthma, including increased asthma control, smoking prevention and the promotion of physical activity.

ACKNOWLEDGEMENTS

We would like to thank Sigrid Sundberg and Britt-Marie Eklund for the data collection and Viktor Johansson Strandqvist for computerising the data.

CONFLICTS OF INTEREST

None of the authors have any conflict of interests to declare.

FUNDING

The study was funded by The Swedish Heart-Lung Foundation (grant numbers 20120247, 20140264), The Swedish Asthma-Allergy Foundation (grant numbers 2013036; 2012039), Visare Norr (grant numbers 465281; 553291) and Norrbotten County Council.

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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article:

Table S1 Risk factors for poor health related quality of life, analysed in three separate multiple logistic regression analyses, adjusted for current asthma, age at onset of asthma, and level of asthma control, respectively, expressed as odds ratios with 95% confidence intervals. Model A adjusting for single parent household. Model B adjusting for maternal smoking.