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Quality of Life in Adolescents With Mild Asthma

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Summary

The majority of individuals with asthma have mild disease, often in conjunction with allergic rhinitis and exercise-induced bronchoconstriction (EIB). Although health-related quality-of-life (HRQoL) is reduced in moderate to severe asthma and allergic rhinitis, little is known about the effect of mild asthma, mild allergic rhinitis, and EIB on HRQoL outcomes. The objective of this study was to determine the effect of mild asthma, allergic rhinitis, and EIB on HRQoL. A cross-sectional study was conducted of 160 adolescent athletes participating in a screening program to detect EIB. Generic HRQoL was assessed with the teen version of the pediatric quality-of-life inventory (PedsQLTM). Prior diagnoses of asthma, allergic rhinitis, and EIB, and current symptoms of dyspnea during exercise and asthma, were recorded. Lung function and the presence of EIB were determined by spirometry before and after an exercise challenge test. Adolescent athletes with a prior physician diagnosis of asthma had a lower HRQoL scale summary score ($P < 0.01$) and lower physical functioning, emotional functioning, and school functioning domain scores (P values, 0.01–0.02) in comparison to adolescent athletes with no prior diagnosis of these disorders. Athletes with a prior diagnosis of asthma reported dyspnea during exercise more frequently than did those without asthma ($P < 0.001$). Adolescent athletes with dyspnea during exercise had a lower scale summary score, and lower physical functioning, general well-being, and emotional functioning domain scores (P values, 0.02–0.03). These data show that mild asthma and dyspnea without asthma significantly affect HRQoL. Symptoms of dyspnea during exercise are common in asthma and are associated with lower HRQoL. The clinical significance of these differences in HRQoL is unclear.

Keywords

asthma; allergic rhinitis; exercise-induced bronchoconstriction; health-related quality of life; spirometry

INTRODUCTION

Health-related quality of life (HRQoL) is a key component of health status and quality of life, and an important patient-reported outcome measure for individuals with pulmonary disease.

¹ By incorporating information about physical, psychological, and social well being, HRQoL reflects the broad impact of a disorder. It is clear that HRQoL is lower in persons with moderate to severe asthma than in those without asthma,^{2,3} and that the reduction in HRQoL is related to disease severity in moderate to severe asthma.³ However, most individuals with asthma

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have mild disease,^{4,5} and it is not known if mild asthma affects HRQoL. Persons with mild asthma frequently have concomitant allergic rhinitis and exercise-induced bronchoconstriction (EIB) that may account for many of their symptoms. Symptoms of dyspnea during exercise are common in asthma because of a heightened ventilatory response to exercise,⁶ in addition to the development of EIB.⁷ These features of asthma may lead individuals with asthma to limit their participation in aerobic activities,^{8,9} and may impair HRQoL.

We hypothesized that symptoms associated with mild asthma, allergic rhinitis, and EIB would negatively impact HRQoL. We therefore evaluated generic HRQoL in a group of adolescent athletes who were participating in a screening program to detect EIB.¹⁰ This study was designed to evaluate the effect of mild asthma, in conjunction with allergic rhinitis and EIB, on HRQoL in adolescents in order to determine whether this group should be targeted for interventions to improve their HRQoL.

METHODS

Study Design and Population

We studied adolescent athletes from three suburban western Washington schools who participated in a cross-sectional study of the effectiveness of screening examinations to detect EIB.¹⁰ First, each student filled out a written HRQoL questionnaire before the start of the screening examination (described below). Then one investigator (T.S.H.) conducted an in-person interview with each student to determine prior diagnoses and symptoms of respiratory and allergic disease. Lastly, each student had an exercise challenge test to identify EIB. Participants gave written informed consent and parental consent. Participants did not receive a financial incentive to participate in the study. The study procedures were approved by the Human Subjects Review Committee of the University of Washington and by each school district.

Measurement of Health-Related Quality of Life

Students were asked to complete the teen (ages 13–18) version of the pediatric quality-of-life inventory (PedsQL™, version 3.0). The PedsQL™ was developed and validated in children and adolescents, demonstrating internal consistency (Cronbach's alpha 0.83 for core items), construct validity with other psychosocial measures, and discriminant validity between known groups.¹¹ The PedsQL™ is made up of 30 items covering five health domains: physical functioning, emotional functioning, social functioning, school functioning, and general well-being. There are two summary scores: psychosocial health summary score (emotional, social, and school functioning summary score) and a total summary score. Each item has a 0–4 scale that was transformed to a 0–100 scale, with a higher score representing better HRQoL.

Allergy and Asthma Evaluation

A detailed assessment of prior diagnoses and self-reported symptoms of asthma, allergic rhinitis, and EIB was obtained using a questionnaire developed by the Sports Committee of the American College of Asthma, Allergy and Immunology.¹² The use of prescription and over-the-counter medications and the use of asthma medications on the day of testing were recorded.

Exercise Testing and Spirometry

The diagnosis of EIB was established by an exercise challenge followed by serial spirometry.^{10,13} A baseline forced expiratory volume in the first 1 sec (FEV₁) was obtained before exercise, according to American Thoracic Society (ATS) guidelines.¹⁴ Each student ran as hard as possible for a total of 7 min under adult supervision. Spirometry was repeated 5 and

15 min from the completion of the run according to ATS standards. A positive exercise test for EIB was considered a $\geq 10\%$ decline in FEV_1 at either 5 or 15 min after exercise.¹⁵

Data Analysis

Differences between the characteristics of the study sample and those adolescents participating in the screening program, but not enrolled in this study, were compared by Student's *t*-test for continuous variables and with a chi-square test for categorical variables. Fisher's exact test was used to compare distributions of medications used in the two groups. HRQoL scores in the study participants with and without features of respiratory disease were compared by Student's *t*-test. Equality of variances was assessed with Levene's test. A chi-square test was used to assess the frequency of symptoms in those with and without asthma. Statistical significance was defined as a two-tailed *P*-value of < 0.05 . Effect size was calculated from the pooled standard deviation and mean difference in the outcome measure.¹⁶

RESULTS

Study Population and Participant Characteristics

A total of 352 adolescent athletes indicated that they planned to participate in sports during the school year. Two hundred and fifty-six were screened for EIB and had the opportunity to participate in the HRQoL study. One hundred and sixty students agreed to participate in this study (Fig. 1). A prior physician diagnosis of asthma, allergic rhinitis, or EIB was noted in 27.5% ($n = 44$) of participants, with the majority of these individuals reporting a prior diagnosis of all three disorders (Table 1). In those who reported a prior diagnosis of asthma, FEV_1 was above 80% predicted in all participants, such that they fit the definition of mild asthma.⁵ Asthma medications were used by 32.4% of the 37 reporting a history of asthma, and allergy medications were used by 26.2% of the 42 participants with a prior diagnosis of allergic rhinitis, mostly inhaled β_2 -agonists and antihistamines, respectively (Table 1).

There were differences between the demographic and clinical characteristics of adolescents who agreed to participate in the HRQoL study compared with the remainder of the adolescents participating in the screening program. The mean age (14.0 vs. 14.8, $P < 0.01$) and percent-predicted FEV_1 (111.7% vs. 119.0%, $P < 0.01$) were slightly but significantly lower in the HRQoL study participants. The mean FEV_1/FVC ratio (0.86 vs. 0.85, $P = 0.06$) and the frequency of spirometrically diagnosed EIB (11.3% vs. 7.8%, $P = 0.32$) were similar in the two groups. There were no differences in gender or ethnic composition of the adolescents who did and did not participate in the HRQoL study. There were also no differences in the percent of adolescents reporting a prior diagnosis of allergic rhinitis (26.3% vs. 24.3%, $P = 0.70$) and asthma (21.9% vs. 14.9%, $P = 0.11$). However, a greater percentage of the HRQoL study participants reported a prior diagnosis of EIB (23.1% vs. 9.5%, $P < 0.01$). There were no differences in reported symptoms of asthma (8.1% vs. 8.8%, $P = 0.84$) or symptoms of dyspnea during exercise (20.0% vs. 24.3%, $P = 0.36$) in adolescents who did and did not participate in the HRQoL study. No differences were noted in the use of asthma medications between the two groups.

HRQoL of Adolescent Athletes With a Prior Diagnosis of Asthma, Allergic Rhinitis, or EIB

Most individuals (92%) who reported a prior physician diagnosis of asthma also reported a prior physician diagnosis of allergic rhinitis and EIB (Table 1). Adolescent athletes with a prior diagnosis of asthma had a 5.0-point lower HRQoL total scale summary score compared to adolescent athletes who reported no prior diagnosis of asthma ($P < 0.01$; Fig. 2). The psychosocial health summary score, and the physical functioning, emotional functioning, and school functioning HRQoL domain scores, were lower in participants with a prior diagnosis of asthma (*P* values between 0.01–0.02; Fig. 2). The effect sizes for comparisons between the

group with a prior diagnosis of asthma and those without a prior diagnosis of asthma ranged from 0.35–0.56 (Table 2).

HRQoL of Adolescent Athletes With Symptoms of Dyspnea During Exercise

Symptoms of dyspnea during exercise (i.e., chest tightness, cough, wheezing, and prolonged shortness of breath during exercise) were present in 20% of the adolescent athletes. Fifty-six percent (18 of 32) of those reporting dyspnea during exercise had a prior diagnosis of asthma, allergic rhinitis, or EIB, or had EIB demonstrated by spirometry. Adolescent athletes reporting dyspnea during exercise ($n = 32$) had a 4.4-point lower HRQoL total scale summary score compared to adolescent athletes who reported no symptoms of dyspnea during exercise ($P = 0.02$; Fig. 3). HRQoL domain scores were lower in adolescents reporting symptoms of dyspnea during exercise; in particular, there was a 4.2-point difference in the physical functioning score ($P = 0.02$), a 7.8-point difference in general well-being score ($P = 0.02$), and a 6.3-point difference in the emotional functioning score ($P = 0.03$; Fig. 3). The effect size of comparisons between those with and without dyspnea during exercise ranged from 0.10–0.59, and was highest for the physical functioning domain. Symptoms of dyspnea during exercise were reported by 44% (16 of 37) of those with a prior diagnosis of asthma, compared to 13% (16 of 123) of those without a prior diagnosis of asthma ($P \leq 0.001$). In those with a prior diagnosis of asthma, although the HRQoL scale summary score was reduced (85.1 vs. 89.6, $P \leq 0.01$), there was no apparent additional reduction in HRQoL that could be attributed to these symptoms (Fig. 4). In those without a prior diagnosis of asthma, symptoms of dyspnea during exercise were associated with a significant reduction in HRQoL scale summary score (Fig. 4).

HRQoL of Adolescent Athletes With Spirometrically Diagnosed EIB

Spirometrically diagnosed EIB was present in 11.3% ($n = 18$) of the study population. We found no significant difference in HRQoL scores in those with and without spirometrically diagnosed EIB (scale summary score 88.0 vs. 88.7, $P = 0.76$). In those with a prior diagnosis of asthma, EIB was demonstrated by spirometry in 19% (7 of 37). Of those without a prior diagnosis of asthma, EIB was also present in 9% (11 of 123). Although the HRQoL total scale summary score was significantly lower in those with a prior diagnosis of asthma, our sample size was too small to allow us to assess the independent role of spirometrically diagnosed EIB on HRQoL in those with and without asthma.

DISCUSSION

Recent studies showed that moderate to severe persistent asthma and allergic rhinitis reduce HRQoL in individuals under medical care for these conditions.^{2,3} In mild asthma, physiological abnormalities may be mild or absent on a chronic basis, but intermittent unpredictable symptoms and perceived loss of control could significantly impact HRQoL.^{17, 18} Using an age-specific, generic HRQoL questionnaire, we found that HRQoL was significantly reduced in individuals with a prior diagnosis of mild asthma, usually in conjunction with diagnoses of allergic rhinitis and EIB. Symptoms of dyspnea during exercise, which were frequently present in those diagnosed with asthma, significantly influenced HRQoL. These findings suggest that interventions targeting adolescents with mild asthma, mild allergic rhinitis, or EIB have the potential to improve HRQoL in these individuals.

Limited information is available about the effect of mild asthma on HRQoL.^{19,20} In adults with asthma, some of whom had mild asthma, but most with moderate severity (i.e., mean FEV₁ of 65% of predicted), there was only a minor reduction in HRQoL scores on the Medical Outcomes Study Short-Form 36 questionnaire (SF-36) in comparison to population normal values for the SF-36.¹⁹ In another study with mild to moderate young adult asthmatics (i.e., mean age of 33.0 years) that included 15% of the study population with an FEV₁ of $\leq 70\%$

predicted, there was a reduction in the physical functioning, energy, mental health, pain, and health perception domains of the SF-36 compared to population normal values for the SF-36.²⁰ Neither of these studies had an internal comparison group of comparable nonasthmatic individuals. In this study, we evaluated HRQoL in persons with mild asthma and compared the results to similar adolescent athletes without asthma. In this direct comparison of otherwise healthy and athletic adolescents, HRQoL was significantly reduced across several domains of HRQoL. The effect size of the scale summary score (0.56) shows that 71% of the comparison group had a lower HRQoL score than the mean of the group with asthma. This effect size is larger than that identified in mild to moderate asthmatics in comparison to population normal values of the SF-36,^{20,21} and slightly smaller than that seen comparing mild asthmatics to moderate and severe asthmatics using the disease-specific Asthma Quality of Life Questionnaire.³

Dyspnea during exercise is common in persons with asthma, either through a heightened ventilatory response to exercise^{6,22} or through the development of EIB.⁷ In this study, those with asthma, allergic rhinitis, or EIB reported dyspnea during exercise most frequently, but a modest number of adolescents without these disorders also reported symptoms of dyspnea during exercise. Dyspnea during exercise in those without a prior asthma diagnosis could have been due to other factors such as decreased fitness or coexistent obesity. Additionally, subtle changes in lung function could have occurred without changes in FEV₁ in adolescents reporting dyspnea during exercise.²³ We found that dyspnea during exercise significantly influenced HRQoL, regardless of the etiology. However, since a prior diagnosis of asthma was associated with reduced HRQoL independent of dyspnea with exercise, it is unlikely that decreased fitness was the primary reason for reduced HRQoL found in this study. Other studies similarly showed that the intensity of symptoms of dyspnea and the frequency of rescue β_2 -agonist use, rather than objective measures such as lung function, were most closely associated with impairments in HRQoL.³ Because we studied an adolescent athlete population, the effect of symptoms of dyspnea during exercise on HRQoL may have been greater than in the general adolescent population.

Exercise-induced bronchoconstriction is a feature of asthma that is present in only a portion of asthmatics. In mild asthma, 27–40% have EIB.²⁴ Although studies suggest that EIB may be a factor in the decision to participate in sports,⁸ little work has been done on the impact of EIB on HRQoL. In this study, EIB diagnosed by spirometry was present in both individuals with and without a prior diagnosis of asthma. In those with asthma, EIB was identified in only 19%. Although there was a significant reduction in the HRQoL scale summary score in those with asthma compared to those without asthma, we were unable to assess for any additional effect of spirometrically diagnosed EIB on HRQoL.

Coexistence of allergic rhinitis and asthma is common, and impairment of HRQoL in asthma can be due to concomitant allergic rhinitis.^{25,26} Compared to healthy subjects, adults with moderately severe to severe allergic rhinitis have lower generic²⁷ and disease-specific²⁸ HRQoL scores. In adolescents, allergic rhinitis may lead to poor self-perception and fatigue,²⁹ and may impair the ability to concentrate.³⁰ In this study, the majority of study participants diagnosed with allergic rhinitis were not on medications for allergic rhinitis, most consistent with mild disease. Although we cannot separate the effect of allergic rhinitis from the effect of asthma on HRQoL, allergic rhinitis may have significantly contributed to the reduction in HRQoL in these adolescents with mild upper and lower airway disease. Given the significant overlap in these clinical syndromes that comprise asthma, allergic rhinitis, and EIB, it will be very difficult to separate the independent effect of the component syndromes. Even in a much larger study, it will be difficult to accurately separate these three components.

This study has a number of potential limitations. First, as noted above, because of the frequent coexistence of asthma and allergic rhinitis, we were unable to isolate the effect of either disorder on HRQoL. Second, the modest sample size is not sufficient to allow us to adjust for confounding; however, the comparison group composed of active adolescent athletes makes confounding by additional diagnoses such as depression unlikely. Finally, although the PedsQL™ instrument shows evidence of reliability and validity,¹¹ the minimal clinically important difference has not been determined, and therefore it is difficult to know whether the decrements in HRQoL seen in this study represent a clinically important decrement.

We conclude that HRQoL is lower in adolescent athletes diagnosed with mild asthma, allergic rhinitis, and EIB in comparison to their peers without these disorders. Symptoms of dyspnea during exercise are common in mild asthma, and significantly influence HRQoL. The information provided in this study shows that individuals with a mild spectrum of asthma and allergic rhinitis severity suffer significant effects on HRQoL. Treatment of moderate to severe asthma and allergic rhinitis improves HRQoL,^{3,31} and similarly, therapy for mild asthma and allergic rhinitis may improve HRQoL. Future studies on the treatment of mild asthma and allergic rhinitis should measure the effect of treatment on HRQoL.

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ABBREVIATIONS

ATS, American Thoracic Society; EIB, Exercise-induced bronchoconstriction; FEV₁, Forced expiratory volume in 1 sec; FVC, Forced vital capacity; HRQoL, Health-related quality of life; PedsQL™, Pediatric quality-of-life inventory; SF-36, Medical Outcomes Study Short Form-36.

Fig 1.
Recruitment of study population from adolescent athletes participating in screening physical examination prior to sports.

Fig 2.

Comparison of HRQoL domain and summary scores in adolescent athletes with and without prior diagnosis of asthma. Error bars represent standard error of mean.

Fig 3. Comparison of HRQoL domain and summary scores in adolescent athletes with and without symptoms of dyspnea during exercise. Error bars represent standard error of mean.

Fig 4.

Comparison of HRQoL scale summary scores in adolescent athletes with and without prior diagnosis of asthma. Groups were subdivided based on presence or absence of dyspnea during exercise. Mean HRQoL score was significantly lower in group with prior diagnosis of asthma. But in those with asthma, no additional reduction in HRQoL was attributable to symptoms of dyspnea. In group without prior diagnosis of asthma, symptoms of dyspnea during exercise were associated with significantly lower HRQoL. Error bars represent standard error of mean.

TABLE 1

Characteristics of Study Population

Characteristic	Value (n = 160)
Age (years)	14.0 (1.8)
FEV ₁ (% predicted)	111.7 (17.4)
FEV ₁ /FVC ratio	0.86 (0.07)
Male, n (%)	85 (53.8%) ^{2,3}
Caucasian, n (%)	154 (96.3%)
EIB by spirometry ⁴	18 (11.3%)
Prior diagnoses	
Asthma	37 (23.1%)
Allergic rhinitis	42 (26.3%)
EIB	35 (21.9%)
All three disorders	34 (21.3%)
Two disorders	2 (1.3%)
One disorder	8 (5.0%)
Symptoms	
Asthma	13 (8.1%)
Dyspnea during exercise	32 (20.0%)
Asthma medications	
β_2 -agonist alone	8 (5.0%)
β_2 -agonist + inhaled corticosteroid	1 (0.6%)
β_2 -agonist + cromone	3 (1.9%)
Allergy medications:	
Antihistamine	7 (4.3%)
Decongestant	3 (1.9%)
Nasal corticosteroid	1 (0.6%)

¹ Mean $\pm$ SD.

² Complete data on 158 for gender.

³ Number percent.

⁴ EIB determined by exercise challenge with pre- and postexercise spirometry.

TABLE 2

Effect Sizes for Comparisons of HRQoL

	Asthma		Dyspnea during exercise	
	Mean difference	Effect size	Mean difference	Effect size
Total scale summary score	5.01	0.56	4.36	0.48
Psychosocial health summary score	5.80	0.51	3.38	0.24
Physical functioning	3.21	0.44	4.22	0.59
Emotional functioning	5.68	0.38	6.32	0.42
Social functioning	4.75	0.36	1.37	0.10
School functioning	6.97	0.51	2.43	0.17
General well-being	5.88	0.35	7.85	0.44