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Patterns of Asthma Control Perception in Adolescents: Associations with Psychosocial Functioning

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Abstract

Objective—The purpose was to identify and describe the patterns of asthma control perception in relation to actual symptom reports in adolescents and to compare the group with accurate control perception with those of inaccurate perception in relationship to sociodemographic characteristics, illness-related factors and psychosocial factors.

Methods—A sample of 126 adolescents from 13 thru 20 years of age participated in the study. Patterns of control perception were constructed based on participants' rating of their perception of asthma control and self-reported asthma symptoms using Latent Class Analysis. ANOVAs and multinomial logistic regressions were computed for group comparisons.

Results—Participants were classified into four groups according to the patterns of control perception. Accurate groups were divided into either the well-controlled (62%) or the poorly-controlled group (7%), and inaccurate groups were manifested in accuracy either with nighttime symptoms (25%) or daytime symptoms (6%). Minority participants ($p<.001$) or those with low socioeconomic status ($p<.001$) were more likely to be represented in the inaccurate group than their counterparts. The well-controlled accurate group consistently reported higher asthma-related knowledge ($p=.02$), more positive attitude toward asthma ($p<.001$), fewer barriers to self-management ($p=.04$) and higher quality of life ($p<.001$) than the inaccurate group.

Conclusion—This study demonstrated that accuracy of asthma control perception can be classified into four criteria based on patterns of various asthma symptoms. Adolescents' tendency toward underperception was evident. The inaccurate groups are at greater risk for psychosocial impairments. This study underscores the importance of an intervention that improves the accuracy of asthma control perception in adolescents while promoting psychosocial wellbeing among adolescents with inaccurate perception.

Keywords

Control perception; Patterns; Adolescents; Psychosocial factors

Successful asthma management depends on the patient's accurate assessment of asthma symptoms. Symptom monitoring informs patient decisions to initiate necessary self-management behaviors (e.g., adjusting medication, altering activity level, altering the surrounding environment or seeking medical assistance) as well as the providers' decisions related to an appropriate treatment course. Thus, current guidelines by Expert Panel Review 3

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(EPR3) (1) highlight the importance of ongoing symptom monitoring. A recent Cochrane review indicated that appropriate symptom monitoring in children and adolescents with asthma can lead to fewer cases of asthma exacerbation and acute care visits as well as better functional outcomes and higher quality of life (2). Often, appropriate symptom monitoring relies on the individual's perception of asthma control.

Many researchers have concurred that symptom reports by both children and parents are often inaccurate (3–7). Literature has cautioned about the likelihood of inaccurate symptom perception particularly in those who experience chronic and high levels of asthma severity (2,8,9). Asthma control perception may be inaccurate or biased by either underperception or overperception (10). Underperception may result in denial, delay in seeking help and suboptimal treatment, while overperception may lead to unwarranted activity restrictions, high risk for adverse effects caused by overuse of medication and overutilization of health care resources (3,6,11,12). Although these two types of perceptual errors have been widely accepted, the specific patterns of symptoms that cause individuals to be more prone to perceptual inaccuracy remains to be discovered.

Studies have consistently reported psychosocial difficulties in adolescents with asthma (13–15). Children with poorly controlled asthma tend to report more problems in psychosocial adjustment (16,17). However, literature is limited regarding the extent to which the accuracy of control perception is associated with psychosocial factors.

With the growing sense of independence and individuality, adolescents gradually assume responsibility for monitoring and managing their asthma whether they are ready or not (18). Yet adolescents' personal beliefs related to invulnerability along with the desire to maintain normalcy may interfere with their capacity to assess and manage symptoms. To date, the literature examining the extent of the accuracy of control perception in adolescents is limited.

The specific aims of this study were (1) to identify and describe the patterns of control perception in relation to actual symptom reports; (2) to compare adolescents with accurate control perception with those of inaccurate perception in relationship to sociodemographic characteristics, illness-related factors and psychosocial factors.

Methods

Sample

A total of 126 adolescents with asthma participated in the study. Eligibility criteria included: (1) age between 13–20 years, (2) asthma diagnosis ≥ 1 year, (3) taking control medication or having persistent asthma as specified by EPR3, (4) no other major chronic/emotional health concerns and (5) ability to understand spoken and written English. Adolescents with learning disabilities based on reports from parents, teachers or clinicians were excluded. Participants were recruited from the communities through flyers and referrals from health care providers and local middle and high schools. To facilitate recruitment of minorities, schools with the highest enrollment of minority students were used for recruitment. About 79% (n=99) of the participants were on controller medications. The average number of years with asthma diagnosis was 10 years (SD=4.7). Table 1 summarizes the sociodemographic characteristics of the sample.

Measurements

Asthma Control Questionnaire—This questionnaire consisted of 5 items. Individual perception of asthma control was measured by a single item (from "completely controlled [1]" to "not controlled at all [5]"). The other 4 items captured the level of actual impairment as recommended by EPR3 on a 4-point scale ranging from 1–4 (high values indicate poorer

symptom control). The four items include asthma symptoms, night-time symptoms, activity limitations and use of short-acting beta agonist (SABA) use during the prior four weeks.

Asthma Knowledge Questionnaire—This 30-item instrument was a modification of Bartholomew's 27 items questionnaire (19) measuring children's knowledge of triggers and symptom identification and asthma management procedures (i.e., what to do and how to do it) in a true/false format. A total score with the possible range of 1 to 30 was calculated by summing correct answers. Higher total scores indicate higher asthma knowledge. Cronbach's alpha in the current adolescent sample was .62.

Child Attitude Toward Illness Scale—This 13-item scale measures children's attitude toward their health condition on a 5-point Likert-type scale (20). The scale includes questions such as "how good or bad do you feel it is that you have asthma?" and, "how often do you feel that your asthma is your fault?" A total score reflects respondents' overall attitudes with higher scores indicating more positive attitudes. Sound psychometric properties were demonstrated in a study using 136 children with asthma (20). Construct validity was also supported. Cronbach's alpha in the current adolescent sample was .85.

Pediatric Asthma Quality of Life Questionnaire—This questionnaire measures asthma-specific quality of life (QOL) in children and adolescents (21). Twenty-three items cover problems identified as being most important and troublesome in children's everyday lives due to asthma. The scale consists of three subdomains including activity limitation (5 items), emotional function (8 items) and symptoms (10 items). Respondents were asked to rate impairments experienced during the previous week on a 7-point scale; with 1 indicating maximum impairment, and 7 indicating no impairment. The total score for each domain is the sum of the item scores. Higher scores indicate better levels of functioning. This scale has been found to be a valid and reliable measure of asthma-specific quality of life in adolescents with asthma (16,21). Longitudinal and cross-sectional construct validity of the scale has been supported (22). Cronbach's alphas of QOL-activity, QOL-emotion, and QOL-symptom in the current sample were .84,.93 and .95, respectively.

Barriers to Asthma Management—This 5-point scale (Illness Management Scale) consisting of 27-items was developed to assess perception of barriers and to predict risk for poor self-management in adolescents with chronic illness (23). Each item represents a variety of barriers involving cognitive skills, denial, illness-related factors, health professional and peer/family influences. The possible range of total scores is from 27 to 135; with higher scores indicating greater perceived barriers. Cronbach's alpha in the current sample was .84.

Child Asthma Self-Efficacy—This 14-item scale measures the child's confidence in attack prevention (e.g., learn asthma self-management skills, correct use of medication) and attack management (e.g., control symptoms, decide which medication to use) (24). Total scores were computed with higher scores indicating higher self-efficacy. Evidence of construct validity and acceptable internal consistency was demonstrated in a sample of 110 children aged 7–15 (24). Cronbach's alpha was .83 for the current sample of adolescents.

Demographic Information including age, race, gender, family income, and parental education was collected from the parents. Race was dichotomized into Whites and non-Whites due to the small number of minority participants other than blacks. Annual gross family income was assessed on a 7-point ordinal level scale. Parents indicated their education in years.

Statistical Analysis

Latent class analysis (LCA) was used to summarize profiles of symptom perception and actual symptom reports among adolescents with asthma. LCA, is a latent variable model that serves to cluster subjects into classes. The classes represent groups of individuals who are similar to each other based on the variables used in the analysis. A sequence of five LCA models, from one to five classes was run with the 5 items from the Asthma Control Questionnaire as observed continuous indicators. The Akaike's Information Criterion (AIC) and Bayesian Information Criterion (BIC) were computed to compare the 5 models, and a model was selected based on minimizing either the AIC or BIC (25). In addition, using the entropy index, the quality of the resulting classification was also evaluated in terms of the separation of the latent classes. Entropy denotes how possible it is to predict class membership given the observed indicators. Values range from 0 to 1, and high values (>0.90) indicate that the latent classes are highly discriminative. All models were fit using Mplus software, version 5 (26). One-way ANOVAs with Tukey's HSD post-hoc comparisons were performed using SAS 9.1 software to characterize the clusters for interval level variables. For categorical variables, multinomial logistic regressions were performed. Significant level (alpha) was predetermined at the .05 level.

Results

Classification of Groups by Symptom Perception and Actual Symptom Reports

Based on the lowest BIC value and entropy value of .93 the latent class analysis identified four classes according to the distinctive patterns of symptom perception and actual symptom reports (see Figure 1). Table 2 summarizes the means of 5 items of the asthma control questionnaire that were used in the latent class analysis. Class 1 (n=78, 62%) include those who perceive their symptoms are well controlled, with a mean of control perception below 3, and report commensurate levels of actual symptoms. The mean of each item capturing asthma symptoms was below 2 indicating well-controlled asthma. Given the consistent pattern between perception and symptom reports, Class 1 was labeled "Well-Controlled Accurate group (WCA)." Class 2 (n=32, 25%) is characterized by perception of control below 3 indicating well-controlled asthma, yet the means for 3 symptoms (nighttime symptoms, activity limitation, and frequency of SABA use) were higher than 2, suggesting that the symptoms were not well-controlled. Because of the discrepancy between symptom perception and symptom reports, Class 2 was labeled "Inaccurate Group-1 (IG-1)." Class 3 consisted of only 7 subjects (6%) whose mean score for perception of control was also below 3, however the mean for symptoms was above 2 for all 3 items (daytime symptoms, activity limitation and the frequency of SABA use) strongly suggesting poorly controlled asthma. As such, Class 3 exhibited another pattern of discrepancy and was labeled "Inaccurate Group-2 (IG-2). In comparing IG-1 and IG-2, some differences in the pattern were noticed (Figure 2) particularly in the manifestation of daytime symptoms and nighttime symptoms. While IG-1 reported relatively high nighttime symptoms and low daytime symptoms, IG-2 presented with an opposite profile in which nighttime symptoms remained at the low level, yet daytime symptoms were considerably elevated. Lastly, 7% of the sample (n=9) constituted Class 4 who scored high on perception of control as well as all four symptom reports, indicating poorly-controlled asthma. Because of the coherent pattern between perception and symptom reports indicating not well-controlled asthma, Class 4 was labeled "Poorly Controlled Accurate group (PCA)."

Prior to the indepth examination of differences among the four groups, we compared the two inaccurate groups (IG-1 and IG-2) to identify similarities and differences in relation to sociodemographic characteristics, illness-related factors and psychosocial variables.

Comparisons between Two Inaccurate Groups

No sex or age differences were found between two inaccurate groups, IG-1 (high in nighttime symptoms) and IG-2 (high in daytime symptoms). Regarding race difference, non-whites were more likely to be included in IG-2, inaccurate perception characterizing high nighttime symptoms ($\beta = -2.24$, SE = 1.06, $p < .03$). Regarding socioeconomic status, there was no difference in annual income, yet IG-1 reported higher parental education ($F[1, 37] = 4.23$, $p < .05$). Those in the inaccurate group with high nighttime symptoms (IG-2) reported significantly longer years living with asthma (mean=12.2 years) than their counterpart (mean =7.6 years) ($F[1, 36] = 6.43$, $p < .01$).

Given that these two inaccurate groups did not present substantial differences in the profiles of psychosocial factors and most demographic characteristics except for race and parental education, we conducted the following analyses of group comparisons by combining two inaccurate groups (IG-1 and IG-2) for a more parsimonious approach

Comparisons between the Accurate and Inaccurate Groups

Demographic Characteristics—Multinomial logistic regressions were performed to compare three groups with regard to categorical levels of demographic variables including gender, and race (whites vs. non-whites). There was no difference in group membership by gender. However, a significant race difference was noticed. Non-whites were nearly 4 times (odds ratio=3.81) more likely to be grouped in the inaccurate group compared to the well-controlled accurate group ($\beta = 1.34$, SE=0.43, $p < .001$). To determine differences in age, family income and parental education, one way ANOVAs with subsequent Tukey's HSD post-hoc tests were conducted. Groups did not differ significantly in age. However, significant differences were revealed in parental education ($F [2, 123] = 7.83$, $p < .001$) and family income ($F [2, 123] = 7.83$, $p < .001$). The well-controlled accurate group reported a significantly higher level of parental education than the poorly-controlled accurate group and the inaccurate group. On the other hand, concerning annual family income, the well-controlled accurate group reported slightly higher income than the poorly-controlled accurate group while the inaccurate group was not significantly different from the two accurate groups.

Illness-related Factors—With regard to illness-related factors, there was no significant difference between the accurate and inaccurate groups in years elapsed since asthma diagnosis; although there was a trend toward significance ($F[2, 123]= 2.43$, $p < .09$) suggesting the inaccurate group had longer years with asthma than the two accurate groups (11.3 vs. 9.44 and 9.11 years, respectively). Groups were not significantly different in the status of control medications.

Psychosocial Factors—Table 3 presents group means for each psychosocial factor. A significant difference in asthma knowledge was found. The well-controlled group scored significantly higher in asthma knowledge than the inaccurate group, and no difference was found between the inaccurate and the poorly-controlled accurate groups. Groups were also significantly different in their attitude toward asthma and perception of barriers. The well-controlled accurate group was significantly different from the inaccurate and the poorly controlled accurate groups in attitude. There was no difference in the attitude scale between the inaccurate and the poorly controlled accurate groups. Perception of barriers to asthma management was significantly higher in the inaccurate group than the well-controlled and the poorly-controlled accurate groups. Analyses also revealed substantial differences in the Quality of Life Activity, Quality of Life Emotion and Quality of Life Symptoms subscales. For the activity and emotion subscale the well-controlled accurate group reported significantly higher levels of quality of life than the inaccurate and the poorly-controlled accurate groups. For the symptoms subscale there were significant differences among all three groups with the well-

controlled accurate group reporting the highest level of quality of life followed by the inaccurate group and then the poorly controlled accurate group. No significant group differences were found in self-efficacy.

Discussion

Often asthma symptom perception is dichotomized either accurate or inaccurate. This arbitrary way of classification, however, makes it difficult to describe the detailed profiles of various asthma symptoms being examined. In addressing this limitation, this study demonstrated an alternative classification using latent class analysis. We found four distinctive patterns of control perception in relation to actual symptom reports. Each participant was classified into one of four groups according to their responses on 5 symptom variables. The majority (69%) were classified into one of two accurate perception groups either well-controlled or poorly-controlled. Two inaccurate-perception groups were comprised of about 31% of the sample. Interestingly, these two types of perceptual errors exhibited the patterns of underperception, but not overperception. That is, these groups perceived that their asthma was well controlled, while the patterns of their symptom reports clearly suggested otherwise. The tendency of downplaying symptoms in adolescents confirms the previous literature that consistently reports underperception as the predominant type of perceptual error in young people as opposed to overperception (4,11,12).

According to our data, inaccurate perception can occur in two ways: underperception of nighttime symptoms or daytime symptoms. We observed that inaccurate perception occurred more frequently in association with nighttime symptoms than daytime symptoms. This finding aligns with the argument that the underrated asthma symptoms may be a result of children's inability to recount nocturnal asthma symptoms (4). Studies have shown that worsening of asthma symptoms often occur during nighttime which continues to impair day-time activity level (27,28). Therefore, it is not surprising that our data demonstrated the elevated pattern of activity limitation in the inaccurate group with nighttime symptoms. Given the fact that nighttime symptoms are more indicative of poorly controlled asthma (29), it is particularly concerning that the majority of inaccurate perception is associated with nighttime symptoms. Another important finding is that the inaccurate group with nighttime symptoms tended to suffer asthma for a longer period than the group with daytime symptoms. It appears that adolescents with a longer duration of asthma are more likely to experience nighttime symptoms, yet they fail to recognize the symptoms as an indication of poorly controlled asthma.

There was some evidence of disparity in control perception. We found that the inaccurate perception groups were more likely to be represented by adolescents of non-white race and/or those of disadvantaged SES. This finding aligns with other studies reporting disproportionately higher asthma morbidity in minority children and adolescents living in poor neighborhoods (17,30). In support of the argument that children suffering the chronic nature of asthma are more vulnerable to underestimation of symptoms (31), we found a trend for a longer duration of asthma in the inaccurate groups compared to the accurate group. Children may become habituated to prolonged symptoms which may reduce the precision of symptom perception and lead to indifference to symptoms (10).

Striking differences were found in the profiles of psychosocial functioning between the inaccurate and accurate groups, particularly the well-controlled accurate adolescents. The inaccurate group presented more negative psychosocial functioning compared to the well-controlled accurate group. Moreover, it is noteworthy that perceived barriers to asthma management were greater in the inaccurate group than the accurate groups either well-controlled or poorly-controlled. A previous study found the association between perceived barriers and poor adherence in children with asthma (32). Hence, it is plausible that the

inaccurate group is at greater risk for suboptimum self-management of asthma. Quality of life in the inaccurate group was worse than the well-controlled accurate group although the level of asthma control perceived by both groups was comparable. In fact, the inaccurate group's activity level and emotional function were as bad as the poorly controlled accurate group which scored worse only in the quality of life-symptom domain than the inaccurate group. This finding suggests that qualify of life is more likely to be dictated by actual symptoms than individuals' perception.

Cautions should be exercised in regard to the findings due to several limitations. Being a cross-sectional design, this study is limited in confirming the stability of group patterns over time. Future research using a longitudinal design is warranted to establish the temporal stability and reproducibility of the identified symptom patterns before this classification scheme can be used as a formal taxonomy. We also advise caution not to claim any causality beyond associations between group membership and psychosocial factors due to the cross-sectional nature of the study. In addition, generalizability of the findings is limited owing to a small sample size. Two of 4 identified groups were comprised of fewer than 10 subjects. Despite the small size, these groups are considered important as their members represent clinically relevant subsets of adolescents manifesting unique patterns of asthma symptoms. Thus, subsequent studies with a larger sample size are needed to affirm the validity of the small groups and to secure statistical power. Lastly, the current study is limited in its capacity to cross-check the self-reported symptom control against objective data from lung function tests. The four items gauging actual control in this study were in alignment with impairment types suggested by EPR3's Asthma Control Classification (1) as well as the Asthma Control Test (ACT). Particularly, the ACT has been accepted as a valid tool that has demonstrated correlations with asthma specialist rating of asthma control and FEV_1 Values (33,34). Given the literature, therefore, it is reasonable to assume that our measure of asthma control be the adequate representation of actual control status. However, further research is warranted to examine the extent to which current findings are replicated when an objective measure of asthma control status is considered.

Despite the recognized shortcomings, this study is important in that this is the first effort to identify subgroups of adolescents with asthma based on the patterns of accuracy in the perception of asthma control by employing an advanced statistical method of classification. This classification method adopts a person-oriented approach as opposed to variable-oriented because it is "people" that are being classified not "variables" (35). This approach affords a capacity to examine and compare the full profile of various sociodemographic characteristics and psychosocial factors of each group as an entity. This study also documents the degree to which inaccurate control perception is represented among adolescents with asthma. In addition, this study suggests that the inaccurate group be in a disadvantageous position in regard to asthma knowledge, attitudes, barriers to asthma management, and quality of life. The findings underscore the importance of further research exploring the nature of the associations (e.g., causality) between control perceptions and psychosocial factors. Future study is also needed to gauge the extent of asthma morbidity associated with perceptual inaccuracy through the evaluation of health care utilization.

Over 31% of inaccuracy in control perception among the adolescent participants is concerning, considering literature documenting increased serious asthma-related morbidity among those with underperception of asthma symptoms (5,8,36). Clinicians must be aware that inaccurate control perception is not uncommon among adolescents particularly those of low SES and non-whites backgrounds, and that the manifestation of the inaccurate perception may vary. Hence, it is critical that clinicians specifically assess various symptoms of asthma in addition to inquiring about an adolescents' overall sense of asthma control in order to screen those with inaccurate perceptions. This study suggests that psychosocial morbidity result from symptom

severity rather than individuals' perception of asthma control. Therefore, consistent and careful monitoring of psychosocial functioning in those of high symptom severity can also be beneficial in identifying and ameliorating potential impairments in the areas of daily activity, attitude and emotional response to living with asthma.

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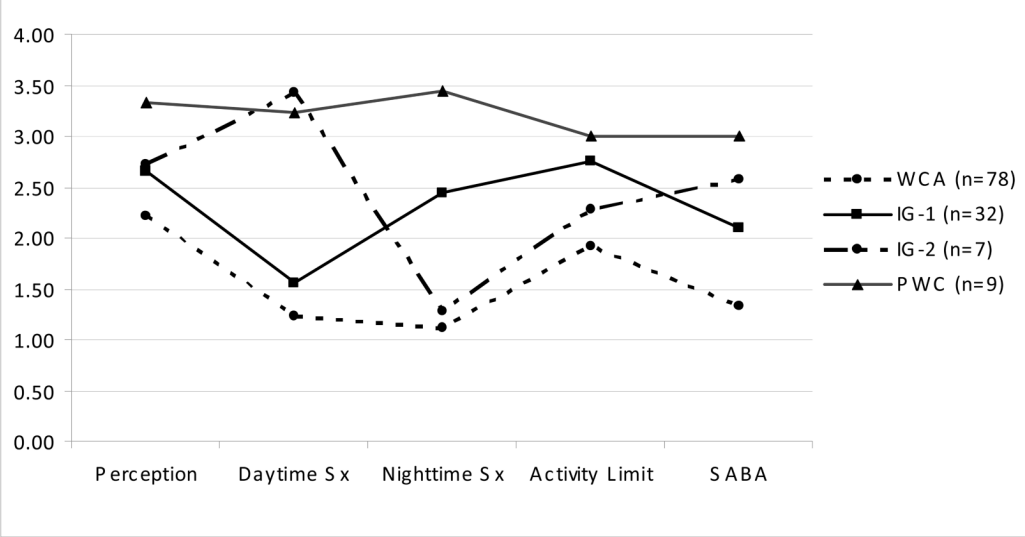

Figure 1. Group Patterns by Asthma Control Variables

Notes: - WCA Well-Controlled Accurate Group; IG-1 Inaccurate Group-1; IG-2 Inaccurate Group-2

- PWC Poorly-Controlled Accurate Group; SABA Short Acting Beta Agonist; Sx Symptoms

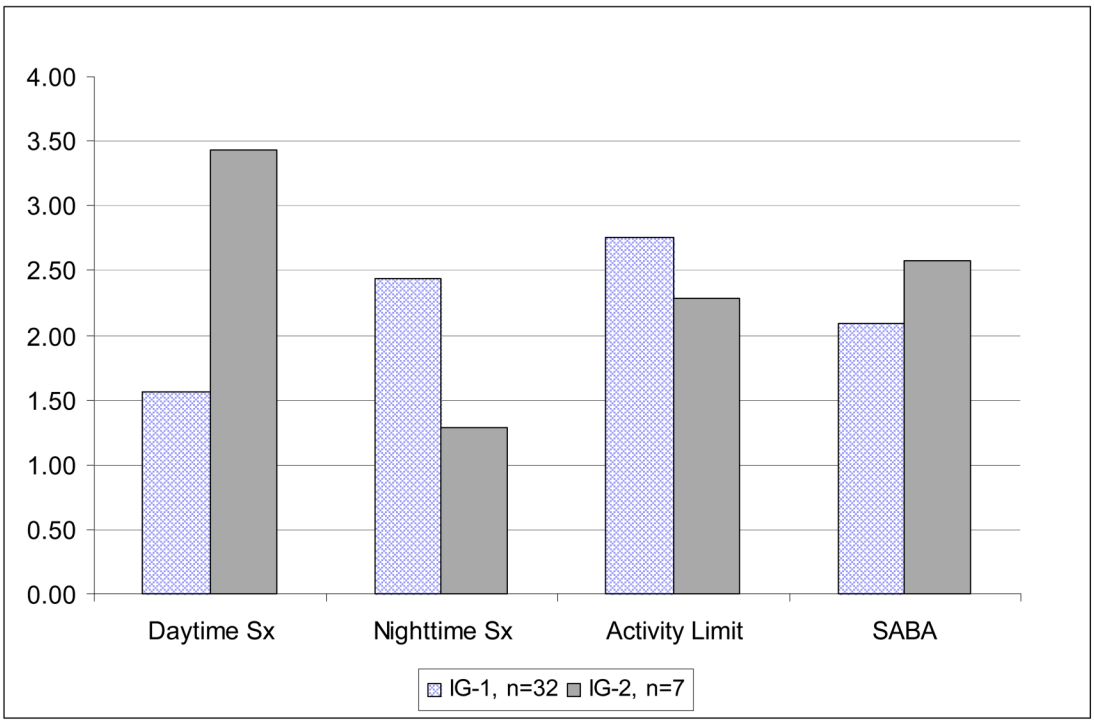

Figure 2. Comparison between Two Inaccurate Perception Groups
Notes: IG-1 Inaccurate Group-1; IG-2 Inaccurate Group-2; SABA Short Acting Beta Agonist

Table 1
Sociodemographic Characteristics of the Sample (N=126)

Age		
	Range	13– 21 years (mean = 15.5, SD = 1.7)
Gender		
	Female	n = 75 (59.5%)
	Male	n = 51 (40.5%)
Race/Ethnicity		
	White	n = 62 (49.2%)
	Black	n = 40 (31.7%)
	Hispanic	n = 14 (11.1%)
	Asian	n = 2 (1.6%)
	Biracial/Multiracial	n = 8 (6.3%)
Gross annual family Income		
	≤$29,000	n = 51 (40.5%)
	$30,000–$69,000	n = 32 (25.4%)
	≥$70,000	n = 43 (34.1%)
Health Insurance Type		
	Public	n = 58 (46%)
	Private	n = 65 (51.6%)
	None	n = 3 (3.4%)
Parental education		
	Range	8–20 (mean = 14.3, SD = 2.9)

Table 2

Means of Symptom Control for Variables for Each Class

	WCA n=78 Mean	SD	IG-1 n=32 Mean	SD	IG-2 n=7 Mean	SD	PCA n=9 Mean	SD	Overall F	Group difference
How would rate your asthma control	2.21	0.65	2.66	0.70	2.71	0.76	3.33	0.87	9.56	a,c.e
How often did your asthma symptoms wake you up at night	1.12	0.32	2.44	0.56	1.29	0.49	3.44	0.53	136.23	a,c,d,e.f
How much did your asthma keep you from doing things at school, home or work	1.92	0.70	2.75	0.67	2.29	0.95	3.00	0.50	14.73	a,c
In an average week, how often do you have asthma symptoms	1.23	0.42	1.56	0.50	3.43	0.53	3.22	0.67	86.96	a,b,c,d,e
In an average week, how often did you use your short relief medication	1.33	0.57	2.09	0.78	2.57	0.79	3.00	0.71	28.24	a.b,c,e

Notes: - WCA Well-Controlled Accurate Group; IG Inaccurate Group; PWC Poorly-Controlled Accurate Group

- a=WCA vs. IG-1; b=WCA vs. IG-2; c=WCA vs. PCA; d=IG-1 vs. IG-2; e=IG-1 vs. PCA; f=IG-2 vs. PCA

Table 3

Means of Psychosocial Factors in Three Groups

	WCA (n=78)		IG (n=39)		PCA (n=9)				
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**F**	**P**	**Group difference**
Asthma Knowledge	23.87	2.42	22.28	3.56	23.78	3.87	3.96	.02	a
Attitude Toward Asthma	46.82	7.67	38.53	6.38	37.44	7.83	20.11	<.0001	a, b
Illness Management	60.19	12.22	66.10	12.58	65.89	16.28	3.21	.04	a
Asthma Self-efficacy	51.57	8.44	51.68	10.06	52.31	9.45	0.03	.97	
Quality of Life									
Activity	28.18	4.99	24.49	7.34	17.67	6.60	15.34	<.001	a, b, c
Emotional Function	50.47	6.32	38.87	13.83	33.78	8.61	27.41	<.001	a, b
Symptoms	59.37	8.18	41.08	15.28	29.22	9.72	56.29	<.001	a, b, c

Notes: - WCA Well-Controlled Accurate Group; IG Inaccurate Group; PWC Poorly-Controlled Accurate Group

- a=WCA vs. IG; b=WCA vs. PCA; c=IG vs PCA