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Under-recognition of childhood asthma in Singapore: evidence from a questionnaire survey

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Summary In a recent study on the prevalence of childhood asthma and allergies using the International Study of Asthma and Allergies in Childhood (ISAAC) questionnaires, 6238 Singapore school children in two age-groups, 6–7 years ($n = 2030$) and 12–15 years ($n = 4208$), were evaluated. Of the 1856 children who reported asthma-like symptoms (wheezing, exercise-wheezing, persistent nocturnal cough), 919 (49%) had not been diagnosed asthmatic. Of these undiagnosed children, 731 (39%) reported current symptoms of asthma. Under-recognition of asthma was more prevalent among those with persistent nocturnal cough and mild symptoms. In addition, the discordance between wheezing in the last 12 months and a diagnosis of asthma was significantly higher among the younger age-group (6–7 years), but exercise-induced wheezing was less recognized as a symptom of asthma among the older age-group (12–15 years). This study has shown that there is a substantial degree of under-recognition of asthma among school children in Singapore.

Introduction

In 1993, asthma ranked second after accidents and injuries only as the leading condition in childhood with the highest number of discharges from all hospitals in Singapore.[1] At the general practitioner and government primary health care clinics, this disease ranked second after upper respiratory tract infections as the condition seen most commonly among children under the age of 15 years.[1] Our childhood asthma prevalence figures have also been on the rise over the past 25 years.[2] The economic cost of asthma in Singapore was estimated to be US$36.57 million per annum.[3] This translated to approximately US$257 per asthmatic person per year, or US$12.85 per person per year in Singapore. These figures indicate that asthma is a common cause of childhood morbidity in Singapore and is of increasing concern.

There is evidence to suggest that under-recognition of asthma symptoms in the community may be contributing to asthma morbidity.[4,5] This study therefore aimed to examine the extent of asthma under-recognition in our childhood population. Data from a survey of the prevalence of asthma in children, using the International Study on Asthma and Allergies in Childhood (ISAAC) questionnaire,[2,6] were employed to evaluate the rate of asthma under-recognition.

Methods

The data collection procedures and protocols of a survey carried out between February and November 1994 using the ISAAC written

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questionnaire for asthma have been described previously.[2,6] The survey concentrated on past and current (in the last 12 months) asthma-like symptoms of wheeze, exercise-induced wheezing, persistent cough unrelated to respiratory infections, frequency of wheezing, severity of symptoms which included sleep disturbance and speech limitation during attacks, and a doctor's diagnosis of asthma.

Two age groups of school children (6–7 years, and 12–15 years) were studied. Twenty-one of thirty schools randomly selected from all parts of Singapore consented to participate in the study. The parents of the 6–7-year-olds were the respondents and the 12–15-year-olds completed the questionnaire themselves. The survey was conducted mainly in English (95%) and only a few parents required Malay or Mandarin translations.

Under-recognition of asthma was evaluated and stratified according to demographic factors such as age-group, sex, race and socio-economic status (defined from total family income and type of residence). Asthma under-recognition was defined as a positive response to asthma-like symptoms but a negative response to a medical diagnosis of asthma. Only questions pertaining to current symptoms (in the 12 months prior to the survey) were evaluated. This was because the 12–15-year age group, who themselves completed the questionnaires, were more likely to give accurate responses regarding current rather than cumulative symptoms. The data included responses to the following: (i) had **any asthma-like symptom** (any form of wheeze or nocturnal cough); (ii) had **wheeze**; (iii) had **exercise-induced wheeze**; (iv) had **nocturnal cough** not associated with cold or chest infection; (v) had **severe** (>12 attacks last year, and/or disturbed sleep >1 per week, and/or wheeze limiting speech) asthma symptoms; (vi) had **moderate** asthma symptoms(4–12 attacks in last year, disturbed sleep <1 per week); and (vii) had **mild** asthma symptoms(1–3 attacks in last year).

The operational definition used to define asthma was based on a positive response to the question 'Have you (your child) *ever* had asthma?' This definition was used as it has been validated and shown to be highly specific and moderately sensitive in categorizing true cases of asthma.[7] A positive response to this question was taken to indicate that asthma had been diagnosed previously in the respondent. However, it could not determine whether a negative response in the presence of asthmatic symptoms was a result of the respondent's failure to seek medical attention or the physician's failure to make the diagnosis.

Statistical analysis was carried out by cross-tabulation using the PROC FREQ procedure of the statistical package SAS (version 6.08) for personal computers. The Mantel-Haenszel test was used to evaluate the significance of the estimated relative risk between the groups categorized within each demographic parameter. Further statistical analyses were performed as for cross-sectional data, with the computation of the prevalence rate ratios (PRRs) and 95% confidence intervals (95% CI) via the modified Cox proportional hazard regression model (PROC PHREG procedure) with the assumption of constant risk period. Cox's proportional hazard model was originally developed for estimating instantaneous hazards ratio based on complete or censored longitudinal data with varying follow-up times.[8] Breslow subsequently showed that by assuming or imposing a condition of constant follow-up time, Cox's model could be adopted for the estimation of rate ratios.[9] Thus, in this study, by assuming the constant risk period, the Cox model was adapted to estimate the prevalence rate ratios for cross-sectional data. This multiple regression analysis was employed to control simultaneously for potential confounding factors (demographic and socio-economic factors in particular), and to select variables as significant independent predictors of under-recognition. The use of prevalence rate ratio for cross-sectional data has been discussed in various epidemiology journals.[10,11] The socio-economic variables (total household income and type of housing) were analysed in separate models to avoid problems with collinearity. In addition, missing values and individuals who were not within the two

TABLE I. Demographic and socio-economic profile of the study population

		Age group		
		Overall No. (%)	6–7 years No. (%)	12–15 years No. (%)
Total no. surveyed		6238	2030	4208
Sex	Male	3400 (54.5)	1065 (52.5)	2335 (55.5)
	Female	2813 (45.1)	947 (46.7)	1866 (44.3)
	Sex not stated	25 (0.4)	18 (0.9)	7 (0.2)
Race	Chinese	5004 (80.2)	1722 (84.8)	3282 (78.0)
	Malay	790 (12.7)	185 (9.1)	605 (14.4)
	Indian	283 (4.5)	68 (3.3)	215 (5.1)
	Other/not stated	161 (2.6)	55 (2.7)	106 (2.5)
Housing	Public housing	4650 (74.5)	1239 (61.0)	3411 (81.1)
	Private condominium	595 (9.5)	276 (13.6)	319 (7.6)
	Landed house	815 (13.1)	435 (21.4)	380 (9.0)
	Not stated	178 (2.9)	80 (3.9)	98 (2.3)
Total family income	< S$1000/month	249 (4.0)	130 (6.4)	119 (2.8)
	S$1000–< 2000/month	790 (12.7)	403 (19.9)	387 (9.2)
	S$2000–4000/month	878 (14.1)	485 (23.9)	393 (9.3)
	> S$4000/month	974 (15.6)	760 (37.4)	214 (5.1)
	Not stated	3347 (53.7)	252 (12.4)	3095 (73.6)

age-groups (6–7 and 12–15 years) or the three main ethnic groups in Singapore (Chinese, Malay, Indian) were excluded from analysis.

Results

Study population

There were 6238 responders, with a response rate of approximately 90%. The demographic profile and socio-economic categories of respondents are shown in Table I. A large proportion (74%) of the 12–15-years respondents did not state family income (because they completed the questionnaire themselves). Other responses excluded from analysis included 63 with invalid or missing ages, and those with inconsistent answers to stem questions ($n = 218$), resulting in 6020 valid responses for asthma.

Bivariate comparisons of under-recognition

Discordance between current (in the past 12 months) asthma-like symptoms (wheezing, wheezing with exercise or persistent nocturnal cough) and diagnosed asthma was 51% (731/1423) (Table II). Approximately half of the respondents who answered positively to the presence of at least one asthma-like symptom (wheezing, nocturnal cough, exercise wheezing) were not diagnosed with asthma. In contrast, only 22% (267/1204) of those who stated they had asthma did not respond positively to any of the asthma symptoms (data not shown).

Discordance between wheezing in the last 12 months and a diagnosis of asthma was significantly higher in the younger age-group ($p < 0.05$) and higher socio-economic groups ($p < 0.05$) (Tables II & III). Other factors such as gender and ethnic origin did not influence the rate of under-recognition. Exercise-induced wheezing was less recognized as a symptom of asthma in the older age-group ($p < 0.001$). In addition, nocturnal cough was more likely to be under-recognized as a symptom of asthma compared with wheezing or exercise-induced wheezing (Table IV). Those with mild symptoms had a higher degree of under-recognition than current severe asth-

TABLE II. Asthma under-recognition stratified by demographic factors

Symptoms in last 12 months		Overall No. (%)	Age group 6–7 years No. (%)	Age group 12–15 years No. (%)	Sex Male No. (%)	Sex Female No. (%)	Ethnic group Chinese No. (%)	Ethnic group Malay No. (%)	Ethnic group Indian No. (%)
Type of symptoms									
Asthma-like symptoms not diagnosed as asthma	Discordance	731 (51.4)	236 (48.9)	495 (52.7)	428 (50.8)	302 (52.2)	587 (51.7)	92 (48.4)	27 (45.8)
	Concordance	692 (48.6)	247 (51.1)	445 (47.3)	414 (49.2)	277 (47.8)	549 (48.3)	98 (51.6)	32 (54.2)
Wheezed last 12 months not diagnosed as asthma	Discordance	240 (33.2)	118 (37.3)	122 (30.0)	149 (34.7)	90 (30.8)	201 (33.8)	22 (29.3)	9 (25.0)
	Concordance	483 (66.8)	198 (62.7)	285 (70.0)	281 (65.3)	202 (69.2)	393 (66.2)	53 (70.7)	27 (75.0)
Exercise-induced wheezing not diagnosed as asthma	Discordance	309 (44.1)	49 (30.4)	260 (48.1)	182 (43.4)	127 (45.2)	248 (43.9)	38 (44.2)	13 (39.4)
	Concordance	392 (55.9)	112 (69.6)	280 (51.9)	237 (56.6)	154 (54.8)	317 (56.1)	48 (55.8)	20 (60.6)
Nocturnal cough not diagnosed as asthma	Discordance	400 (53.1)	148 (51.7)	252 (53.8)	227 (51.6)	172 (55.0)	313 (54.1)	58 (50.4)	15 (38.5)
	Concordance	354 (46.9)	138 (48.3)	216 (46.2)	213 (48.4)	141 (45.0)	266 (45.9)	57 (49.6)	24 (61.5)
Severity of symptoms									
Severe† asthma, symptoms not diagnosed as asthma	Discordance	57 (30.2)	17 (30.4)	40 (30.1)	36 (29.8)	21 (30.9)	42 (32.1)	7 (20.6)	6 (31.6)
	Concordance	132 (69.8)	39 (69.6)	93 (69.9)	85 (70.2)	47 (69.1)	89 (67.9)	27 (79.4)	13 (68.4)
Moderate† asthma, symptoms not diagnosed as asthma	Discordance	51 (25.0)	31 (29.0)	20 (20.6)	31 (28.4)	20 (21.1)	44 (25.4)	4 (23.5)	1 (12.5)
	Concordance	153 (75.0)	76 (71.0)	77 (79.4)	78 (71.6)	75 (78.9)	129 (74.6)	13 (76.5)	7 (87.5)
Mild† asthma symptoms not diagnosed as asthma	Discordance	132 (40.0)	70 (45.8)	62 (35.0)	82 (41.0)	49 (38.0)	115 (39.7)	11 (45.8)	2 (22.2)
	Concordance	198 (60.0)	83 (54.2)	115 (65.0)	118 (59.0)	80 (62.0)	175 (60.3)	13 (54.2)	7 (77.8)

Discordance = positive responses to the symptoms but negative responses to the diagnosis.
Concordance = positive responses to both the symptoms and diagnosis;
† Severity of asthma: **severe** (> 12 attacks last year and/or disturbed sleep > 1 per week and/or wheeze-limited speech); **moderate** (4–12 attacks in last year, disturbed sleep < 1 per week); and **mild** (1–3 attacks in last year).

TABLE III. Asthma under-recognition stratified by socio-economic factors

Symptoms in last 12 months		Overall No. (%)	Type of housing: Public housing No. (%)	Type of housing: Private condos No. (%)	Type of housing: Landed house No. (%)	Total family income: < S$2000 /mth No. (%)	Total family income: S$2000–4000/mth No. (%)	Total family income: > S$4000 /mth No. (%)
Type of symptoms								
Asthma-like symptoms not diagnosed as asthma	Discordance	731 (51.4)	538 (53.4)	85 (54.1)	94 (41.4)	109 (51.4)	100 (51.5)	127 (44.6)
	Concordance	692 (48.6)	469 (46.6)	72 (45.9)	133 (58.6)	103 (48.6)	94 (48.5)	158 (55.4)
Wheezed last 12 months not diagnosed as asthma	Discordance	240 (33.2)	151 (33.1)	36 (37.9)	47 (30.5)	27 (29.0)	36 (32.1)	69 (35.6)
	Concordance	483 (66.8)	305 (66.9)	59 (62.1)	107 (69.5)	66 (71.0)	76 (67.9)	125 (64.4)
Exercise-induced wheezing not diagnosed as asthma	Discordance	309 (44.1)	242 (46.8)	32 (44.4)	31 (31.3)	42 (42.0)	40 (47.1)	35 (30.4)
	Concordance	392 (55.9)	275 (53.2)	40 (55.6)	68 (68.7)	58 (58.0)	45 (52.9)	80 (69.6)
Nocturnal cough not diagnosed as asthma	Discordance	400 (53.1)	300 (55.0)	43 (53.1)	48 (45.3)	68 (54.0)	55 (50.5)	72 (46.2)
	Concordance	354 (46.9)	245 (45.0)	38 (46.9)	58 (54.7)	58 (46.0)	54 (49.5)	84 (53.8)
Severity of symptoms								
Severe† asthma symptoms not diagnosed as asthma	Discordance	57 (30.2)	48 (34.8)	2 (11.1)	6 (21.4)	7 (25.9)	14 (42.4)	6 (23.1)
	Concordance	132 (69.8)	90 (65.2)	16 (88.9)	22 (78.6)	20 (74.1)	19 (57.6)	20 (76.9)
Moderate† asthma symptoms not diagnosed as asthma	Discordance	51 (25.0)	34 (25.8)	7 (30.4)	10 (22.7)	5 (16.7)	7 (20.6)	19 (29.7)
	Concordance	153 (75.0)	98 (74.2)	16 (69.6)	34 (77.3)	25 (83.3)	27 (79.4)	45 (70.3)
Mild† asthma symptoms not diagnosed as asthma	Discordance	132 (40.0)	69 (37.1)	27 (50.0)	31 (37.8)	15 (41.7)	15 (33.3)	44 (42.3)
	Concordance	198 (60.0)	117 (62.9)	27 (50.0)	51 (62.2)	21 (58.3)	30 (66.7)	60 (57.7)

Discordance = positive responses to the symptoms but negative responses to the diagnosis.
Concordance = positive responses to both symptoms and diagnosis.
† Severity of asthma: **severe** (> 12 attacks last year and/or disturbed sleep > 1 per week and/or wheeze-limited speech); **moderate** (4–12 attacks in last year, disturbed sleep < 1 per week); and **mild** (1–3 attacks in last year).

TABLE IV. Under-recognition based on type and severity of symptoms

Symptoms and severity	Prevalence rate ratio	95% confidence interval	χ^2 value (p-value)
Type of symptom (last 12 mth)			
Wheezing	1	—	$\chi^2 = 59.29$
Exercise-induced wheezing	1.59	1.27–1.98	($p < 0.001$)
Nocturnal coughing	2.27	1.83–2.82	
*Severity of symptom**			
Severe	1	—	$\chi^2 = 13.85$
Moderate	0.77	0.48–1.23	($p < 0.001$)
Mild	1.54	1.04–2.30	

*Severity of asthma: **severe** (> 12 attacks last year and/or disturbed sleep > 1 per week and/or wheeze limiting speech); **moderate** (4–12 attacks in last year, disturbed sleep < 1 per week); and **mild** (1–3 attacks in last year).

matics (Table IV). However, asthma was under-recognized in 30% of those with severe symptoms (> 12 attacks last year, and/or disturbed sleep > 1 per week, and/or wheeze-limited speech).

Multiple regression analysis

To evaluate the effects of each variable (age, sex, race, socio-economic status and severity of symptoms) on under-recognition rate of asthma, multivariate regression analysis was carried out (Tables V & VI). This analysis confirmed that under-recognition of asthma was more prevalent among the 6–7-year age group (with the exception of exercise-induced wheezing) and the higher socio-economic groups. However, the 12–15-year-olds were more likely to under-recognize exercise-induced wheezing as a symptom of asthma. In addition, the influence of socio-economic factors on the rate of wheeze under-recognition was observed to have been confounded by the severity of symptoms as their corresponding prevalence rates ratios were reduced with the inclusion of a variable indicating severity of symptoms into the model (not shown in the table). Wheezing was found to be more common in the higher socio-economic groups but the lower income group experienced greater severity.

Discussion

This study demonstrated a substantial degree of under-recognition of asthma amongst school children in Singapore. Approximately half of those who reported asthma-like symptoms had not been diagnosed as asthmatic.

Our previous data showed that the prevalence of wheezing was higher in the higher socio-economic groups but the lower income group experienced more severe disease.[2] In this study, the data suggested that under-recognition of wheezing as a symptom of asthma occurred more frequently among the higher socio-economic groups. This, however, was confounded to some extent by the disease severity. Elsewhere, the association between asthma recognition and social status has been attributed to differences in access to health care.[12] However, this is unlikely in Singapore where health care is highly subsidized and a greater proportion of the lower compared with upper income group were found to use health care resources (i.e. hospitalization and outpatient treatment) for asthma.[1,3] Asthma awareness may play a greater role in influencing asthma recognition. In addition, a previous study noted that Malays and Indians were less inclined to seek medical attention for asthma symptoms.[13] Together with the older generation of Chinese, they had a tendency to seek traditional treatment.[14] Our results, however, did not show any difference in the degree of

TABLE V. Influence of demographic factors on under-recognition of asthma in Singapore school children analysed by modified Cox's proportional hazards models

Dependent variable	Age group 6–7 years	Sex Male	Ethnic group Malay	Ethnic group Indian
	Adjusted prevalence rate ratios (95% confidence intervals) and p-value†			
Asthma-like symptoms for last 12 months but not diagnosed as asthma	NS	NS	NS	NS
Wheezed in last 12 months but not diagnosed as asthma	1.39 (1.21–1.59)**	1.18 (1.03–1.35)*	NS	NS
Exercise-induced wheezing in last 12 months but not diagnosed as asthma	0.69 (0.57–0.84)**	NS	NS	NS
Nocturnal cough last 12 months but not diagnosed as asthma	NS	NS	NS	NS
‡Severe asthma symptoms but not diagnosed as asthma	NS	NS	NS	NS

† Reference categories for age-group = 12–15-year-olds, sex = female, ethnic group = Chinese; ** $p < 0.001$; * $p < 0.01$; NS: not significant.
‡ Severity of asthma: **severe** (> 12 attacks last year and/or disturbed sleep > 1 per week and/or wheeze-limited speech).

asthma under-recognition between the three main races in Singapore.

In this study, it was noted that persistent nocturnal cough was more likely to be under-recognized as a symptom of asthma compared with wheezing and exercise-induced wheezing. This may be because in many cases persistent cough may be ascribed to respiratory tract infections by parents and physicians alike. Although this survey did not evaluate under-treatment of asthma, a local study revealed that use of cough mixtures and antibiotics for childhood asthma by private practitioners is prevalent, indicating that childhood asthma is under-treated in our community.[15] This is of considerable concern as under-treatment of asthma is a major factor contributing to morbidity and mortality.[16,17]

Under-recognition of asthma has been observed in other communities also.[4,5,18] In the United Kingdom, under-diagnosis and treatment was most pronounced in children from ethnic minority groups.[19] A study from Australia reported that only 60% of symptomatic children were labelled asthmatic, and only 20% were using appropriate asthma treatment.[5] When more stringent criteria were used for evaluation (> 12 wheezing attacks/year or sleep disturbed on an average of one or more nights per week due to wheezing), our data demonstrated that more than 30% were not diagnosed asthmatic. These results underline the fact that a disturbingly large proportion of asthmatics are undiagnosed and are therefore unlikely to have received appropriate treatment. On a more optimistic note, however, it is encouraging to note a trend towards increasing recognition of asthma; in 1989 the label of 'asthma' was used in 52% of subjects with wheeze compared with only 21% in 1964.[20] Although this study has shown that asthma is under-recognized amongst school children in Singapore, it has been shown previously that further development of asthma education and increased medical and public awareness are an important means to address this issue.

TABLE VI. Influence of socio-economic factors on under-recognition of asthma in Singapore school children analysed by modified Cox's proportional hazards models

		Type of housing		Total family income	
	Model #*	Private condos	Landed house	S$2000–4000/month	> S$4000/month
Dependent variable		Adjusted prevalence rate ratios (95% confidence intervals) and p-value†			
Asthma-like symptoms in last 12 months but not diagnosed as asthma	Model #1	NS	0.82 (0.71–0.94)**	—	—
	Model #2	—	—	NS	NS
Wheezed in last 12 months but not diagnosed as asthma	Model #1	1.37 (1.15–1.64)***	NS	—	—
	Model #2	—	—	NS	1.71 (1.36–2.15)***
Exercise-induced wheezing in last 12 months but not diagnosed as asthma	Model #1	NS	NS	—	—
	Model #2	—	—	NS	NS
Nocturnal cough in last 12 month but not diagnosed as asthma	Model #1	NS	NS	—	—
	Model #2	—	—	NS	NS
‡Severe asthma symptoms but not diagnosed as asthma	Model #1	0.51 (0.27–0.94)*	NS	—	—
	Model #2	—	—	NS	NS

* Model #: the influence of socio-economic factors were analysed separately to avoid problems associated with colinearity. Model 1: analyses for the influence of age, sex, race and type of housing. Model 2: analyses for the influence of age, sex, race and total monthly family income.

† Reference categories for type of housing = public housing (Housing Development Board flats), total monthly family income = less than S$2,000 per month. ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$; NS: not significant.

‡ Severity of asthma: **severe** (> 12 attacks last year and/or disturbed sleep > 1 per week and/or wheeze-limited speech).

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