Validation of a new asthma screening questionnaire

Walidacja kwestionariusza przesiewowego astmy oskrzelowej

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Wstęp. Dane epidemiologiczne na temat częstości występowania astmy oskrzelowej wieku dziecięcego uzasadniają potrzebę opracowania i wdrożenia skutecznych populacyjnych badań przesiewowych, z wykorzystaniem kwestionariuszy. Istniejące standaryzowane kwestionariusze dotyczące stanu układu oddechowego służą głównie celom naukowym. Uzasadnione jest opracowanie krótkiego kwestionariusza, spełniającego kryteria zwalidowanego testu przesiewowego astmy wieku dziecięcego.

Cel badania. Walidacja nowo opracowanego kwestionariusza skriningowego.

Materiał i metody. Analizie poddano dane pochodzące z badania przekrojowego, dotyczącego stanu układu oddechowego i obejmującego 6420 dzieci (wiek: 6-16 lat) zamieszkałych w Bielsku-Białej, Cieszynie i Żywcu. Na podstawie wyniku analizy trafności pytań o objawy ze strony układu oddechowego skonstruowany został przesiewowy kwestionariusz, poddany następnie ocenie powtarzalności odpowiedzi i trafności diagnostycznej (bezpośrednie lekarskie rozpoznanie astmy jako „złoty standard"), uwzględniającej trzy sposoby klasyfikowania choroby.

Wyniki. W badaniu przekrojowym największą czułością charakteryzuje się objaw świszczącego oddechu występującego kiedykolwiek (86,6%) oraz kombinacja świszczącego oddechu, napadów duszności i objawów kaszlu (57,1%). W badaniu przesiewowym najlepszą trafnością odznacza się scenariusz 2. Ocena zgodności rozpoznania astmy (kwestionariusz-bezpośrednia diagnoza lekarska) wskazuje na umiarkowaną zgodność w przypadku scenariusza pierwszego (PABAK: 0,46) oraz dobrą zgodność w przypadku scenariusza drugiego i trzeciego (PABAK: odpowiednio 0,65 i 0,63).

Wnioski. Opracowany, krótki kwestionariusz przesiewowy odznacza się dobrą powtarzalnością oraz trafnością, co uzasadnia możliwość wykorzystania go w badaniach przesiewowych astmy wieku dziecięcego.

Słowa kluczowe: *astma, kwestionariusz, skrining, dzieci*

Introduction. Epidemiological evidence on the prevalence of childhood asthma justifies implementation of effective population-based screening programs. Standard asthma questionnaires (i.e. ISAAC), however, have been developed to address research-oriented goals. There is a need for short questionnaires.

Aim. Validation of a new asthma screening questionnaire.

Material & methods. The analysis involved data obtained from a cross-sectional study on respiratory health of 6420 children (age: 6-16 years) living in Bielsko-Biała, Cieszyn and Żywiec (Poland). The diagnostic accuracy was examined according to the questionnaire-derived data on asthma diagnosis ("gold standard" of asthma). Based on the results of validation procedures a short screening questionnaire was designed and examined for repeatability and diagnostic accuracy according to three scenarios.

Results. In the cross-sectional study the largest sensitivity was shown in relation to symptoms of wheeze ever (86.6%), combination of wheeze, dyspnea and cough symptoms (57.1%). In the screening, Scenario 2 provided the best diagnostic accuracy. The assessment of the agreement between screening questionnaire and medical diagnosis revealed a moderate agreement in case of Scenario 1 (PABAK: 0.46) and good agreement in case of Scenarios 2 and 3 (PABAK: 0.65 and 0.63, respectively).

Conclusions. The designed and validated short screening questionnaire has a good repeatability and accuracy, thus it could be applied in childhood asthma population-based screening programs.

Key words: *asthma, questionnaire, screening, children*

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Nadesłano: 15.08.2012
Zakwalifikowano do druku: 31.10.2012

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Introduction

Childhood asthma affects 5-30% of children's population worldwide [1]. The results of recent epidemiologic studies on respiratory health among children living in Żywiec, Bielsko-Biała and Cieszyn (south Poland) show that the frequency of asthma is 4.1%, 5.0% and 6.2%, respectively [2]. The scope of the problem is also indicated by an increasing incidence of asthma; the percentage of new cases has been doubling every 10-15 years for the past several decades [3]. It justifies treating asthma as a priority issue of public health care [4-6]. In the report entitled

"WHO Strategy for Prevention and Control of Chronic Diseases" the World Health Organization stresses the need of developing screening tests based on the results of validated epidemiologic studies [6].

The reports concerning prevalence and frequency of bronchospastic symptoms occurrence, and the opinions expressed by various expert groups justify the need of designing and implementing effective prevention programs. One of the conditions for implementing an effective prevention program is the availability of a reliable screening test. In the case of asthma, a standard questionnaire is applied as a screening test [1, 7]. The available standardized questionnaires, used for scientific studies of childhood asthma are complex and time-consuming [1]. Thus, they do not fulfill the criteria of suitability for a screening test. Moreover, in Poland there is no screening program for childhood asthma, with a short questionnaire to identify children suspected of the disease. Under these circumstances, an attempt to develop a new shortened and suitably validated questionnaire for asthma screening population studies seemed fully justified.

Material and methods

The study was conducted in three stages. In the first one, we analyzed data from a large epidemiologic survey (conducted in 2003) of a group of 6420 children living in Żywiec, Cieszyn and Bielsko-Biała (south Poland). A short screening questionnaire was developed based on the accuracy analysis of single and complex respiratory symptoms. The accuracy assessment included the following single respiratory symptoms and diseases: morning cough, daytime cough in winter and fall, chronic cough (lasting longer than 3 months), dry nighttime cough within the last 12 months, sputum-productive cough, wheezing ever and within the last 12 months, waking up at night due to wheezing within the last 12 months, dyspnea ever and within the last 12 months and asthmatic/spastic bronchitis. The accuracy assessment for complex respiratory symptoms included combinations of the above-listed single symptoms.

Based on the results of validation procedures a short screening questionnaire was designed (the second stage of the study). A screening survey was carried out among all children living in Sławków and attending first, second and third grade of the Jan Baranowski Memorial Elementary School (n=146). A questionnaire was filled in by the parents of children.

In the final stage of the study the developed screening questionnaire was validated using direct clinical verification of asthma that had been declared in the questionnaire (assessment of repeatability and diagnostic accuracy).

In the first stage the accuracy of single and complex respiratory symptoms was determined from sensitivity, specificity and predictive value (positive as well as negative), using a standard validation scheme for a screening test [8]. A physician-diagnosed bronchial asthma, annotated in the cross-sectional questionnaire, was the "gold standard" (disease +/-). Additionally, Youden's index was calculated.

In the final stage the repeatability and diagnostic accuracy was assessed. The repeatability of questionnaire-derived data was examined by distributing the screening questionnaire twice. The repeatability was assessed based on the percentage ratio of consistent answers to the same questions in both survey rounds and on calculating kappa statistics. Due to the fact that the values of kappa statistics depend on the frequency of disease or frequency of analyzed cases, as well as on systematic error, the analyses took into account these two interfering factors by calculating the so-called frequency index, the measure of systematic error, as well as the so-called prevalence-adjusted bias-adjusted kappa statistics (PABAK) [9-11].

Asthma occurrence declared in the screening questionnaire was verified by two independent pediatricians from the Independent Public Health Care Institution in Sławków. The pediatricians invited to cooperate received a list of names of children whose parents completed the screening questionnaire. The results obtained during this phase of the study (screening questionnaire) were not known to the pediatricians, who were not in contact with the research team during the clinical review. It was only established that clinical verification of asthma would be conducted on the basis of available medical records and test results (at the discretion of physicians) and would encompass three diagnostic categories: "asthma present", "asthma probable", "no asthma". The assessment of diagnostic accuracy (direct medical diagnosis of asthma as a "gold standard") took into consideration three ways of classifying the disease: Scenario 1: "asthma + probable asthma" category contrasted to "no asthma" category; Scenario 2: "asthma" category contrasted to "no asthma + probable asthma" category; Scenario 3: "asthma" category contrasted to "no asthma" category.

Figure 1 shows the scheme of tasks undertaken to implement the study goals. It also shows the order of undertaking the individual tasks ("flow chart").

Results

The cross-sectional study encompassed 6420 children (49.2% boys and 50.6% girls) aged 6-16 living in Żywiec, Cieszyn and Bielsko-Biała; 322 asthma cases were revealed (5.0%). Table I shows

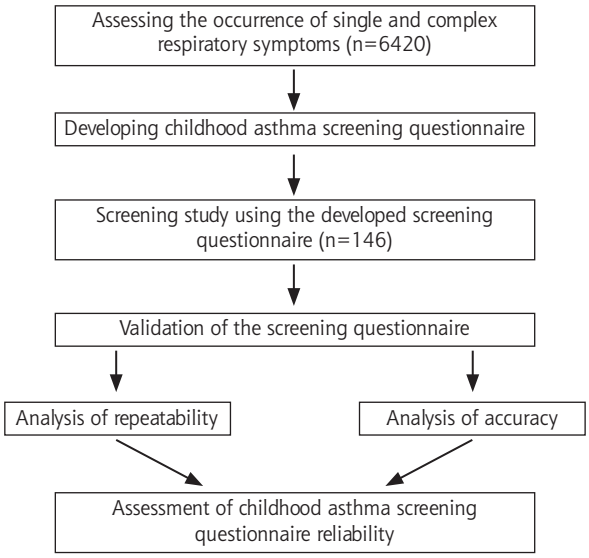

Fig 1. Scheme of population-based screening study

accuracy analysis results of simple respiratory symptoms.

The most sensitive symptom in the accuracy analysis was that of wheezing ever (86.6%), as well as asthmatic or spastic bronchitis ever diagnosed by a physician (73.9%). The highest values of Youden's index were noted for wheezing ever (0.71), dyspnea ever (0.60) and for wheezing in the last 12 months (0.49), as well as asthmatic or spastic bronchitis diagnosed ever by a physician (0.49). Table II presents the results of accuracy analysis of complex respiratory symptoms.

In the case of complex respiratory symptoms the greatest sensitivity (57.1%) was found for combinations of three symptoms: wheezing, dyspnea and cough.

Considering the accuracy results obtained for particular respiratory symptoms the following ones were qualified to be included in the short screening questionnaire:

- wheezing ever
- wheezing occurring within the last 12 months
- dyspnea ever
- dyspnea within the last 12 months
- winter/fall cough (except for seasonal common cold periods)
- cough for at least 3 months during winter/fall
- dry cough within the last 12 months
- spastic or asthmatic bronchitis.

182 children were invited to the screening test. The screening survey involved 146 parents of first-, second- and third-graders (response rate = 80,2%). The studied group included 72 boys (49.3%) and 74 girls (50.7%). Wheezing ever and dyspnea ever (31.0% and 21. 2%, respectively) as well as winter/fall cough (20.5%) were the most frequently occurring respiratory symptoms. Asthma affected 14.5% of the investigated children. The repeatability of the questionnaire was assessed by resending the same form to the parents of the participating children two weeks after collecting the first-round forms. The repeated study involved 62 children (31 boys and 31 girls). The agreement between data originating from the first and the second round of study was assessed based on the percentage ratio of compatible answers and on kappa statistics value. The repeatability of answers (compatibility percentage) concerning respiratory health varied between 80.6% and 91.9%. The highest percentage ratio of compatible answers was noted for the question concerning asthmatic or spastic bronchitis diagnosed ever by a physician (91.9% of compatible answers) and for the question concerning symptoms of dyspnea ever (90.3% of compatible answers). The lowest percentage ratios of compatible answers were noted for questions concerning the symptoms of dry cough during the last 12 months, winter/fall cough, as well as asthma diagnosed ever by a physician (80.6%; 82.8%; 82.2% of compatible answers, respectively). The value of kappa statistics varied from 0.14 to 0.70. Only three

Table I. Simple respiratory symptoms accuracy – results of the cross-sectional analysis of 6420 children

Respiratory symptom/disease	Sensitivity %	Specificity %	Positive predictive value %	Negative predictive value %	Youden Index
Morning cough	62,4	77,8	12,8	97,5	0,44
Daily winter/fall cough	62,5	80,2	14,3	97,5	0,42
Cough during 3 months (chronic cough)	40,8	93,1	24,0	96,7	0,32
Dry cough in the last12 months	53,7	88,5	19,8	97,3	0,42
Wheezing ever	86,6	84,3	22,6	99,1	0,71
Wheezing in the last 12 months	56,8	93,6	32,3	97,6	0,49
Night awakening cause of wheezing in the last 12 months	35,0	97,5	42,6	96,5	0,32
Wheezing during or after exercises in the last 12 months	41,5	96,6	39,5	96,9	0,38
Dyspnea ever	64,7	95,3	42,1	98,0	0,60
Dyspnea in the last 12 months	38,1	98,0	50,6	96,7	0,36
Cough with sputum	33,0	95,3	27,1	96,4	0,28
Asthmatic or spastic bronchitis (ever)	73,9	93,4	37,3	98,7	0,49
Mother's asthma (ever)	8,4	97,9	17,6	95,3	0,06
Father's asthma (ever)	8,8	97,7	16,8	95,3	0,06

questions, i.e. concerning wheezing ever, dyspnea ever and spastic or asthmatic bronchitis diagnosed ever by a physician were characterized by a good agreement of answers. A moderately good compatibility of answers was noted for the question concerning wheezing that occurred within the past 12 months.

In order to confirm or to exclude asthma diagnosis, the questionnaire-derived data were verified by independent pediatricians. The verification results showed the frequency of asthma occurrence to be 8.7%. Asthma was suspected in 12.3% of the investigated children.

The results of assessing the accuracy of the screening questionnaire with respect to the first Scenario showed that the greatest sensitivity and the highest Youden's index was characteristic for wheezing ever (sensitivity=69.0%; Youden's index=0.47). High sensitivity and high Youden's index were next obtained in the case of dyspnea ever (sensitivity=55.2%, Youden's index=0.42) and spastic or asthmatic bronchitis (sensitivity=44.8%; Youden's index=0.35). For complex symptoms the greatest sensitivity (52.9%) was noted for the combination of wheezing, dyspnea and dry cough.

In the case of Scenario 2, the greatest sensitivity was noted for the wheezing ever symptom (91.7%). For this symptom also the Youden's index was found to be high (0.66).

A slightly higher Youden's index was found for dyspnea ever with sensitivity at the 83.3% level. For complex symptoms high sensitivity (above 80%) concerns the combination of wheezing, dyspnea and cough symptoms. For these combinations, high Youden's indexes were also found. For the Scenario 3 the highest sensitivity of single symptoms concerned wheezing and dyspnea ever (91.7% and 83.3%, respectively). Equally high sensitivities were noted for wheezing within the past 12 months (66.7%) and asthmatic or spastic bronchitis (66.7%). The value of Youden's index varied between 0.23 and 0.70 and was the highest in the case of wheezing and dyspnea ever. In complex symptoms, the highest sensitivity and the highest Youden's index were observed for the combination of wheezing, dyspnea and cough symptoms.

The agreement between the questionnaire survey data and medical diagnoses was assessed based on the question about the presence or absence of asthma in a studied child. The screening questionnaire data were compared with medical diagnosis according to the previously adopted scenarios. The percentage ratios of agreeing answers were determined and kappa statistics were calculated. Table III shows the analysis results.

Due to the differences in interpreting the percentage agreement results and kappa values shown

Table II. Complex respiratory symptoms accuracy – results of the cross-sectional analysis of 6420 children

Respiratory symptom/disease	Sensitivity %	Specificity %	Positive predictive value %	Negative predictive value %	Youden Index
Wheezing and dyspnea and cough in winter and fall and chronic cough and dry cough and asthmatic or spastic bronchitis	43,8	98,7	87,5	89,2	0,42
Wheezing in the last 12 months and dyspnea in the last 12 months and winter/fall cough and dry cough and chronic cough and asthmatic or spastic bronchitis	30,8	97,7	66,7	90,5	0,28
Wheezing in the last 12 months or dyspnea in the last 12 months and winter/fall cough or dry cough or chronic cough and asthmatic or spastic bronchitis	52,4	87,9	42,3	91,6	0,40
Wheezing or dyspnea and winter/fall cough or dry cough or chronic cough and asthmatic or spastic bronchitis	57,1	75,0	28,6	90,9	0,32
Wheezing or dyspnea and winter/fall cough or dry cough or chronic cough	57,1	68,3	23,5	90,3	0,25
Winter/fall cough or dry cough or chronic cough	52,4	77,4	28,2	90,6	0,29
Winter/fall cough and dry cough and chronic cough	44,4	97,0	72,7	90,6	0,41
Wheezing or dyspnea	57,1	71,5	25,5	90,7	0,28
Wheezing and dyspnea	52,6	84,6	38,5	90,7	0,37
Wheezing and dyspnea and chronic cough	52,6	96,7	76,9	90,7	0,49
Wheezing and dyspnea and dry cough	50,0	93,2	60,0	90,1	0,43
Wheezing and dyspnea and winter/fall cough	50,0	94,2	64,3	90,0	0,42

Table III. Agreement between answers concerning asthma confirmation by the questionnaire survey and medical examination results

Questions concerning child's health condition	Number of answers n (%)				Agreement percent (%)	Kappa value (95% CI)
	YES/YES	YES/NO	NO/YES	NO/NO		
Scenario 1	6 (4.1)	14 (9.5)	23 (15.7)	94 (64.3)	68.4	0.08 (-0.05-0.27)
Scenario 2	4 (2.7)	16 (10.9)	8 (5.4)	109 (74.6)	77.3	0.15 (-0.002-0.36)
Scenario 3	4 (2.7)	14 (9.5)	8 (5.4)	94 (64.3)	67.0	0.16 (-0.005-0.39)

Scenario 1: "asthma + probable asthma" contrasted to "no asthma"
Scenario 2: "asthma" contrasted to "no asthma + probable asthma"
Scenario 3: "asthma" contrasted to "no asthma"

in Table III, as well as due to the fact that values of kappa statistics depend of the disease frequency and systematic error, further analyses were conducted, taking into account these two interfering factors. Thus, the so-called frequency index, systematic error and PABAK index were calculated. The results for the three Scenarios are shown in Table IV.

Table IV. Values of frequency index, systematic error and adjusted kappa (PABAK) in the assessment of agreement between asthma-confirming answers in the questionnaire survey and medical examination results

Questions concerning child's health condition	Frequency index value	Systematic error value	PABAK value
Scenario 1	0.64	0.66	0.46
Scenario 2	0.76	0.05	0.65
Scenario 3	0.76	0.05	0.63

Scenario 1: "asthma + probable asthma" contrasted to "no asthma"
Scenario 2: "asthma" contrasted to "no asthma + probable asthma"
Scenario 3: "asthma" contrasted to "no asthma"

The results of analysis of adjusted kappa statistics value (PABAK) demonstrated a moderate agreement between answers in the case of Scenario1 and a good agreement between the answers in the case of Scenarios 2 and 3.

Discussions

A short questionnaire concerning key asthma-suggesting symptoms can be a successful tool used in asthma screening tests. The goal of the presented work was to develop such a questionnaire, fulfilling the criteria of a validated screening test. By comparing the accuracy of single and complex symptoms one can state that single symptoms such as wheezing and dyspnea are characterized by higher sensitivity than their various combinations. Analogous observations were made in the Swiss Study on Air Pollution and Lung Diseases in Adults (SAPALDIA), carried out on the group of 17 500 adult inhabitants of Switzerland [12]. The sensitivity of single symptoms in the case of dyspnea was 47.1%, and 74.7% in the case of wheezing. The combination involving "wheezing and dyspnea" showed the sensitivity of 38.4%.The results of analyzing accuracy of questions concerning symptoms from the respiratory system correspond well to the results of similar analyses conducted in numerous epidemiologic studies [12-15]. These studies were based mainly on developing and validating screening survey questionnaires concerning childhood asthma. There is no single model questionnaire which might be used as a standard tool in the childhood asthma screening studies. This may result from diagnostic difficulties as well as from the definition of childhood asthma.

The reliability of a questionnaire survey is reflected in a variety of criteria for the so-called "gold standard". For example, in a screening survey conducted in Great Britain two "gold standard" criteria were adopted, based on a consensus of expert pediatricians [15]. A "gold standard" was considered by the majority of researchers as a positive answer to the question of medically diagnosed asthma ever. In the current study this criterion was also used for selecting the screening questionnaire content. The mentioned criterion is not actually the only proper "gold standard" of test validation. There are no explicit recommendations, however, for using a "gold standard" in this type of study.

In order to develop acceptable validated methods of population-based identification of childhood asthma, several attempts have been undertaken to design a screening questionnaire. Such questionnaires are constructed using mainly basic respiratory symptoms [12-16]. A five-question Brief Pediatric Asthma Screen (BPAS) turned out to be an accurate instrument of this kind [14]. All the questions contained therein have high sensitivity and specificity.; Some of the short questionnaires fit perfectly the health policy programs. For example, an eight-question-containing survey instrument was a part of the NHLBI – CSGA (National Heart, Lung and Blood Institute, Collaborative Studies on the Genetics Asthma) project [17].

The results presented herein appear interesting in the perspective of the demonstrated usefulness of short screening questionnaires. The screening questionnaire developed (Appendix 1) was designed by selecting accurate questions (at the cross-sectional study phase) and this version was subjected to validation. The latter

Appendix 1. Screening Questionnaire

Last and first name of the child .....
Sex of the child: BOY [ ] GIRL [ ]
Date of birth .....
Exact place of the child's domicile (please fill out)
Sreet .....
House number..... Apartment number.....
City/Town.....
5. Has your child ever had wheezing or whistling in the chest at any time in the past? YES [ ] NO [ ]
6. Has your child had wheezing or whistling in the chest in the last 12 months? YES [ ] NO [ ]
7. Has your child ever had dyspnea? YES [ ] NO [ ]
8. Has your child had dyspnea in the last 12 months? YES [ ] NO [ ]
9. Does the child usually cough at daytime (nighttime) during winter or fall (except for seasonal common cold infection periods and respiratory tract infections)? YES [ ] NO [ ]
10. Did the child cough for most of the days for at least three months during the past winter or fall (except for seasonal common cold infection periods and respiratory tract infections)? YES [ ] NO [ ]
11. Has your child had dry cough at nighttime in the last 12 months (except for seasonal common cold infection periods and respiratory tract infections)? YES [ ] NO [ ]
12.Has your child ever had asthmatic, spastic or obstructive bronchitis diagnosed by a physician? YES [ ] NO [ ]
13. Has your child ever had asthma diagnosed by a physican? YES [ ] NO [ ]

Thank you for participating in this survey

included the assessment of repeatability of answers to the screening questions and then the assessment of these questions' accuracy.

In the accuracy assessment we decided to compare the meaning of the screening questionnaire answers with medical diagnoses made by pediatricians involved in day-to-day care of the studied children. It is important to note that this comparison procedure involved "blindness" to the questionnaire-derived data. The accuracy of single and complex respiratory symptoms was calculated on the basis of a child's medical assignment to one of the three groups. The three so-called "gold standards" mentioned earlier were evaluated.

In each Scenario the greatest sensitivity among simple symptoms was shown by wheezing ever (69.0-91.7%), whereas in the case of combined symptoms it was "wheezing, dyspnea and dry cough" (52.9-85.7%). The lowest sensitivity values and lowest Youden's index involved the first Scenario, i.e. "asthma + probable asthma" in contrast to "no asthma" category (0.47). The sensitivity of wheezing symptom was in this case 69.0%, whereas with respect to the complex symptom it was 52.9%, respectively. The two remaining Scenarios (the second: "asthma" in contrast to "no asthma +probable asthma", as well as the third: "asthma" in contrast to "no asthma" category) were characterized by equal sensitivity values for single (91.7%) and combined (85.7%) symptoms.

From the clinical perspective, determination of positive predictive value is as important as determining the test sensitivity. Nonetheless, such a value being dependent on disease frequency is not necessarily a decisive factor of the screening test accuracy. Therefore, in the light of the results obtained herein in terms of screening questionnaire accuracy, Scenario 2 can be considered a useful algorithm to identify children with suspected bronchial asthma. This conclusion is even more justified since the results of assessing the agreement between questionnaire-based asthma diagnosis and medical asthma diagnosis were the best in case of this Scenario, with the compatibility level at 77.3%. The lowest percentage ratio of compatibility (67.0%) was noted for Scenario 3 ("asthma" in contrast to "no asthma" category). The observation that, at relatively high compatibility percentage ratios, the values of kappa statistics were low, appears interesting. The difference found (percentage compatibility – kappa statistics) is not an isolated observation. The value of kappa statistics depends on the prevalence of disease or the prevalence of analyzed cases. If the prevalence index is high, the compatibility percentage is also high and kappa statistics is low [9-11, 18]. The prevalence index in all three discussed Scenarios turns out to be high. This result explains the discrepancy observed in the presented study.

Another kind of interference affecting the value of kappa statistics may stem from the bias index [11]. The size of such index calculated for each of the three Scenarios, shows low value. Because of the revealed potential sources of kappa statistics distortion, an additional standardization procedure for this statistics was used in terms of the prevalence of the investigated occurrence and bias index (prevalence-adjusted bias-adjusted kappa, PABAK) [18]. The results of applying this procedure have shown a moderate answer agreement (0.46) for the first Scenario and a good agreement for both second and third Scenarios (0.65 and 0.63, respectively).

The results of this analysis allow us to conclude that the developed childhood asthma screening questionnaire is acceptable (small size), shows good repeatability and accuracy levels that do not differ from the results of validating similar tools developed elsewhere. Its additional and substantial asset is that it was validated under conditions that characterize a regional children's population. This opinion requires a comment, however, concerning possible drawbacks that might encumber the results obtained. Above all, although the screening study enrolled a relatively small number of subjects, the participation level (80.2% in the first round, pivotal for accuracy assessment) appears satisfactory. In addition this study included most of the children's population 7-10 yrs. living in Sławków. Second, a difference was found between the frequency of asthma reported by the parents and the frequency of asthma diagnosed in direct physical examination. This observation is not surprising, however. Medical diagnosis is a "gold standard", and an additional category such as "probable asthma" helps in interpreting this difference. It needs to be mentioned that, because of financial limitations, not all of the published validation procedures included direct clinical examination. Third, this study did not develop a clinical assessment protocol, leaving to physicians the choice of proper diagnostic method and qualifying a child into one of the three diagnostic groups. This cannot be treated, however, as an element disqualifying the study credibility. The childhood asthma diagnosis has not been universally standardized yet. In turn, the involvement of physicians who have had direct and long-term care of children participating in the study increases the probability of a credible disease diagnosis, to a large extent making reference to the survey-derived data and valuable systematic uninterrupted observation of the study subjects. Lastly,

the physicians involved in clinical assessment of the children's respiratory health did not have access to the questionnaire-derived data.

Conclusions

1. The designed and validated short screening questionnaire has a good repeatability and accuracy.
2. A new developed questionnaire could be applied in childhood asthma population-based screening programs.

Acknowledgements

This study was partially financed from a Ph. D. grant (number N 404 055 31/2821) entitled "Development and reliability assessment of a childhood asthma screening questionnaire" from the Ministry of Science and Higher Education (Poland). The results of this study constitute also a part of the doctoral dissertation (under the same title) of Agata Wypych-Ślusarska and were presented at her doctoral thesis defense. The study results were presented as a poster communication at the Xth Anniversary Scientific Conference and Workshops ("Allergy, Asthma and Immunology Łódź 2010").

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