Asthma and Asthma-like Symptoms in Adults Assessed by Questionnaires*
A Literature Review
Kjell Torén, M.D.; Jonas Brisman, M.D.; and Bengt Järchholm, M.D.

The first widely used questionnaire in respiratory epidemiology was the questionnaire from the Medical Research Council (MRC) of Great Britain. In the first version, from 1960, there were only a few questions about wheezing, but in later editions, more questions about asthma and asthma-like symptoms were added. The MRC questionnaire initiated the development of other questionnaires such as the European Community for Coal and Steel (ECSC) questionnaire of respiratory symptoms and the questionnaire from the American Thoracic Society and the Division of Lung Diseases (ATS-DLD-78). In Tucson, Ariz, a questionnaire was developed in the 1970s that was focused on the subject's own report of asthma. In Great Britain, a questionnaire was developed in the 1980s with the intention of finding the most valid symptom-based items for identifying asthma, "the IUATLD (1984) questionnaire." When judging the validity of a questionnaire, it is essential to understand sensitivity and specificity. The fraction is the fraction of the truly diseased subjects found to be diseased using the questionnaire. Specificity is the fraction of the truly healthy subjects found to be healthy using the questionnaire. Regarding questionnaires dealing with asthma, the situation is confusing because of the absence of any gold standard for asthma. The most usual mode of validation has been to test the questionnaire against the results of a clinical physiologic investigation, often a nonspecific bronchial challenge test. Another approach has been to compare the answers from the questionnaire with the clinical diagnoses of asthma. When validated in relation to bronchial challenge tests, the questions about self-reported asthma have a mean sensitivity of 36 percent (range, 7 to 80 percent) and a mean specificity of 94 percent (range, 74 to 100 percent). The questions about "physician-diagnosed asthma" have even higher specificity, 99 percent. When validated in relation to a clinical diagnosis of asthma, the mean sensitivity for the question about self-reported asthma was 68 percent in the reviewed studies (range, 48 to 100 percent). The specificity was 94 percent (range, 78 to 100 percent). One problem in using the presence of bronchial hyperreactivity (BHR) as a gold standard for asthma is that many people with BHR report no respiratory complaints. In other words, the presence of BHR is a measure with high sensitivity but low specificity for asthma. The effect of using a methacholine challenge test as a standard for the disease will thus be an underestimation of the sensitivity of the questionnaire. The problem with using validation in relation to a physician's diagnosis of asthma is that the bias is probably considerable between different physicians. Hence, the best way to identify subjects with asthma when validating a questionnaire is to use a combination of clinical physiologic investigations and a clinical judgment of the symptoms. In epidemiologic studies of asthma, a disease with a low prevalence (<5 percent), the specificity of the diagnostic test is of great importance. A low specificity, below 98 percent, will generate many false-positive cases. This will be deleterious for both the exposure-disease analyses and the comparisons of prevalences between different populations. In epidemiologic studies of asthma, incidence studies are preferable. Hence, questions that take temporal aspects into consideration have to be developed.

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BHR = bronchial hyperreactivity; DFP = discriminant function predictor; DLD = Division of Lung Diseases; ECSC = European Steel and Coal Community; IUAT = International Union against Tuberculosis and Lung Diseases; IUATLD = International Union against Tuberculosis and Lung Diseases; MCT = methacholine challenge test; MRC = Medical Research Council; NIH = National Heart and Lung Institute; PC10-10, 15, 20 = provocative concentration causing 10, 15 or 20 percent decline in FEV1.

The importance of asthma as a cause of chronic respiratory disease has increased. This has initiated a large number of studies designed to detect risk factors for asthma. A major tool in these studies has been the use of questionnaires, which, however, have only been properly validated in a few studies.

Validity and reliability are general problems with questionnaires. The reliability can readily be tested by administering the same questionnaire two or more times to the same individuals. The validation procedure is much more troublesome, as there is no generally accepted operational definition of asthma, and the outcome of the validation hence will depend
Table 1—Questions About Asthma and Asthma-like Symptoms in the 1960, 1966, and 1986 Versions of the British Medical Research Council's Questionnaire About Respiratory Symptoms*

<table>
<thead>
<tr>
<th>1960 version</th>
<th>16a</th>
<th>Have you ever had attacks of shortness of breath with wheezing?</th>
</tr>
</thead>
<tbody>
<tr>
<td>15a</td>
<td>Have you ever had wheezing or whistling?</td>
<td></td>
</tr>
<tr>
<td>16b</td>
<td>If yes to 15a Is/was your breathing absolutely normal between attacks?</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Have you ever had bronchial asthma? 1966 version</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Have you had attacks of wheezing or whistling in your chest at any time in the last 12 months?</td>
<td></td>
</tr>
<tr>
<td>10a</td>
<td>Have you ever had attacks of shortness of breath with wheezing?</td>
<td></td>
</tr>
<tr>
<td>10b</td>
<td>If yes 10, Is/was your breathing absolutely normal between attacks?</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Have you at any time in the last 12 months been woken at night by an attack of shortness of breath?</td>
<td></td>
</tr>
<tr>
<td>13g</td>
<td>Have you ever had, or been told to have had bronchial asthma?</td>
<td></td>
</tr>
</tbody>
</table>

*The items are numbered according to their location in the questionnaire.

Questionnaires are shown in Table 1. In 1962, the first version of the European Community for Coal and Steel (ECSC) Questionnaire on Respiratory Symptoms was produced.3 This questionnaire was a translation of the MRC questionnaire with the addition of certain items regarding asthma and occupational history. The questionnaire was revised in 1967 and in 1987. The questions concerning asthma and asthma-like symptoms in the 1987 version are shown in Table 2.

In 1966, the version of the American Thoracic Society and the Division of Lung Diseases of the National Heart and Lung Institute produced a new questionnaire in North America. In the United States, the Division of Lung Diseases of the National Heart and Lung Institute produced a new questionnaire in 1975.

Table 3—Items About Asthma and Asthma-like Symptoms in the 1975 Version of the Questionnaire About Respiratory Diseases From the American Thoracic Society and the Division of Lung Diseases, National Heart, Lung and Blood Institute, USA (ATS-DLD-75)*

| 10A | Does your chest ever sound wheezy or whistling: |
| 1. | When you have a cold? |
| 2. | Occasionally apart from cold? |
| 3. | Most days or nights? |
| 10B | If yes to 1, 2 or 3 in 10A. For how many years has this been present? |
| 11A | Have you ever had an attack of wheezing that has made you feel short of breath? |
| If yes to 11A. | B. How old were you when you had your first attack? |
| C. | Have you had 2 or more such episodes? |
| D. | Have you required medicine or treatment for the(se) attack(s)? |
| 20A | Have you ever had asthma? |
| If yes to 20A | B. Do you still have it? |
| C. | Was it confirmed by a doctor? |
| D. | At what age did it start? |
| E. | If you no longer have it at what age did it stop? |

*The items are numbered according to their location in the questionnaire.

The Questionnaires

In the Medical Research Council (MRC) questionnaire,1,2 the items were selected for identification of chronic bronchitis. The "British hypothesis" stated that the presence of chronic cough and sputum were predictors of chronic respiratory disability.7 In the 1960 version of the MRC questionnaire, there were only a few questions about wheezing and unspified chest illnesses. In the 1966 version, this topic was expanded with questions about attacks of shortness of breath and wheezing. A specific question on bronchial asthma was also added. In 1976, a slightly modified version appeared. In the 1986 version, the questions about wheeze and episodic breathlessness also dealt with the occurrence within the last 12 months. The questions dealing with asthma and asthma-like symptoms in the 1960, 1966, and 1986 versions of the MRC
Table 4—Questions About Asthma and Asthma-like Symptoms in the Questionnaire Used in the Arizona Tucson Epidemiologic Study of Obstructive Lung Diseases*

<table>
<thead>
<tr>
<th>Question</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>15a</td>
<td>Does your chest ever sound wheezy or whistling?</td>
</tr>
<tr>
<td>16a</td>
<td>Have you ever had attacks of shortness of breath with wheezing?</td>
</tr>
<tr>
<td>30a</td>
<td>Have you ever had asthma?</td>
</tr>
<tr>
<td>(d)</td>
<td>Have you ever seen a doctor about your asthma?</td>
</tr>
</tbody>
</table>

*The items are numbered according to their location in the questionnaire.

1971, the NHLI questionnaire. By adding more detailed questions on asthma but also about smoking history and occupational history, this questionnaire was further developed into “The questionnaire for respiratory diseases recommended by the American Thoracic Society and the Division of Lung Diseases for use in epidemiologic research of adults (ATS-DLD-78)” (Table 3).4

In Tucson, Ariz, an epidemiologic study of obstructive lung diseases began in the early 1970s. The early NHLI questionnaire was used initially. However, after some years into the study, the researchers developed a self-completed questionnaire of their own design (Table 4).5

In the mid-1980s the International Union Against Tuberculosis and Lung Disease (IUATLD) developed a questionnaire, “the IUATLD (1984) Bronchial Symptoms Questionnaire.” The purpose of the questionnaire was to find the most valid combination of symptom-based items for identification of asthma. There was no question about physician-diagnosed asthma. From the 1984 version, a shorter, generally available version, “the IUATLD (1986) Bronchial Symptoms Questionnaire,” has been developed (Table 5).

Assessment of Validity

There are few published studies dealing with the validity of the questions about asthma and asthma-like symptoms. In many studies, the “cases” have been investigated, but to assess the validity, a sample of those screened as negative by the questionnaires must also be investigated.

The answers to a questionnaire are affected by the mode of administration and the formulation of the questions. Regarding items dealing with asthma-like symptoms, validity is probably only slightly influenced by varying the wording or varying the order of the questions.5,12

When judging the validity of a questionnaire, it is essential to understand sensitivity and specificity. Sensitivity is the proportion of the truly diseased subjects found to be diseased by use of the questionnaire. Specificity is the proportion of the truly healthy subjects found to be healthy using the questionnaire.

Because of the absence of any gold standard for asthma, at least three methods of validation have been used: (1) to test the questionnaire in relation to a clinical physiologic investigation, often a nonspecific bronchial challenge test; (2) to compare the answers from the questionnaire with a clinical diagnosis of asthma; and (3) to compare a new questionnaire with an old one, often the MRC questionnaire.

Validation in Relation to Clinical Physiologic Investigations

Hendrick et al13 studied 253 workers exposed to toluenedisocyanate. They compared the findings of methacholine challenge test (MCT) with a modified ATS-DLD-78-questionnaire. The sensitivity and specificity for the question about wheezing were low for identifying subjects with positive MCT (Table 6).

Welty et al14 investigated 171 subjects 20 to 59 years of age with a bronchial cold air challenge test and the ATS-DLD-78-questionnaire (interview-based). Four subjects reported asthma and 49 subjects reported “any wheeze” (Table 6).
Table 6—Sensitivity and Specificity of Questions About “Self-Reported Asthma,” “Physician Diagnosed Asthma,” and “Wheeze” in Identifying Subjects with a Positive Non-specific Bronchial Challenge Test*

<table>
<thead>
<tr>
<th>Study</th>
<th>Sensitivity, %</th>
<th>Specificity, %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Self-Reported Asthma</td>
<td>Physician-Diagnosed Asthma</td>
</tr>
<tr>
<td>Hendrick et al, 1983</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Welty et al, 1985</td>
<td>—</td>
<td>38</td>
</tr>
<tr>
<td>Mortagy et al, 1986</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Rijken et al, 1986†</td>
<td>13</td>
<td>—</td>
</tr>
<tr>
<td>Dales et al, 1987</td>
<td>7</td>
<td>—</td>
</tr>
<tr>
<td>Enarson et al, 1987‡</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>Burney et al, 1989§</td>
<td>22</td>
<td>—</td>
</tr>
<tr>
<td>PD20 &lt;8 µmol histamine</td>
<td>43</td>
<td>—</td>
</tr>
<tr>
<td>Finland</td>
<td>74</td>
<td>—</td>
</tr>
<tr>
<td>West Germany</td>
<td>33</td>
<td>—</td>
</tr>
<tr>
<td>France</td>
<td>80</td>
<td>—</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>53</td>
<td>—</td>
</tr>
<tr>
<td>Abramsson et al, 1991</td>
<td>26</td>
<td>—</td>
</tr>
<tr>
<td>Kongerud and Søyseth, 1991</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

*The criteria for a positive test vary among the different studies.
†Persistent wheeze.
‡Recalculated by Smith et al, 1989.
§Wheezing and reported asthma in last 12 months.
∥PC20 ≤8 mg/ml.

In a Canadian study, the ATS-DLD-78-questionnaire was compared with a MCT.15 The study population included 248 men 50 years old or younger. A positive test was defined as PC15 of less than 16 mg/ml. The sensitivity was low (Table 6).

In another Canadian study, the ATS-DLD-78-questionnaire and two additional questions about chest tightness were compared with a MCT.16 Positive MCT was defined as a PC20 <8 mg/ml. The design of the study was to investigate the validity of MCT to identify subjects with asthma. Asthma was defined according to the answers in the questionnaires. However, Smith et al17 have used the data to estimate the validity of the questions regarding asthma in identifying a positive or a negative MCT (Table 6), indicating a similar result as the previous cited studies.17

In a British study, Mortagy et al18 distributed a self-administered questionnaire to a sample of 2,145 inhabitants of Southampton. The questionnaire was mainly based on the MRC design with three questions added that the researchers thought likely to disclose increased bronchial reactivity. Bronchial reactivity, expressed as PC20, was assessed in four subsamples, of 50 subjects each, with a histamine challenge test. Regarding wheezing, the specificity was 71 percent and the sensitivity was 50 percent (Table 6); regarding shortness of breath with wheezing, the specificity was 48 percent and the sensitivity was 86 percent. It was also found that subjects with certain respiratory symptoms all had a PC20 below 0.5 mg/ml. The certain symptoms were the combination of morning tightness lasting longer than 1 h, nocturnal dyspnea, and response with shortness of breath or wheezing provoked by a wide range of atmospheric irritants. This complex of symptons was called “bronchial irritability syndrome.” These results initiated a second study on a new sample of Southampton inhabitants.18 If PC20 <8 mg/ml was accepted as the cut-off limit for bronchial hyperreactivity (BHR), sensitivity for the symptom complex “bronchial irritability syndrome” was 100 percent and the specificity was 32 percent. If the limit was decreased to 0.5 mg/ml, the sensitivity and specificity were both 100 percent.

Rijken et al19 investigated 1,905 subjects with a histamine challenge test and a Dutch version of the MRC questionnaire. The population was a random sample of subjects from two Dutch communities. The BHR was defined as PC10 of less than 16 mg/ml (Table 6).

In an Italian study, a random population sample in the age range 15 to 65 years were investigated with MCT.20 A cumulative dose of 200 mg of methacholine was given and a positive test was defined if FEV1 fell more than 15 percent. The validity of the question “Have you ever had attacks of breathlessness with wheeze outside common colds?” was investigated on the positive responders (n = 29) and a random sample of 10 percent (n = 86) of the negative responders. The sensitivity was 89 percent and specificity was 80 percent in identifying subjects with a positive MCT.21

The IUATLD (1984) questionnaire has been compared with a histamine challenge test in 833 adults.
aged 18 to 64 years in two English villages. In the study, half of these subjects were used for working out a cluster of questions with as a high predictive value as possible for identifying BHR. The cluster of questions was called the discriminative function predictor (DFP). This predictor consisted of a positive response for at least one of the following items: (1) wheezing in the last 12 months; (2) awakened by shortness of breath at night in the last 12 months; (3) regular trouble with the breathing that gets completely better or breathing is never quite right; and (4) tightness in chest in dusty parts of house or in contact with animals or feathers. The validity of the questionnaire was tested on the other half of subjects. The sensitivity for DFP was 53 percent but the specificity was 90 percent when compared with PD20 ≤8 μmol. Regarding asthma in the last 12 months, the sensitivity was low, but the specificity was higher, 99 percent (Table 6).

In an international comparison, the IUATLD (1984) questionnaire was tested against a histamine challenge test.22 The study was performed on 175 subjects from four European countries (age range, 16 to 66 years). The PD20 level of 8 μmol or less was considered as positive (Table 6).

In an Australian study, the IUATLD questionnaire was issued to employees of an aluminium smelter.23 The answers were compared with MCT for 809 subjects. A PD20 level of 6.14 μmol methacholine was considered positive (Table 6).

Kongerud and Søyseth34 investigated 337 Norwegian aluminium potroom workers with a MCT and a self-administered questionnaire. The BHR was defined as PC20 ≤8 mg/ml or ≤32 mg/ml. The following question about wheezing was formulated35: "Have you at any time during the past year felt wheezing in your chest?" (Table 6). Bennett et al36 have assessed the validity of a computer-based questionnaire about respiratory symptoms. They studied 12 patients with asthma, defined as having positive MCT and daily peak flow variability greater than 15 percent. This group was compared with two groups: 12 patients with COPD, defined as an irreversibly impaired FEV1, and 12 healthy subjects. The results are recalculated as the sensitivity and the specificity of a given question to identify the patients with asthma, compared both to patients with COPD and with the healthy subjects (Table 7).

Validations in Relation to a Clinical Diagnosis of Asthma

Edfors-Lubs27 estimated the prevalence of asthma among Swedish twins from answers in questionnaires. The question about asthma was formulated "Have you ever had asthma?" A sample of asthma cases and noncases were compared with the diagnosis of an allergist. This part of the study included only 39

<table>
<thead>
<tr>
<th>Question</th>
<th>Sensitivity, %</th>
<th>COPD</th>
<th>Healthy Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Have you at any time suffered from asthma?</td>
<td>58</td>
<td>75</td>
<td>100</td>
</tr>
<tr>
<td>2 Have you ever had bronchitis?</td>
<td>33</td>
<td>33</td>
<td>92</td>
</tr>
<tr>
<td>3 Have you ever had attacks of wheezing of the chest?</td>
<td>100</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td>5 Do you ever wake up at night with an attack of wheezing?</td>
<td>92</td>
<td>58</td>
<td>100</td>
</tr>
<tr>
<td>9 Have you—at any time—suffered from attacks of shortness of breath?</td>
<td>100</td>
<td>0</td>
<td>83</td>
</tr>
<tr>
<td>11 Is your breathing normal between attacks?</td>
<td>92</td>
<td>75</td>
<td>92</td>
</tr>
<tr>
<td>12 Do you ever wake at night with attacks of shortness of breath?</td>
<td>75</td>
<td>42</td>
<td>100</td>
</tr>
</tbody>
</table>

*The table is calculated from Bennett et al.26 The items are numbered according to their location in the questionnaire.

subjects (Table 8).

Kiviloog et al29 interviewed 95 subjects who had responded positively to the question "Have you at any time been troubled by asthma?" and 299 subjects who had denied any respiratory symptoms. Both groups were 35 to 54 years old. A diagnosis of asthma was considered if the subject had a history of reversible dyspnea at rest, with chest wheezing (Table 8).

Kongerud et al30,31 investigated 296 potroom workers (mean age, 36.5 years) from four Norwegian aluminium plants with a modified MRC questionnaire. The validity of the questionnaire was tested against a clinical history obtained by an experienced chest physician. Ninety persons with symptoms and 44 randomly selected persons denying all respiratory symptoms were examined. The sensitivity and speci-
ficity for the dyspnea were 75 percent and 88 percent, respectively, and for wheezing, 77 percent and 82 percent, respectively.

The questions "Have you ever had asthma?" and "Have you had an attack of asthma in the last 12 months?" from the IUATLD (1984) questionnaire have been compared with a physician's opinion. For self-reported asthma, the overall sensitivity was 62 percent and the overall specificity was 92 percent (Table 8). For "Asthma last 12 months," the overall sensitivity was 56 percent and the overall specificity was 96 percent.

Comparability

The questionnaire used in the Tucson epidemiologic study in Arizona has been validated by comparing it with the MRC and NHLI questionnaires. The agreement was defined as the fraction of subjects who had the same answers in both questionnaires. The agreement in response between the questionnaires was about 0.9 concerning the items about wheezing, shortness of breath, and exertion breathlessness. Questions about physician-diagnosed chest diseases such as asthma showed a lower agreement, about 0.8. The comparison about asthma was tested only in relation to the NHLI questionnaire. Samet et al compared the results of an interview-based modified MRC questionnaire with a self-administered version of the NHLI questionnaire. The agreement between the different modes of administration was about 0.8 for questions about dyspnea, cough, phlegm, and wheezing. In this study, the prevalence of all those symptoms was higher in the self-administered questionnaires.

Comstock et al compared the ATS-DLD-78 questionnaire with the MRC questionnaire. The MRC questionnaire was completed with the question "Have you ever had asthma?" The study population included 946 men aged 45 to 84 years. The investigations were interview based, and half of the subjects were given the modified MRC questionnaire at the start of the interview and the ATS-DLD-78 questionnaire in the end of the interview. For the other half of the subjects, the questionnaire was administered in a reverse order. Regarding asthma, the fraction with subjects with the same response in the different questionnaires was 0.99.

Helsing et al investigated 400 subjects with either the NHLI questionnaire, the ATS-DLD-78 questionnaire, or the MRC questionnaire. In each group, 200 subjects received a mailed self-administered version of the questionnaire and 200 were selected for a standardized interview by telephone. The study showed no significant differences regarding wheeze. Breathlessness was reported significantly less often by the interviewer in the NHLI group. The prevalence of asthma was 5.6 percent with the MRC questionnaire and 4.8 percent with the ATS-DLD-78 questionnaire.

Abramson et al compared the IUATLD questionnaire with items from the MRC questionnaire. Regarding wheezing, the fraction of subjects with the same response was 0.92. The agreement between the questionnaires was also analyzed using the kappa index of Cohen. This index adjusts the observed agreement with agreement that occurs by chance. The kappa index was 0.72 for wheezing and 0.90 for "ever asthma."

Assessment of Reliability

The agreement of response between two administrations of the same questionnaire is an appropriate measure of reliability. Of course, such an approach is based on the assumption that the investigated conditions do not change in the time interval between the examinations. Items about respiratory symptoms are probably more affected by real variation than items about medical diagnosis such as asthma. The interval between the distributions of the questionnaires is also of importance. If the interval is too long, the probability of real variation is greater and if the interval is too short, the subjects may recall their former answers and hence bias the results.

Reliability is most often calculated as the agreement between the two occasions of answering the questionnaire. This is calculated as the fraction of subjects with the same answers. The reliability has also in some studies been estimated with the kappa index.

Bridges-Webb interviewed 102 subjects, and they were reinterviewed about 3 months later. The question about asthma was worded "Do you suffer from asthma?" The agreement was 0.99.

Van der Lende et al investigated 540 men with the ECSC questionnaire. The subjects were interviewed by a chest physician on four occasions over 2 years. Two hundred forty subjects attended all four investigations and for asthma the agreement for all four occasions was 0.96. For wheezing the agreement for four occasions was 0.72.

Samet et al studied the reliability of the MRC questionnaire among asbestos workers, who answered the questionnaire twice 1 year apart. The agreement regarding wheezing was 0.73.

Dales et al have analyzed the reliability of a modified ATS-DLD-78 questionnaire answered in 1983 and standardized ATS-DLD interview in 1984. The agreement for a history of asthma was 0.96, for wheezing it was 0.76, and for wheezing with dyspnea it was 0.86.

Kongerud et al distributed a modified MRC questionnaire twice to Norwegian aluminum potroom workers. The interval between the administrations was 3 to 5 months. They found kappa index of 0.63 for dyspnea, 0.66 for wheezing, and 0.66 for a history of asthma.
Burney et al. have investigated the reliability and in the British study the kappa index for wheezing in last 12 months was 0.76 and in the international study it was between 0.73 and 0.95. For a history of asthma, the kappa index varied between 0.70 and 1.00.

**DISCUSSION**

One major disadvantage in the development of a questionnaire for asthma and asthma-like symptoms is the lack of a generally accepted definition of asthma. The definition has been intensively discussed over the years, and the description of asthma has been focused on narrowing of the airways and the increased responsiveness to various stimuli. This is an illusory consensus because there was no agreement on any operational criteria, i.e., which symptoms or which clinical physiologic characteristics are to be the gold standard for asthma. A major reason for this is that although "asthma" is a qualitative concept, the subject either having it or not, it is generally described in terms of two continuous variables, the reversibility of airways obstruction and BHR. This absence of a generally accepted definition is not just a problem when using a questionnaire but in all studies of "asthma." The validation of the questionnaire thus measures the validity in relation to the selected standard. Bronchial hyperreactivity is an important component of asthma and the assessment of BHR is often important in the clinical judgment of single patients. However, in epidemiologic settings, a major disadvantage of using BHR as a gold standard for asthma is that many people with BHR report no respiratory complaints. In other words, the presence of BHR is a measure with high sensitivity but low specificity for asthma. The effect of using MCT as a standard for asthma disease will be to underestimate the sensitivity of the questionnaire. This can be seen in Table 6, where the assessed sensitivity is remarkably low.

Other studies have validated the asthma questionnaires against a physician's diagnosis of asthma. These studies, however, are often handicapped by the fact that the operational criteria for the asthma diagnosis is not mentioned. If the validation is based on a single physician's opinion or a panel of physicians, there may be a considerable bias in the diagnoses. This is probably different between communities, and it is influenced by the age, gender, pulmonary function, and smoking status of the subject, and the diagnostic habits among the physicians.

The rather low specificity of MCT when using it as a gold standard for asthma could probably be increased by adding a clinical judgment of the subject. Such a combination will properly identify the false positives, i.e., the subjects without symptoms but with a positive MCT.

Hence, at present the best way to identify subjects with asthma when validating a questionnaire seems to be a combination of a clinical physiologic investigation and a clinical judgment of the symptoms. The clinical physiologic investigation should be a bronchial challenge test, sometimes supplemented with a bronchodilatation test in those subjects with poor resting lung function.

If the aim of an asthma survey is to identify as many cases as possible, then a test or a battery of tests with as high sensitivity as possible is needed. This could be a relevant design when different workplaces are screened with the intention to identify as many subjects as possible with occupational asthma. In an analytical epidemiologic study, the aim is to estimate the risk for developing asthma due to different exposures. Hence, if studying asthma with a test with low specificity, the true positives will rapidly become swamped with the false positives, producing a dilution of the risk estimate. Thus, in analytical epidemiologic studies, questions with very high (>99 percent) specificity should be used. This is especially important if the questionnaire is the only diagnostic tool in the study. It is better to use a question with very high specificity (>99.5 percent) and low sensitivity (around 50 percent) than a question with lower specificity, around 95 percent, and better sensitivity (70 to 80 percent).

The sensitivity of the question "Have you ever had asthma?" is rather poor in identifying subjects with asthma. When a "physician's diagnosis" is used as the standard (Table 8), the mean sensitivity in the reviewed studies is 68 percent (range, 48 to 100 percent). The sensitivities vary greatly between the different studies, but mostly they show rather low sensitivities. When a bronchial challenge test is the gold standard, the sensitivity is probably underestimated, as discussed earlier. If sensitivity is properly assessed, the "cases" should be compared with "noncases" and not compared with subjects without symptoms. Otherwise, the sensitivity will be overestimated. This is probably the reason for the very high sensitivity found by Kiviloog et al. Another factor of importance for sensitivity of the question about self-reported asthma is the accessibility to medical service. In populations with low accessibility, this question probably has a low sensitivity.

The mean specificity of the question "Have you ever had asthma?" when using a "physician's diagnosis" as standard is 94.3 percent (range, 77 to 100 percent) (Table 8). When using MCT as the standard (Table 6), the mean specificity is 94 percent (range, 74 to 100 percent). The specificity is even higher, 99 percent, for the question about "physician-diagnosed asthma."
In epidemiologic investigations, the questions about self-reported asthma, especially physician-reported asthma, have been used mainly by researchers in North America. These questions seem to be among the questions with the highest specificity, regardless the mode of validation. These questions are also among the most reliable.

An alternative model could be to identify subjects with asthma by a combination of symptom-based items. This has mainly been argued for by British researchers. However, the items have been designed mainly to identify subjects with BHR, a condition with low specificity for asthma. Others have argued for using simple respiratory symptoms as end points in respiratory epidemiologic studies to avoid diagnostic bias and misclassification.

One major reason for low specificity of the different questions in identifying subjects with asthma is probably due to the difficulty in distinguishing between subjects with asthma and COPD. This is illustrated in the study of Bennet et al (Table 7) where the patients with COPD to a large degree responded positively to questions about asthma-like symptoms. This will be of importance if the "questionnaire-asthma" is defined as a combination of different symptoms. However, the same problem, to a lesser extent, is also present if "questionnaire-asthma" is based on self-reported or physician-reported asthma. Dodge et al have shown that in a population 40 years of age and older, in subjects who developed new attacks of shortness of breath with wheezing, 9.2 percent of the women received a diagnosis of asthma as compared with 2.9 percent of the men. The effect is probably more pronounced in even higher age groups. This indicates that the specificity of the "asthma"-related questions could be increased by restricting the study to the younger segment of the population.

Most of the studies dealing with risk factors for asthma have been cross-sectional, ie, the prevalence of asthma has been analyzed. Cross-sectional studies, however, may be heavily biased. To increase our knowledge about the etiology of asthma, longitudinal studies are probably to be preferred. The advantage with such a design is that it gives an opportunity to study incident cases of asthma. These incident cases (and properly selected referents) could be studied either in a traditional cohort design or in a case-referent study. The first design is mainly applicable in occupational settings, and the latter design is recommended for population-based studies. The main advantage when studying the incidence of asthma or asthma-like symptoms is the possibility for the researcher to analyze the first appearance of the disease/symptom as related to previous exposures for each subject.

An important problem when studying the incidence of asthma is to determine the starting point of the disease. This problem is illustrated by Burrows et al in a study on subjects older than age 60 years who responded positively about physician-diagnosed asthma. Many of these subjects had complaints of wheezing 5 to 10 years before the diagnosis of asthma. However, the lag-time is probably shorter in younger subjects.

Hence, if the incidence of asthma or asthma-like symptoms is to be studied, it is important to develop questions that take the temporal aspects into consideration. Some researchers have attempted to construct such questions but more research is certainly needed.

**Conclusions**

Questionnaires, including questions about asthma and asthma-like symptoms, should be validated against clearly stated operational definitions of asthma. This operational definition must include both clinical physiologic findings and a clinical history.

When selecting items about asthma and asthma-like symptoms, questions with high specificity should be preferred in most situations. Questions about "self-reported" asthma, especially "physician-diagnosed" asthma, have such properties.

Questions attempting to determine the time of onset of asthma or asthma-like symptoms should be developed. Such questions will allow an assessment of incidence of asthma or asthma-like symptoms.

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