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Dyspnea reproducibility in a rural Bangladesh population

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Abstract

Introduction—Dyspnea may signal serious disease with increased morbidity/mortality. Dyspnea screening would only be valid if reproducible.

Objective—The study aim was to determine the reliability (reproducibility) of assessing dyspnea through a simple questionnaire among a rural population.

Methods—Participants were recruited from a Health Effects of Arsenic Longitudinal Study in Araihazar, Bangladesh. Dyspnea assessment used a questionnaire among 129 participants at two time points: at baseline and after 2-weeks to 9-months by trained physicians. All subjects were asked about the presence/absence of dyspnea in the last 6 months. At the second interview a physician (blinded-to-questionnaire) conducted a clinical heart/lung examination and obtained a pulse oximeter reading.

Results—Dyspnea prevalence by baseline questionnaire was 2.4%. Overall dyspnea reliability was 94% (121/129). If the initial response was ‘yes’ for the presence of dyspnea, reliability was 91% (49/54). For an initial response of ‘no’ for presence of dyspnea, reliability was 96% (72/75). The pulmonary examination and pulse oximeter readings were significantly more likely to be abnormal in those with dyspnea ($p < 0.01$).

Conclusions—The reliability of a simple question on dyspnea is very high when obtained by physicians. Although validity was not the primary outcome, the increased likelihood of an abnormal chest examination or low pulse oximeter saturation for those reporting ‘yes’ to the dyspnea question suggests more significant underlying cardiopulmonary disease in those reporting recent dyspnea.

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Keywords

dyspnea reproducibility; dyspnea prevalence; dyspnea and Bangladesh; dyspnea reliability study

Introduction

Dyspnea is an uncomfortable subjective sensation of breathing or shortness of breath (1-3). The shortness of breath, in general, is perceived as out of proportion to the degree expected for a given level of exertion (2). Complaints of persistent dyspnea are often the stimulus to physicians to investigate whether or not an individual has cardiopulmonary disease, anemia, or other less common clinical conditions (1,3,4). The converse, abnormal radiologic and pulmonary function findings without association with dyspnea, highlights the importance of emphasizing evaluation of those with the subjective complaint of dyspnea (5).

Among patients coming to the emergency department with either cardiopulmonary disease or diabetes, dyspnea as a presenting complaint was associated with a high mortality of over 60% during ten years of follow-up (6). These findings were consistent with another study where among patients referred for cardiac stress testing, the presence of dyspnea was evaluated as a simple yes or no response. Those with dyspnea were found to have about a 2-fold greater risk of both cardiac and all cause mortality compared to those without dyspnea when followed for an average of 2.7 years (7).

The reliability (reproducibility or precision) of a response to a simple question about the presence or absence of dyspnea is unknown, both in developed and developing country settings. If detection of dyspnea by questionnaire can be demonstrated to be reliable, its presence might serve as a useful marker to inexpensively screen populations to target those at risk for increased morbidity and mortality. The purpose of this investigation was to determine the reproducibility of a positive or negative response to a question regarding the presence of dyspnea among a sample of a rural developing country population.

Materials and methods

The study subjects were recruited from an ongoing, prospective cohort study entitled Health Effects of Arsenic Longitudinal Study (HEALS) in Araihazar, Bangladesh[8]. The study procedures were approved by the Columbia University Institutional Review Board and the Ethical Committee of the Bangladesh Medical Research Council.

Study Design and Subject Selection

Design—This study was a prospective test retest reliability study to determine the reproducibility of a positive or negative response to the question of whether or not subjects have dyspnea in the last 6 months. The retest was done at greater than two weeks but less than 9 months after the baseline assessment.

Subjects—Subjects were recruited from the HEALS participants between May and December, 2007. The eligibility criteria for HEALS included the following: being aged 18 years or more, being married (in order to increase stability of residence), and having resided in the study area for 5 years or more. For the current reliability study, we included 54 individuals who answered ‘yes’ to the dyspnea question at recruitment and 75 individuals who said ‘no’ to the dyspnea question at baseline. These 129 participants were selected from a larger eligible number of HEALS participants recruited during May to December of 2007. This allowed us to evaluate the reliability of the HEALS participants' responses to the

dyspnea question at least two weeks (but not more than nine months) after their initial response (see below). Verbal consent was obtained from all participants.

Dyspnea is relatively uncommon and all dyspnea patients that could be easily found during the period of the retest study were re-evaluated. Nondyspneic subjects (at baseline) were randomly selected from those with an age within 5 years of those with dyspnea to control for age effects. Nondyspneic subjects were taken from the same geographic villages as those with dyspnea to control for village effects.

Rationale and measurements/logistics

Rationale—When the study subjects are initially recruited an extensive baseline interview occurs. One of the many questions on the baseline interview questionnaire is the presence or absence of dyspnea in the last 6 months. A dichotomous response of either ‘yes’ or ‘no’ was obtained. To prevent study physicians and the participants from focusing on the question about dyspnea, seven questions (see Appendix), including the question about dyspnea, were repeated. The time intervals between the two assessments ranged from greater than two weeks to nine months. Based on a prior study, at least a two week interval was chosen before repeating the questionnaire so subjects will not remember the answers to the questions when repeated (9). Less than 9 months was chosen to repeat the questionnaire since it is unlikely that a change in clinical status or new disease will occur in this short time frame that might alter the response to the question of dyspnea compared to the baseline questionnaire. In particular, if nondyspneic subjects are studied too long after baseline, they could acquire new disease and develop dyspnea from the new disease. Then the questionnaire would no longer be studying reproducibility of response, but new disease and defeat the goal of the study.

Measurements/logistics—Information on demographics and the history of dyspnea at both the first and second interview were obtained by the same set of trained physicians. The interviewing physicians were blind to the presence or absence of dyspnea on the baseline questionnaire when repeating the brief clinical questionnaire the second time. Study teams went to the villages of the subjects where the interviews occurred for both the baseline interview and follow-up dyspnea retest interview.

The interviewers were trained local physicians who spoke fluent Bengali and English. The question on dyspnea that was of interest (see Appendix) was: During the last 6 months, have you had dyspnoea? This question with a simple yes/no response was the seventh of a series of questions about general health. All questions, although answered as yes/no, could be probed by the clinician to elicit a specific response if the subject was unsure of the answer. The clinician was given the leeway to ask whether or not the subjects had dyspnea with normal activities or with exercise. A positive response to either question would translate into a yes on the dichotomous response for dyspnea. The test-retest reliability was the primary outcome variable for the current study.

After repeating the brief (about 5 minutes) seven question second taken from the long baseline interview a single second examiner physician (GRP) did a brief examination of the chest and heart and used a pulse oximeter (Pro Basics by PMI, Smiths Medical PM, Waukesha, WI) to obtain a hemoglobin oxygen saturation during the retesting visit. The clinical chest examination was done in a standardized manner on all subjects with auscultation of the posterior chest at both bases and both upper chest areas. Anteriorly, chest auscultation was performed bilaterally in both the superior aspect and the mid-lower chest area with the patient taking deep breaths throughout auscultation. The physician conducting the cardiac and pulmonary assessments and measuring pulse oximeter readings was blind to

the responses to the dyspnea question which was assessed by a separate set of HEALS physicians.

A pulse oximeter value less than 95% was defined as abnormal in this study since it has been demonstrated that arterial blood gas pO2 values less than 60 mm Hg (hypoxemia) are often seen with pulse oximeter values of 94% or less (10). In addition, pulse oximetry tends to over-estimate simultaneously obtained arterial blood gas saturation values by 2 to 4 saturation points (10,11).

Data analysis and power

Reliability was calculated as agreement on both questionnaires divided by total number of subjects (9). Same or different interviewer effects were evaluated by subdividing the overall reliability calculation into subjects with the same interviewer and subjects with a different interviewer. Descriptive statistics with mean, standard deviation, and range were used for age and mean interval between tests. The nonpaired t-test compared ages between groups. The z test for independent proportions was used for comparison of proportions between groups. Odds ratios with 95% confidence intervals were calculated with EpiInfo version 3.3.2 (February 9, 2005, CDC). Multivariate logistic regression analysis was carried out with SPSS for Windows version 14.0 (SPSS, Inc, Chicago, Illinois). A p value less than 0.05 was considered significant.

An a priori power analysis based on one study with a previous positive response to a dyspnea question of about 70% (reliability) was done (12). The power analysis used a significance level alpha of 0.05 and a beta of 0.2 and assumed that a minimal reliability of 0.5 would be needed with an optimal reliability of at least 0.7 based on one previous study (12,13). The analysis suggested that at least 63 subjects should be recruited for a test retest study given the above parameters and assumptions (13).

Results

Subjects

A total of 129 subjects were recruited with 77 females and 52 males. The mean age was 43.4 ± 9.1 for the group as a whole (range 22 to 60) with mean ages of 42.6 ± 9.1 and 44.6 ± 9.1 for females and males respectively (not significant). Those with baseline dyspnea had a mean age of 45.1 ± 10.0 and those without baseline dyspnea had a mean age of 42.2 ± 8.2 years (not significant). The mean interval from test to retest was 168 ± 80 days with a range of 19 to 276 days for the subjects.

From May to December of 2007 a total of 2,504 subjects were recruited into the major study on arsenic. Of these subjects, only 60 had dyspnea at baseline and 54 of the sixty were found and retested. The prevalence of dyspnea based on the baseline questionnaire was 60/2,504 or 2.4%.

Reliability

The overall test retest reliability was 94% (121/129) for consistency of response as seen in Table 1. For subjects with a positive response to the dyspnea question on the first questionnaire the reproducibility of response was 91% (49/54). In subjects with a negative response to dyspnea on the first questionnaire the reproducibility of response was 96% (72/75).

The above analysis was also done subdividing the interviews by whether or not the baseline and follow-up interviews were done by the same or different interviewers. The re-interview

was done by the same physician in 23/129 instances (Table 2). In this situation, the overall test reliability was 91% (21/23). In those with an initial positive response or negative response, the reproducibility of responses was 80% (4/5) and 94% (17/18), respectively. In the 106 instances where the re-interview was done by a different physician (Table 3), the overall test reliability was 94% (100/106). In those with an initial positive or negative response, the reproducibility of responses was 92% (45/49) and 96% (55/57), respectively. Therefore, it appears that reproducibility was not affected by whether or not the interviewer was the same or different at baseline and follow-up.

Validity: Dyspnea versus In the Field Clinical Findings

An evaluation comparing those with at least one positive response to the dyspnea question versus those with no positive response to the dyspnea question and the presence or absence of an abnormal clinical pulmonary examination was done. The pulmonary examination was abnormal in 36.8% (21/57) of those with dyspnea on either questionnaire versus 6.9% (5/72) of those without dyspnea ($p < 0.01$). Using univariate analysis, this translates into an odds ratio (OR) of 7.8 (95% C.I.; 2.5-26.0) or those with dyspnea are 7.8-fold more likely to have an abnormal chest physical examination compared to without dyspnea. After adjusting for age, gender, smoking history, and education, the OR is 8.7 (95% C.I.; 2.7-27.4) or those with dyspnea are 9-fold more likely to have an abnormal chest physical examination compared to those without dyspnea.

The cardiac examination in the field was normal in all subjects.

A pulse oximeter value below 95% was defined as abnormal and was present in 9 subjects. Comparing those with at least one positive response to dyspnea versus those with no positive response to the dyspnea question revealed 14.0% (8/57) with a low pulse oximeter value in the dyspnea group. In those without dyspnea, 1.4% (1/72) had a low pulse oximeter saturation ($p < 0.01$). Six of eight in the dyspnea group had an abnormal chest physical examination and the one patient in the nondyspnea group also had an abnormal physical examination of the chest (Table 4).

Logistic regression analysis using dyspnea as the outcome variable and smoking (dichotomous as ever versus referent of never), the presence or absence of an abnormal lung examination, gender with female as the referent value, the presence or absence of any education, and age as a continuous variable revealed significance for an abnormal lung examination and male gender (Table 5). The presence of ever being a smoker, while not significant, still suggests a 2-fold greater likelihood of smoking in those subjects with dyspnea.

Using multivariate logistic regression analysis and substituting the presence or absence of a low pulse oximeter examination for the lung examination gave similar findings. The OR was 11.6 (95% C.I., 1.3 – 100) when adjusting for age, education, gender, and smoking. This suggests that those with dyspnea were 11.6-fold more likely to have a low pulse oximeter saturation compared with those without dyspnea. The pulse oximeter data is limited by only 9 subjects with low values, however.

Discussion

This study revealed a high test retest reproducibility (reliability) for the presence or absence of dyspnea assessed by a simple question in a rural Bangladesh or Asian population. Reproducibility was not affected by whether the same or a different interviewer administered the questionnaire. Our overall reliability estimate (93.8%) is remarkably similar to the 93% that was obtained by previous investigators using trained nurse

interviewers in a white urban population in Arizona using the question, “Do you get short of breath walking with other people of your own age on level ground?” (12). This latter question was retested at between one week and just over one month. When subdividing the question into positive and negative responses the two studies differed a little. In the Arizona study those with dyspnea on the first questionnaire responded affirmative on the second questionnaire between 68.6 to 72.5 percent of the time. In our study, those with dyspnea on the first questionnaire had dyspnea on the second questionnaire 90.7% of the time. This higher rate of reproducibility occurred despite an average longer time between retesting. One difference between studies was that physicians were the interviewers in the Bangladesh study and had the leeway of asking whether dyspnea occurred over the last 6 months and could also ask if it occurred with normal activity or with exercise. This might capture more subjects who had dyspnea at any time and might push the subjects to remember more and thus account for the greater reliability in our study. When looking at the negative response of no dyspnea, our study revealed a reliability of 96% and the previous study has a similar reliability as gleaned from the data. The exact value cannot be calculated from the data given in the article (12).

The Arizona project (12,14) was the only study that evaluated dyspnea reliability as a simple dichotomous outcome in a general population to serve as a basis for comparison with this study. More complex methods of determining dyspnea presence would not serve the concept of screening very well.

The prevalence of dyspnea in this study was 2.4% whereas it was about 12.3% in the Arizona study (14). One reason dyspnea prevalence may have been lower in one study versus the other relates to age. The Arizona study had a higher mean ages of 46.8 and 49.5 years for males and females, respectively. The increased age would result in more clinical disease and undoubtedly more dyspnea in Arizona. In addition, the primitive, more harsh living conditions of the Bangali villages would make it less likely those with severe disease and dyspnea would survive relative to the U.S.

Although the reliability of the determination of dyspnea was high in this study when determined by physicians, this does not necessarily mean that dyspnea is related to underlying disease relative to those without dyspnea. It is still possible that those who complain of dyspnea have less underlying disease than those who do not complain of dyspnea. In order to evaluate this question, a clinical chest examination was done after the retest along with pulse oximeter analysis to obtain an estimate of easily detectable overt cardiopulmonary disease detected at the field level. Those with dyspnea were at least 8-fold more likely to have an abnormal physical examination of the chest relative to those without dyspnea. In addition, 14% of those with dyspnea had an abnormal pulse oximeter oxygen saturation compared to 1.4% of those without dyspnea resulting in a 11-fold greater likelihood of having dyspnea with a low pulse oximeter reading.

Finally, the baseline questionnaire was re-evaluated for the presence or absence of ever smoking and logistic regression analysis adjusting for age, gender, education, and the presence or absence of an abnormal chest examination revealed a 2.4-fold greater smoking prevalence in those with dyspnea relative to those without dyspnea. These results suggest that those subjects with dyspnea were more likely to have cardiopulmonary disease and risk factors for such disease compared to those without dyspnea. Although this study is not a validity study, the above results imply that the complaint of dyspnea increases the likelihood that underlying cardiopulmonary disease is present.

We conclude that the determination of the presence or absence of dyspnea by physicians in a rural Bangladesh population has a high reliability. In addition, it appears that those with

dyspnea may be more likely to have cardiopulmonary disease as suggested by clinical pulmonary examination and pulse oximeter analysis. Further studies are needed to determine if the presence of dyspnea is a robust marker for detectable cardiopulmonary disease as determined by more objective measures of disease such as spirometry, arterial blood gas analysis, chest roentgenogram, electrocardiogram, etc. In addition, longitudinal populations studies will help determine whether those with dyspnea have different morbidity and mortality profiles relative to those without dyspnea. Such studies will validate whether using dyspnea as a screening tool is justified.

Given that Bangladesh is a population of 100 million adults, if the prevalence of dyspnea is consistent throughout this population, this would imply that 2.4 million Bangladeshi have dyspnea and might have significant cardiopulmonary disease.

Findings of this study have clinical and public health implications. From a clinical perspective, it appears in this study that those with reproducible dyspnea are more likely to have clinical disease. Since dyspnea can signify very serious disease (1,3,4,6,7) persistent dyspnea needs to be evaluated aggressively. From a public health perspective, dyspnea presence as determined by simple, inexpensive, question fits the characteristics as a feasible screening tool that can be used in undeveloped countries to identify subjects who might benefit from a more comprehensive health examination. In addition, Bangladesh is the most densely populated country in the world (15), excluding small “city states”, and should serve as the quintessential population to generalize to other undeveloped countries.

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Appendix: Section H: Clinical Section

Instructions to Interviewer: “Now I would like to ask you questions about your health and perform a clinical exam”.

General History (During the last 6 months)

C-01. Nausea	1 = Yes	2 = No
C-02. Vomiting	1 = Yes	2 = No
C-03. Weight loss	1 = Yes	2 = No
C-04. Hyperhydrosis	1 = Yes	2 = No
C-05. Weakness	1 = Yes	2 = No
C-06. Frequent loose motion	1 = Yes	2 = No
C-07. Dyspnoea	1 = Yes	2 = No

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Table 1
The overall first and second interview dyspnea response

FIRST QUESTIONNAIRE			
SECOND QUESTIONNAIRE	**DYSPNEA PRESENT**	**DYSPNEA ABSENT**	**TOTALS**
DYSPNEA PRESENT	49	3	52
DYSPNEA ABSENT	5	72	77
Totals	54	75	n = 129

Overall Retest Reliability = 94% (121/129).

Overall Presence of Dyspnea Reliability = 91% (49/54).

Overall Absence of Dyspnea Reliability = 96% (72/75).

Cohen's Kappa = 0.87 (0.79 – 0.96).

Table 2

The first and second interview dyspnea response in the 23 subjects with the same interviewer.

FIRST QUESTIONNAIRE			
SECOND QUESTIONNAIRE	**DYSPNEA PRESENT**	**DYSPNEA ABSENT**	**Totals**
DYSPNEA PRESENT	4	1	5
DYSPNEA ABSENT	1	17	18
Totals	5	18	n = 23

Overall Retest Reliability = 91% (21/23).

Overall Presence of Dyspnea Reliability = 80% (4/5).

Overall Absence of Dyspnea Reliability = 94% (17/18).

Table 3

The first and second interview dyspnea response in the 106 subjects with different interviewers.

FIRST QUESTIONNAIRE			
SECOND QUESTIONNAIRE	**DYSPNEA PRESENT**	**DYSPNEA ABSENT**	**Totals**
DYSPNEA PRESENT	45	2	47
DYSPNEA ABSENT	4	55	59
Totals	49	57	n = 106

Overall Retest Reliability = 94% (100/106).

Presence of Dyspnea Reliability = 92% (45/49).

Absence of Dyspnea Reliability = 96% (55/57).

Table 4

Demographics, Abnormal Pulse Oximeter Values, Dyspnea Presence/Absence and Lung Examination*

Number Interviewed	Age and Gender	Pulse Oximeter Saturation	Dyspnea Present 1st - 2nd Visits	Abnormal Chest Examination
9	40 - male	91	No - No	Bilateral rhonchi
39	38 - male	94	Yes - Yes	Expiratory wheezing
51	48 - female	94	Yes - Yes	Bilateral rhonchi
56	52 - male	93	Yes - No	Normal Exam
92	44 - male	94	Yes - Yes	Bilateral basilar crackles. Bilateral rhonchi
109	29 - male	93	Yes - Yes	Bilateral rhonchi
114	44 - female	92	Yes - Yes	Normal Exam
127	44 - female	91	Yes - Yes	Bilateral rhonchi
128	47 - male	89	Yes - Yes	Bilateral Rhonchi

* Only those subjects with a pulse oximeter saturation of less than 95% are included in this table.

Table 5

Independent variables in a logistic regression model with the dichotomous outcome; the presence or absence of dyspnea

Independent Variables	Beta	S.E.	Wald	Significance Level	Odds Ratio (OR)	95% C.I. for OR
Smoker	0.867	0.600	2.088	0.148	2.38	0.73-7.69
Lung Exam	2.122	0.566	14.045	< 0.001	8.34	2.75-25.64
Gender	1.189	0.580	4.208	0.040	3.28	1.05-10.23
Education	0.047	0.413	0.013	0.910	1.05	0.47-2.35
Age	0.009	0.022	0.162	0.687	1.01	0.97-1.06
Constant	0.963	1.187	0.658	0.417	2.62	