The objective of this study was to determine the association between lung function and mental health problems among adults in the United States. Data were drawn from the First National Health and Nutrition Examination Survey (1971–1975), with available information on a representative sample of US adults aged 25–74 years. Lung function was assessed by spirometry, and provisional diagnoses of restrictive and obstructive airway disease were assigned based on percentage of expected forced expiratory volume. Mental health problems were assessed with the General Well-Being scales. Restrictive lung function and obstructive lung function, compared with normal lung function, were each associated with a significantly increased likelihood of mental health problems. After adjustment for differences in demographic characteristics, obstructive lung function was associated with significantly lower overall well-being ($p = 0.025$), and restrictive lung function was associated with significantly lower overall well-being ($p < 0.001$), general health ($p < 0.0001$), vitality ($p < 0.0001$), and self-control ($p = 0.001$) and with higher depression ($p = 0.002$) subscale scores compared with no lung function problems. Consistent with previous findings from clinical and community-based studies, these results extend available data by providing evidence of a link between objectively measured lung function and self-reported mental health problems in a representative sample of community adults. Future studies are needed to determine the mechanisms of these associations.

Abbreviations: FEV$_1$, forced expiratory volume in 1 second; FVC, forced vital capacity; GWB, General Well-Being.

Mounting data suggest an association between respiratory disease and mental disorders. These data come mainly from four sources. First, studies using epidemiologic samples have linked respiratory disease and mental disorders among youth and adults in the community. For instance, several community-based samples have shown strong links between asthma and anxiety and mood disorders (1) and between respiratory disease and panic attacks (2–4). Among youth, a number of studies have shown associations between asthma and anxiety disorders, and panic attacks (5, 6). Second, data from clinical studies of psychiatric patients with anxiety disorders have shown respiratory abnormalities in those with anxiety disorders compared with those with no mental disorders in controlled laboratory settings. For instance, Pine et al. (7) found that youth with anxiety disorders, compared with those without mental disorders, showed respiratory abnormalities in response to carbon dioxide challenge.

Third, data from medical patient populations show increased rates of anxiety and depressive disorders among patients with respiratory disease. For instance, Goodwin and Eaton (3) found significantly higher rates of panic....
attacks among primary care patients with asthma compared with those without asthma. Similarly, Kolte et al. (8) have shown an elevated rate of asthma among inpatients with posttraumatic stress disorder. Fourth, smaller clinical studies have shown evidence of links between anxiety and emotion and lung function in youth and adults (9, 10).

Despite the consistency of findings to date, several methodological features of previous studies leave important questions unanswered. Specifically, although several community-based studies have shown linkages between respiratory disease and mental disorders, previous community-based studies have relied on self-reported asthma or respiratory diseases (or parental report of asthma in youth), with one exception in which a physician report of asthma was used (1). Thus, previous studies have not been able to directly examine the relation between physiologic measures of lung function and mental health. Specifically, with obstructive lung disease, the Airways are narrowed, which results in an increased duration of time required to empty the lungs and difficulty in breathing (11). Restrictive lung disease is categorized by a loss of lung tissue, a decrease in the lung’s capacity for expansion, and/or a decrease in the lung’s ability to transfer oxygen and carbon dioxide (11). Whether and to what degree each type of lung function is directly related to psychiatric symptoms in an unselected (nonclinical) sample is not known.

The goal of the current study was to examine the association between lung function and mental health problems among adults in the United States. We hypothesized that, compared with normal lung function, impaired lung function (restrictive and obstructive) would be associated with a significantly higher level of mental health problems among adults in the community.

MATERIALS AND METHODS

Sample

Data were drawn from the First National Health and Nutrition Examination Survey conducted by the National Center for Health Statistics. This instrument was a survey of a probability sample of the civilian, noninstitutionalized, US population aged 25–74 years (12, 13) from 1971 to 1975.

Mental health

The General Well-Being (GWB) scale (13–17) was used to assess symptoms of mental health. Specific items directly describing perceptions of mental health were selected from the scale and were administered by trained personnel at mobile examination centers during the First National Health and Nutrition Examination Survey (13). This scale has been widely used as an index of general subjective psychological well-being or happiness in relation to mental health (15). The GWB scale consists of 18 items including a mixture of six-point Likert-type and 10-point analogue-scales responses (15). For each of the items, a score of 0 to 5 is indicated. The range of scores for the GWB scale is 0–110. The GWB scale consists of six separate subscales: positive well-being, anxiety, depression, self-control, vitality, and general health.

Spirometry

A total of 6,913 participants included in the First National Health and Nutrition Examination Survey sample were eligible to undergo the forced expiratory spirogram (18). Spirometric data were obtained from participants in the cardiorespiratory module by using an Ohio Medical Instruments 800 spirometer (18). The forced expiratory spirogram was administered by technicians trained for the First National Health and Nutrition Examination Survey, and the procedure consisted of five maximal expiration tests (13). Participants were instructed how to use the spirometer during a practice attempt. To ensure that the exhalation was recorded properly, the participant placed the tube of the spirometer into his or her own mouth (over the tongue) and exhaled as quickly and completely as possible (18). Each participant was given a rest period at the end of each trial. After five trials were completed, data were analyzed to make sure the trials were reproducible.

The primary criterion for reproducibility for trials with three liters of volume was that the results had to be within 5 percent of each other for the two best trials, whereas results of trials with less than three liters were required to be within 10 percent of each other (18). A best trial for each subject was chosen, using the simple criterion of highest summed forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV1). A provisional diagnosis was made based on the FEV1/FVC ratio and the relation between predicted and observed FVCs, and a diagnostic code of normal, restrictive, or obstructive was included (18). This diagnostic code was provided for 5,544 participants. Technicians were trained to recognize procedural errors, such as inhalation artifacts or extra breaths, and were forced to void these trials (13). Participants were excluded from the analysis if they either did not perform spirometric tests or had results that were not reliable. Participants with no trials free of procedural errors were not included. In addition, a number of persons were excluded from participation because they generally failed to comprehend the procedure because of language difficulties, mental insufficiency, physical disabilities, or excessive discomfort (18).

Finally, several quality control systems were enforced during data collection. In particular, qualified spirometric consultants were involved in periodic field visits to the mobile examination centers to observe administration of the tests and review the samples (18). A biomedical engineer routinely checked all equipment and made any necessary repairs and adjustments. Prior to each testing day and periodically throughout the day, the barometric pressure, temperature, and water level of each spirometer were noted and recorded.

Restrictive lung diseases were assessed by measuring FVC, which is the maximal amount of air that can be forcefully expelled from the lungs during maximal inhalation. These measurements can reveal mechanical defects and deformities of the chest cage and wall, as well as loss of lung.
tissue and elasticity. Obstructive lung diseases were examined by the objective method of quantitating flow-rate measurements, FEV1,0 and FEV25–75 percent (19). Two measurements were involved in the diagnoses: 1) maximum FVC (the maximum of the best two trials, or the best trial if only one was available) and 2) the ratio of the best FEV1 to the best FVC (FEV1/FVC). If the maximum FVC was less than 80 percent of the predicted FVC, a diagnosis of “restrictive lung disease” was recorded. If the ratio between the maximum FEV1 and the maximum FVC was less than 70 percent of the predicted FEV1/FVC ratio, the diagnosis of “obstructive lung disease” was recorded. The equations for the predicted values may be found in a publication by Discher and Palmer (20).

**Data analysis**

Analysis of variance was used to determine differences in GWB subscales (continuous measures) between adults with and without either restrictive or obstructive respiratory function. Multiple logistic regression analyses were then used to determine the association of lung function with anxiety and depressive symptoms, adjusting for differences in demographic characteristics.

**RESULTS**

**Prevalence**

Impairment in lung function (either obstructive or restrictive) was found among 13.85 percent of adults.

**Demographic characteristics associated with lung function**

Obstructive lung function was more common among males, those of racial minority status, and those who were older, and it was less common among those who were married (table 1). Restrictive lung function was also more common among adults who were older, were less likely to be married, and were Caucasian.

**Obstructive lung function and mental health problems**

Obstructive lung function was associated with significantly lower scores on the overall GWB total score and the general health, vitality, positive well-being, and self-control subscales (table 4). Significantly higher scores on the depression subscale were found for those with restrictive lung function compared with those without. After adjustment for differences in demographic characteristics, the associations between restrictive lung function and overall GWB score and for scores on the general health, vitality,

<table>
<thead>
<tr>
<th>Normal lung function (n = 4,776)</th>
<th>Obstructive lung function (n = 68)</th>
<th>Restrictive lung function (n = 642)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age in years (standard deviation)</td>
<td>46.2 (13.9)</td>
<td>55.0*** (12.6)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>44.6 (2,129)</td>
<td>57.4* (39)</td>
</tr>
<tr>
<td>Female</td>
<td>55.4 (2,647)</td>
<td>42.6 (29)</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minority</td>
<td>8.9 (426)</td>
<td>25.0*** (17)</td>
</tr>
<tr>
<td>White</td>
<td>91.1 (4,350)</td>
<td>75.0 (51)</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>80.0 (3,820)</td>
<td>61.8** (42)</td>
</tr>
<tr>
<td>Widow</td>
<td>6.8 (327)</td>
<td>16.2 (11)</td>
</tr>
<tr>
<td>Never married</td>
<td>6.0 (286)</td>
<td>10.3 (7)</td>
</tr>
<tr>
<td>Separated/divorced</td>
<td>7.1 (341)</td>
<td>11.8 (8)</td>
</tr>
</tbody>
</table>

* p < 0.05; **p < 0.01; ***p < 0.0001.

**Restrictive lung function and mental health problems**

For those participants with restrictive lung function, compared with those without, we found an association with significantly lower scores on the overall GWB total score and the general health, vitality, positive well-being, and self-control subscales (table 4). Significantly higher scores on the depression subscale were found for those with restrictive lung function compared with those without. After adjustment for differences in demographic characteristics, the associations between restrictive lung function and overall GWB score and for scores on the general health, vitality,
depression, and self-control subscales remained statistically significant (table 3). The association between restrictive lung function and positive well-being subscale score was no longer significant after adjustment.

**DISCUSSION**

The goal of this study was to investigate the relation between lung function and mental health problems among adults in the United States. Our results suggest that obstructive lung function and restrictive lung function are associated with significantly increased levels of mental health problems. These linkages appeared to persist after adjusting for differences in demographic characteristics. These data are consistent with and extend previous findings from clinical and community studies showing links between respiratory diseases and mental health problems by providing evidence of a consistent link between physiologic measures of lung function and mental health problems in a representative community of US adults. A key limitation of previous research in this area has been the nearly exclusive use of self-reported respiratory problems. Our results addressed that limitation and provide consistent evidence in support of this previously reported link.

The mechanism of the association between lung function and mental health problems is not known and cannot be determined from these data. It may be that restricted lung function leads to a decreased sense of well-being due to functional limitations associated with physical disease. It is also conceivable that subjective distress over poor physical health, even in the absence of limitations on functioning, is related to increased depression and worry, resulting in decreased well-being, as observed here. Alternatively, it may be that mental health problems lead to decreased lung function or respiratory disease. It is not yet clear through what mechanism this may occur except via a common environmental factor. For instance, depression and anxiety are associated with increased cigarette smoking. Cigarette smoking is also associated with increased risk of respiratory problems and impaired lung function. Because mental health problems, especially anxiety disorders (21–23) and major depression, are strongly related to cigarette use and nicotine dependence, various levels of cigarette smoking may mediate the relation between mental health problems and respiratory disease (24, 25).

It is also possible that another factor not assessed here explains this risk. In this analysis, as well as in numerous previous studies, differences in sociodemographic differences were adjusted for, and, whereas the strength of associations was somewhat attenuated after adjustment in most instances, they did remain statistically significant. Our goal was to examine simply whether there was any link between physiologically assessed lung function and mental health, although the study was not capable of explaining the pathway for the observed link.

The association we observed between restrictive lung function and obstructive lung function and mental health problems is not known and cannot be determined from these data. It may be that restricted lung function leads to a decreased sense of well-being due to functional limitations associated with physical disease. It is also conceivable that subjective distress over poor physical health, even in the absence of limitations on functioning, is related to increased depression and worry, resulting in decreased well-being, as observed here. Alternatively, it may be that mental health problems lead to decreased lung function or respiratory disease. It is not yet clear through what mechanism this may occur except via a common environmental factor. For instance, depression and anxiety are associated with increased cigarette smoking. Cigarette smoking is also associated with increased risk of respiratory problems and impaired lung function. Because mental health problems, especially anxiety disorders (21–23) and major depression, are strongly related to cigarette use and nicotine dependence, various levels of cigarette smoking may mediate the relation between mental health problems and respiratory disease (24, 25).

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consistent linkages between restrictive lung function and GWB scales, where only the link between obstructive lung function and overall GWB score remained significant after adjustment. The reason for this discrepancy is not clear from these data. Needed are future studies that can replicate the findings that mental health is linked with obstructive and not restrictive lung function and follow up by further investigating the potential mechanism of these links, taking into account both lung function—diagnoses of specific respiratory or other types of physical disease—and mental health.

Limitations of this study should be considered carefully when interpreting our results. First, we did not have information on specific respiratory diseases or diagnoses; therefore, these results cannot be directly applied to one specific respiratory disease in the population. Second, our measure of mental health problems did not assess mental disorders, as previous studies have used measures based on the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (26). Therefore, conclusions regarding the association between lung function and mental disorders cannot be drawn from these data. As such, these results can be interpreted as only suggesting an association between respiratory disease and mental health problems. The GWB scale is a well-validated measure of “psychological status/well being”; therefore, although the scale does not directly assess psychopathology, it does reflect mental health using a widely accepted scale (14–17). Future studies that include respiratory disease diagnoses, as well as physiological measures of lung function, and mental disorders defined according to the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition would be a useful next step in understanding whether this link applies to the relation between specific respiratory diseases and specific mental disorders.

Third, the inaccessibility of information on potential common risk factors (e.g., family history, cigarette smoking) prohibited us from further investigating possible mechanisms of this association in this study to test this potential pathway, as described earlier. Fourth, note that the strength of the observed links was not overwhelming in each case, and the large sample size may have contributed to these outcomes. Yet, we did use continuous measures, thereby showing an increase with each numeric increase in score on the GWB subscales, not merely a dichotomous measure, and only those measures significant at the $p < 0.01$ level were included. Finally, lack of information on the association between another form of physical limitation, for comparison with restrictive/obstructive lung function, in the link with mental health prevented a relative comparison of the degree to which lung function, compared with another physical limitation, is related to mental health.

In sum, these data imply linkages between decreased lung function and mental health problems. A long history of theory and research suggests links between respiratory problems and emotional health. These results provide evidence of a link between the two in an unselected sample of adults representative of the United States. Because major depression and anxiety disorders are the most common mental disorders, and respiratory diseases, such as chronic obstructive pulmonary disease, are among the leading causes of morbidity and premature mortality among adults in the United States, future studies that replicate and further investigate the mechanism of this association may have important public health implications regarding both primary and secondary prevention.

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REFERENCES


