Behavioral Health is Essential To Health

Prevention Works

Treatment is Effective

People Recover
Challenges of Using Prediction Models to Produce Nationally Representative Estimates of Mental Illness

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The 1992 ADAMHA Reorganization Act required SAMHSA to develop a definition and methodology for estimating serious mental illness (SMI) among adults. SAMHSA convened a technical advisory group (TAG) that developed a definition of SMI, published in the Federal Register in 1993 (SAMHSA, 1993).
Persons aged 18 and over, who currently or at any time during the past year, have had diagnosable mental, behavioral, or emotional disorder of sufficient duration to meet diagnostic criteria specified within DSM-III-R that has resulted in functional impairment.

- Functional impairment is defined as difficulties that substantially interfere with or limit role functioning in one or more major life activities including basic daily living skills; instrumental living skills; and functioning in social, family, and vocational/educational contexts.
2006 TAG Recommendations

- The TAG recommended that SAMHSA's National Survey on Drug Use and Health (NSDUH) be modified to produce estimates of SMI among adults.
- The TAG recommended that the data from short scales in NSDUH be used to estimate SMI, using a prediction model fit on clinical psychiatric interviews conducted on a subsample of NSDUH respondents.
- The TAG suggested that the K6 psychological distress scale, already in the NSDUH, be supplemented with items on functional impairment.
  - The K6 had already been demonstrated to be a good predictor of SMI in prior studies (Kessler et al, 2003).
  - Adding impairment indicators, would improve prediction and add face validity, and consequently public acceptance of the estimates, since impairment is a component of the SMI definition.
Implementation of TAG Recommendations

• After the TAG meeting, SAMHSA began the development of a program to implement the Mental Health Surveillance Study (MHSS)

• The Mental Health Surveillance Study (MHSS) included
  • Clinical Follow-up Sample (1,500 in 2008 and 500 planned in 2009-2012)
  • Adding impairment items and other mental health items (suicide behavior and past month K6) to the NSDUH
  • Development of an estimation methodology for SMI using data collected in 2008
  • Plans to use 2008-2012 data to evaluate 2008 model

• Through an interagency agreement with NIMH the MHSS was expanded by 1000 in 2011 and 2012.
  • Methodological studies to improve estimates
Clinical Follow-Up Interview

• Nationally representative, stratified sample (K6, WHODAS, and age adjustment)

• At end of NSDUH interview, a request for 2nd interview on mental health is made to respondents sampled for the clinical follow-up interview
  – $30 incentive

• Interview conducted by a trained clinical interviewer, by telephone, 2-4 weeks after main interview
# Modules in the Structured Clinical Interview for DSM-IV (SCID)

### MOOD DISORDERS
- *Past Year Major Depressive Episode*
- Lifetime Major Depressive Episode
- *Past Year Manic Episode*
- Lifetime Manic Episode
- *Past Year Dysthymic Disorder*

### PAST YEAR PSYCHOTIC DISORDERS
- *Psychotic Screen*

### PAST YEAR ANXIETY DISORDERS
- *Posttraumatic Stress Disorder*
- *Panic Disorder with and without Agoraphobia*
- *Agoraphobia without History of Panic Disorder*
- *Social Phobia*
- *Specific Phobia*
- *Obsessive Compulsive Disorder*
- *Generalized Anxiety Disorder*

### PAST YEAR EATING DISORDERS
- *Anorexia Nervosa*
- *Bulimia Nervosa*

### PAST YEAR IMPULSE CONTROL DISORDERS
- *Intermittent Explosive Disorder*

### PAST YEAR PSYCHOTIC DISORDERS
- Alcohol Abuse
- Alcohol Dependence
- Non-Alcohol Substance Abuse
- Non-Alcohol Substance Dependence

### PAST YEAR SUBSTANCE USE DISORDERS
- *Psychotic Screen*
- Alcohol Abuse
- Alcohol Dependence
- Non-Alcohol Substance Abuse
- Non-Alcohol Substance Dependence

### PAST YEAR ADJUSTMENT DISORDERS
- *Adjustment Disorder*

### GLOBAL ASSESSMENT OF FUNCTIONING
- *SMI Functional impairment = GAF ≥ 50*

*Modules used in the operational definition of SMI*
Estimation Step 1: Determine Best Weighted Logistic Regression Model Using Clinical Subsample

Let $\pi = \Pr(\text{“true” SMI} \mid X_1, X_2, \ldots X_p)$

$$\logit(\pi) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_p X_p$$
Estimation Step 2: Determine Minimum-Bias Cutpoint from Clinical Interview Data

1. Based on model, each CI respondent has predicted
   \[ \Pr(\text{SMI}+) = \hat{\pi} \]

2. Based on clinical interview, each CI respondent has a “true” SMI diagnosis

3. Select cutpoint, \( \pi_0 \), for which false positives equal false negatives in the CI subsample
   - If \( \hat{\pi} \geq \pi_0 \) then predicted SMI status = positive
   - If \( \hat{\pi} < \pi_0 \) then predicted SMI status = negative
Estimation Step 3: Apply Model to Main Sample

1. Based on model, and reported data on predictor variables, each NSDUH respondent has predicted Pr(SMI+) = \( \hat{\pi} \)

2. If \( \hat{\pi} \geq \pi_0 \) then predicted SMI status = yes
   If \( \hat{\pi} < \pi_0 \) then predicted SMI status = no
2008 Prediction Model

For 2008-2011 reports, original 2-predictor model was used to produce estimates (Aldworth et al., 2010).

\[
\logit(\hat{\pi}) \equiv \log \left( \frac{\hat{\pi}}{1 - \hat{\pi}} \right) = -4.7500 + 0.2098X_k + 0.3839X_w
\]

where the \(X_k\) and \(X_w\) refer to K6 and WHODAS terms, respectively

Based on 2008 clinical sample (n=759)!
Options:

- Update models, parameters, and/or cutpoints each year
  - Small annual sample → high variance

- Continue to accumulate clinical interview data and evaluate 2008 model
  - Only update model when there is evidence that model/estimates can be substantially improved
    - Update all prior estimates
By the end of 2012 we had a cumulative sample of approximately 5,000.

Questions:

Should we revise the clinical sample weights?

Is the 2008 model ‘good enough’ or can it be improved?
Revising Clinical Sample Weights

2008 Weights

- simple nonresponse adjustment: using K6 classes

Revised Weights

- coverage adjustment: due to the exclusion of NSDUH Spanish-language respondents because the MHSS clinical interviews were only conducted in English
- nonresponse bias adjustment: using more information on nonresponse between the NSDUH interview and clinical interview
Revising Clinical Sample Weights

Mental Health by Sample and Response Status among Persons Aged 18 or Older

<table>
<thead>
<tr>
<th>NSDUH Variables</th>
<th>Full NSDUH Sample</th>
<th>Selected MHSS Sample</th>
<th>MHSS Non-respondents</th>
<th>Respondents Before Adjustment</th>
<th>Respondents After Adjustment (2008 Weights)</th>
<th>Respondents After Adjustment (Revised Weights)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAJOR DEPRESSIVE EPISODE (MDE)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lifetime MDE</td>
<td>12.8</td>
<td>12.6</td>
<td>9.5</td>
<td>14.7</td>
<td>14.6</td>
<td>12.9</td>
</tr>
<tr>
<td>Past Year MDE</td>
<td>6.6</td>
<td>6.4</td>
<td>5.3</td>
<td>7.2</td>
<td>7.2</td>
<td>6.6</td>
</tr>
<tr>
<td>MDE TREATMENT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Past Year Counseling</td>
<td>61.8</td>
<td>64.5</td>
<td>56.3</td>
<td>68.5</td>
<td>66.6</td>
<td>65.9</td>
</tr>
<tr>
<td>Past Year Medication</td>
<td>51.7</td>
<td>57.7</td>
<td>53.4</td>
<td>59.7</td>
<td>56.9</td>
<td>56.4</td>
</tr>
<tr>
<td>MENTAL HEALTH SERVICE USE</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Received Any Tx in Past Year</td>
<td>13.6</td>
<td>13.7</td>
<td>12.2</td>
<td>14.7</td>
<td>14.2</td>
<td>13.7</td>
</tr>
<tr>
<td>SUICIDAL THOUGHTS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Past Year Serious Thoughts of Suicide</td>
<td>3.7</td>
<td>3.5</td>
<td>2.8</td>
<td>4.1</td>
<td>3.8</td>
<td>3.7</td>
</tr>
</tbody>
</table>

NSDUH and MHSS 2008 – 2011
1. Minimize error rate
   • Minimize misclassification error (error rate=sum of false positives & false negatives)

2. Minimize bias (difference between the clinical sample estimates and model-based estimates)
   • All adults
   • Subpopulations (e.g., age, gender, race/ethnicity, education, employment, poverty level, health insurance coverage, region, metro-status, mental health service use, substance use disorder status)

3. Parsimony, try to limit to direct indicators of mental illness
Revised Prediction Model

\[ X_1 = \text{recoded K6 score (0-17)} \]
\[ X_2 = \text{recoded WHODAS score (0-8)} \]
\[ X_3 = \text{serious thoughts of suicide in past year (0,1)} \]
\[ X_4 = \text{past year MDE (0,1)} \]
\[ X_5 = \text{recoded age (age 18-29: 0-11; age 30+: 12)} \]

Based on combined 2008-2012 samples clinical sample (n=5000)
# Model Parameter Estimates and Misclassification: Clinical Interview Sample, 2008a-2012

<table>
<thead>
<tr>
<th>Model Terms</th>
<th>Model Parameter Estimates</th>
<th>Error rate</th>
<th>FP/FN Ratio (bias)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intercept</td>
<td>K6 (0-17)</td>
<td>WHODAS (0-8)</td>
</tr>
<tr>
<td>K6 Only Model</td>
<td>-4.25</td>
<td>0.28</td>
<td>-</td>
</tr>
<tr>
<td>K6 and WHODAS (2008 model)</td>
<td>-4.71</td>
<td>0.16</td>
<td>0.40</td>
</tr>
<tr>
<td>K6, WHODAS, Suicide, MDE and Age (2012 model)</td>
<td>-5.97</td>
<td>0.09</td>
<td>0.34</td>
</tr>
</tbody>
</table>

*Weights used for this tables are the scaled MHSS weights.*
Bias for Age Group Estimates of SMI, by Model: 2008a-2012 Clinical Interview Sample

Bias (%)

K6 Only

-2.91+
-1.81+
-0.02
1.89+
0.68

K6 and WHODAS

1.81+
0.68
0.12

K6, WHODAS, Suicide, MDE, Age

0.69
0.37
-0.02
-1.10

18-25  26-34  35-49  50+

1.59+  -0.30  -1.67+  -1.10

-3.00 -2.00 -1.00  0.00  1.00  2.00  3.00  4.00

2.00  1.59+  1.89+  1.81+  0.68  0.12  0.69  0.37

-2.00 -1.00  0.00  1.00  2.00  3.00  4.00

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Prior and Revised Estimates of Serious Mental Illness (SMI) in Past Year among Persons Aged 18 or Older, by Age Group: NSDUH 2011

Prior Estimates*  
Revised Estimates**

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Prior Estimates</th>
<th>Revised Estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 to 25</td>
<td>7.6</td>
<td>5.0</td>
</tr>
<tr>
<td>26 to 34</td>
<td>6.7</td>
<td>5.1</td>
</tr>
<tr>
<td>35 to 49</td>
<td>5.6</td>
<td>3.8</td>
</tr>
<tr>
<td>50 or Older</td>
<td>3.0</td>
<td>2.8</td>
</tr>
</tbody>
</table>

* NSDUH estimates using 2008-based model (distress and impairment variables).
** NSDUH estimates using improved model (distress, impairment, age, suicide thoughts and depression variables).

Source: SAMHSA, Center for Behavioral Health Statistics and Quality, National Surveys on Drug Use and Health (NSDUHs), 2008 to 2012 (revised May 2013).
Other Issues with Methodology

• SE of estimate is ‘naive’
  – treats the predicted SMI values as true values.
  – However, these standard errors are useful when comparing the estimates from different subpopulations

• Bias in SMI estimates by domains defined using variables included in the model
Bias by Domains Defined by Predictor Variables

• When a variable is added to the logistic model for SMI, there is a tendency for the resulting cut point predictions of SMI to exhibit and larger correlation with that variable than exists between the variable and the clinical diagnosis of SMI.

• This can cause a significant bias in domain estimation.
## SMI Bias by Suicidal Behavior Domains

<table>
<thead>
<tr>
<th>Domain</th>
<th>Direct Estimate from MHSS Clinical Sample</th>
<th>Standard Cut Point Estimator Using 2008 Models</th>
<th>Standard Cut Point Estimator Using 2012 Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>Had Serious Thoughts of Suicide in the Past Year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>38.9</td>
<td>40.5</td>
<td>57.0*</td>
</tr>
<tr>
<td>No</td>
<td>2.6</td>
<td>3.5*</td>
<td>1.8*</td>
</tr>
<tr>
<td>Made Suicide Plans in the Past Year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>56.1</td>
<td>53.6</td>
<td>66.6*</td>
</tr>
<tr>
<td>No</td>
<td>3.4</td>
<td>4.4*</td>
<td>3.2</td>
</tr>
<tr>
<td>Had Suicide Attempt in the Past Year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>47.1</td>
<td>40.9</td>
<td>59.1</td>
</tr>
<tr>
<td>No</td>
<td>3.8</td>
<td>4.9*</td>
<td>3.6</td>
</tr>
</tbody>
</table>

* Significantly different from the direct estimate
Restricted Use Data File

The clinical interview data will be available through the CBHSQ Data Portal which can be accessed by designated agents. The final data files and documentation are currently under construction and should be ready for dissemination starting in 2014.