from the NHLBI. During the time that this work was conducted, Dr Barreto-Filho was a postdoctoral fellow at Yale University supported by grant 3436-10-1 from CAPES (Coordenacao de Aperfeicoamento de Pessoal de Nivel Superior, Ministry of Education, Brazil). Dr Spretus has received funding from the NHLBI, the American Heart Association in Dallas, Texas, and the American College of Cardiology Foundation in Washington, DC.

Role of the Sponsors: The funding sponsors had no role in the design and conduct of the study; in the collection, management, analysis, and interpretation of the data; or in the preparation, review, or approval of the manuscript.

Additional Information: Dr Barreto-Filho is now with the Division of Cardiology, Federal University of Sergipe, Aracaju, Sergipe, Brazil.

Additional Contributions: We gratefully acknowledge the contributions of Vishnu Patilolla, MD, Gregory Mulvey, MD, and Marian Mocanu, MD.


A Comparative Analysis of the Quality of Patient Education Materials From Medical Specialties

Given the access to a seemingly unsurpassable amount of information online, one can understand why the Internet has become one of the most commonly used sources of information, including health care–oriented resources. According to a 2011 study performed by the Pew Internet and American Life Project, 59% of Americans use the Internet to find and understand health care–oriented information. However, a potential problem is the difficult reading level of the patient-specific education materials. The average American adult reads at approximately a seventh to eighth grade level. Therefore, the American Medical Association, the National Institutes of Health, and the US Department of Health and Human Services advocate for patient education materials to be written at a fourth to sixth grade reading level. As explored in this Research Letter, we assess the readability of patient education resources by using various readability parameters. To our knowledge, this is the first study to compare the readability of patient education materials to comprehensively assess the quality of resources provided by various medical professional organizations.

Methods | Online patient education materials from each medical specialty were downloaded in 2012. Resources from the 16 specialties were examined. For each website, material written specifically for patients was downloaded into Microsoft Office Word (Microsoft). Tables, figures, hyperlinks, and text unrelated to the patient education material, including copyright notices, disclaimers, and author information, was deleted.

Readability assessment of each article was performed using Readability Studio Professional Edition, Version 2012.1 (Oleander Software). The analysis included the Coleman-Liau index, FORCAST formula, simple measure of gobbledygook (SMOG) grading, New Dale-Chall readability formula, Flesch Reading Ease, Flesch-Kincaid grade level, Fry graphical analysis, Gunning fog index, New Fog Count, and the Raygor readability estimate. A separate analysis was performed to identify grammatical errors, cliches, and passive voice.

Results | All readability assessments, excluding the New Fog Count, showed that patient education materials from all 16 medical specialties were too complex for the recommended sixth grade reading level (Table). The New Fog Count yielded the following scores near the recommended guidelines: dermatology, 4.3; obstetrics and gynecology, 6.0; plastic surgery, 6.1; and family medicine, 6.6. The New Dale-Chall readability formula test showed that only dermatology, family medicine, and obstetrics and gynecology were within the boundaries of the average American adult reading level. Flesch Reading Ease readability analysis showed that largely, patient resources were considered to be “difficult.” For the Flesch-Kincaid grade level readability test, family medicine was the only specialty within the parameters of the average adult reading ability. Readability scores using the Fry graphical analysis test ranged from the eighth grade level in family medicine to unclassifiable in dermatology because the complexity of the patient educational materials was beyond the 17th grade level.

Overall, across all readability analyses used to measure each of the 16 websites, the New Fog Count demonstrated the lowest mean grade level score of 9.3, whereas SMOG grading demonstrated the highest mean grade level score of 14.1. The proportion of passive voice sentences used throughout resources ranged from 6% in family medicine to 27% in neurological surgery. Obstetrics and gynecology materials contained the most cliches with a total of 40, corresponding to 5.8 cliches per 50 pages. Obstetrics and gynecology materials also contained the highest total number of indefinite article mismatches (the improper use of “a” or “an”) at 14 errors, corresponding to 1.8 errors per 50 pages.

Discussion | Research conducted at the US Department of Education found that 12% of adults had proficient health literacy, 53% had intermediate health literacy, 22% had basic health literacy, and 14% had below basic health literacy. As a result, on an individual level, problems arise in the form of preventable recurrent hospitalizations or visits. On the national level, there are negative economic consequences: it has been estimated that inadequate health literacy is costing the US economy between $106 and $236 billion dollars annually.

Our analysis of the level of readability across all 10 readability scales showed that none of the patient education re-
Table. Individual Medical Specialty Readability Scores and Grammatical Errors*

<table>
<thead>
<tr>
<th>Medical Specialty (Professional Association)</th>
<th>CLI</th>
<th>FC</th>
<th>SMOG</th>
<th>NDC</th>
<th>FRE</th>
<th>FKGL</th>
<th>Fry</th>
<th>GFI</th>
<th>NFC</th>
<th>RRE</th>
<th>PV, %</th>
<th>Clichés</th>
<th>AMs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anesthesiology (ASA)</td>
<td>14.5</td>
<td>11.6</td>
<td>15.8</td>
<td>13-15</td>
<td>30</td>
<td>14.5</td>
<td>17</td>
<td>15.7</td>
<td>11.7</td>
<td>17</td>
<td>15</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dermatology (AAD)</td>
<td>10.5</td>
<td>10.7</td>
<td>11.3</td>
<td>7-8</td>
<td>56</td>
<td>9.0</td>
<td>...</td>
<td>3.6</td>
<td>9</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Diagnostic radiology (ACR)</td>
<td>14.9</td>
<td>12.0</td>
<td>15.7</td>
<td>16+</td>
<td>24</td>
<td>14.8</td>
<td>17</td>
<td>15.1</td>
<td>11.1</td>
<td>17</td>
<td>18</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Emergency medicine (ACEP)</td>
<td>11.3</td>
<td>10.8</td>
<td>13.5</td>
<td>9-10</td>
<td>50</td>
<td>11.4</td>
<td>12</td>
<td>13.0</td>
<td>10.4</td>
<td>12</td>
<td>15</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Family medicine (AAFP)</td>
<td>9.9</td>
<td>10.0</td>
<td>10.9</td>
<td>7-8</td>
<td>64</td>
<td>7.8</td>
<td>8</td>
<td>10.1</td>
<td>6.6</td>
<td>8</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>General surgery (ASGS)</td>
<td>15.4</td>
<td>12.0</td>
<td>17.8</td>
<td>13-15</td>
<td>24</td>
<td>16.2</td>
<td>17</td>
<td>18.2</td>
<td>15.4</td>
<td>17</td>
<td>15</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Internal medicine (ACP)</td>
<td>13.5</td>
<td>11.4</td>
<td>14.6</td>
<td>11-12</td>
<td>41</td>
<td>12.9</td>
<td>15</td>
<td>12.5</td>
<td>9.4</td>
<td>17</td>
<td>8</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Neurosurgery (AANS)</td>
<td>13.4</td>
<td>11.5</td>
<td>15.1</td>
<td>13-15</td>
<td>37</td>
<td>13.5</td>
<td>17</td>
<td>14</td>
<td>10.3</td>
<td>17</td>
<td>27</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>Neurology (AAN)</td>
<td>13.3</td>
<td>11.2</td>
<td>14.0</td>
<td>11-12</td>
<td>43</td>
<td>12.1</td>
<td>16</td>
<td>13</td>
<td>9.2</td>
<td>13</td>
<td>6</td>
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<td>0</td>
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<tr>
<td>Obstetrics and gynecology (ACOG)</td>
<td>10.1</td>
<td>10.7</td>
<td>11.4</td>
<td>7-8</td>
<td>58</td>
<td>8.7</td>
<td>10</td>
<td>9.8</td>
<td>6.0</td>
<td>10</td>
<td>23</td>
<td>40</td>
<td>14</td>
</tr>
<tr>
<td>Ophthalmology (AAO)</td>
<td>11.9</td>
<td>11.0</td>
<td>13.6</td>
<td>11-12</td>
<td>47</td>
<td>11.7</td>
<td>13</td>
<td>12.4</td>
<td>9.4</td>
<td>13</td>
<td>20</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Orthopedic surgery (AAOS)</td>
<td>11.3</td>
<td>10.8</td>
<td>12.2</td>
<td>9-10</td>
<td>54</td>
<td>9.7</td>
<td>11</td>
<td>11.3</td>
<td>7.9</td>
<td>11</td>
<td>19</td>
<td>19</td>
<td>1</td>
</tr>
<tr>
<td>Otolaryngology (AAO/NS)</td>
<td>12.5</td>
<td>11.2</td>
<td>13.3</td>
<td>11-12</td>
<td>46</td>
<td>11.4</td>
<td>14</td>
<td>12.5</td>
<td>8.9</td>
<td>13</td>
<td>20</td>
<td>5</td>
<td>0</td>
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<tr>
<td>Physical medicine and rehabilitation (AAPMR)</td>
<td>17.4</td>
<td>12.3</td>
<td>17.1</td>
<td>13-15</td>
<td>17</td>
<td>15.9</td>
<td>17</td>
<td>17.4</td>
<td>11.8</td>
<td>17</td>
<td>5</td>
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<td>0</td>
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<tr>
<td>Plastic surgery (ASPS)</td>
<td>13.5</td>
<td>11.7</td>
<td>14.4</td>
<td>14-15</td>
<td>38</td>
<td>12.3</td>
<td>16</td>
<td>12.1</td>
<td>6.1</td>
<td>17</td>
<td>13</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Psychiatry (APA)</td>
<td>15.1</td>
<td>12.2</td>
<td>15.5</td>
<td>13-15</td>
<td>29</td>
<td>14</td>
<td>17</td>
<td>15.1</td>
<td>10.9</td>
<td>17</td>
<td>13</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>


*All scores are indicative of grade level with the exception of FRE (scored from 0 to 100), which represents reading ease.

Text was too difficult to be classified to a specific grade level because it contained too many polysyllabic words.

| Source(s) provided by the 16 professional organizations met the recommended sixth grade maximum readability level or even the seventh to eighth grade reading ability of the typical American adult. As such, website revisions may be warranted to increase the level of readability and quality of these patient resources to effectively reach a broader patient population. One simple adjustment is to write more clearly, which may increase comprehension regardless of the reader’s health literacy capabilities. The use of pictures and videos may also be an effective way of increasing a patient’s comprehension of health information that is too complex to fully explain through pure text. Future studies will seek to better explain the relationship between readability and multimedia effectiveness at improving the communication of health information, which would ultimately help to improve patient comprehension and outcomes.

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Additional Contributions: Chirag D. Gandhi, MD, provided guidance throughout the duration of this study.

No Effect of Multivitamin Supplementation on Mortality

Although substantial numbers of people worldwide take multivitamin supplements, including an estimated 40% or more of US adults, their effectiveness remains unclear. Recent reports from the Physicians’ Health Study (PHS) II, a randomized trial of daily multivitamins, found fewer total cancers in multivitamin recipients but no effect on overall or cause-specific mortality. In a Western population that was well nourished. However, few multivitamin trials have been conducted in undernourished populations where the potential for benefit is most likely.

In 1985, we initiated the Linxian Dysplasia Nutrition Intervention Trial (NIT) to evaluate the effect of multivitamin supplements on cancer incidence and mortality in Linxian, China, a region with extremely high rates of esophageal and gastric cardia cancer and multiple vitamin and mineral deficiencies. Participants with a previous cytological diagnosis of esophageal squamous dysplasia were randomized to receive multivitamin supplementation or placebo for 6 years. Results after the 6-year intervention period showed no statistically significant benefit on mortality. However, an additional 20 years of active follow-up after cessation of the intervention gave us the opportunity to examine the long-term effects of supplementation.

This report updates the results of the Linxian Dysplasia NIT after 26 years of follow-up to provide informative data on the effect of multivitamin supplementation on mortality in an undernourished population. Our findings should be helpful for clinical practice and public health recommendations.

Methods | The Linxian Dysplasia NIT was a randomized, double-blind, placebo-controlled trial of multivitamins conducted in 1985 through 1991 in northern China in an undernourished population of 3,318 persons aged 40 to 69 years who had received a previous cytologic diagnosis of esophageal squamous dysplasia. Participants were followed up for 20 additional years after cessation of supplementation. The methods and results for the intervention phase of this trial were previously published and are further detailed in eAppendix, eFigure 1, and eTable 1 in the Supplement.

Results | Baseline characteristics are summarized in eTable 2 in the Supplement. Participant characteristics, including age, sex, smoking, drinking, family history of esophageal and gastric cancers, and body mass index, were similar between the supplementation and placebo groups.

A total of 2,239 deaths occurred during follow-up (1985-2010), including 42% from cancer, 21% from heart disease, 25% from cerebrovascular disease, and 12% from other causes. Cumulative mortality for all causes, cancer, heart disease, and cerebrovascular disease for all participants is shown in eFigure 2 in the Supplement. Results from Cox models were similar to the cumulative mortality graphs (Table). Overall, multivitamin supplements had no effect on total mortality or mortality from any of the specific causes of death examined (including cancer mortality) among all participants.

When results were examined by subgroups defined by sex and age (Table), heart disease deaths were reduced in supplemented men (hazard ratio [HR], 0.73; 95% CI, 0.56-0.96) and cerebrovascular disease deaths were increased in supplemented women (HR, 1.25; 95% CI, 1.00-1.56) (P = .047). Heart disease deaths were also decreased in older supplemented participants (HR, 0.79; 95% CI, 0.64-0.98) and cerebrovascular disease deaths were increased in younger supplemented participants (HR, 1.42; 95% CI, 1.07-1.88).

Discussion | In the Linxian Dysplasia NIT, after 6 years of supplementation and nearly 20 years of additional follow-up, multivitamin supplementation had no effect on total or cause-specific mortality. Both beneficial and adverse effects on heart disease and stroke mortality were observed among subgroups defined by sex and age.

Most prior micronutrient intervention trials tested only 1 or 2 supplements. Among those that tested 3 or more vitamins and minerals, supplements reduced total mortality in 2 trials. However, only 1 previously reported micronutrient trial was truly comparable to the Linxian Dysplasia NIT in terms of testing an existing commercially available multivitamin and mineral supplement formulation: the PHS II supplemented with Centrum Silver (Pfizer Inc) (31 vitamins and minerals), whereas the Linxian Dysplasia NIT supplemented with 2 Centrum tablets (26 vitamins and minerals). Poorly nourished populations should benefit most from multivitamin supplementation, making the present study a strong test of their potential beneficial effects. However, like the well-nourished PHS II population, no benefit of multivitamins for total mortality was observed in our study.

Our results show differences in the effect of supplementation on heart disease and stroke mortality in men and women. Multivitamin trials in well-nourished Western populations have not shown reduced heart disease in supplemented men or women. For stroke, Western trials in women either showed no effect or suggested a benefit. For heart disease in men, the PHS II indicated no effect. The different cardiovascular dis-