The Trajectory of Depressive Symptoms Across the Adult Life Span

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IMPORTANCE Long-term longitudinal studies are needed to delineate the trajectory of depressive symptoms across adulthood and to individuate factors that may contribute to increases in depressive symptoms in older adulthood.

OBJECTIVES To estimate the trajectory of depressive symptoms across the adult life span; to test whether this trajectory varies by demographic factors (sex, ethnicity, and educational level) and antidepressant medication use; and to test whether disease burden, functional limitations, and proximity to death explain the increase in depressive symptoms in old age.

DESIGN Longitudinal study.

SETTING Community.

PARTICIPANTS The study included 2320 participants (47.0% female; mean [SD] age at baseline, 58.1 [17.0] years; range, 19-95 years) from the Baltimore Longitudinal Study of Aging.

MAIN OUTCOMES AND MEASURES Estimated trajectory of depressive symptoms modeled from 10 982 assessments (mean [SD] assessments per participant, 4.7 [3.6]; range, 1-21) based on the Center for Epidemiologic Studies Depression scale and 3 subscales (depressed affect, somatic complaints, and interpersonal problems).

RESULTS The linear ($\gamma_{10} = 0.52; P < .01$) and quadratic ($\gamma_{20} = 0.43; P < .01$) terms were significant, which indicated that depressive symptoms were highest in young adulthood, decreased across middle adulthood, and increased again in older adulthood. The subscales followed a similar pattern. Women reported more depressed affect at younger ages, but an interaction with age suggested that this gap disappeared in old age. Accounting for comorbidity, functional limitations, and impending death slightly reduced but did not eliminate the uptick in depressive symptoms in old age.

CONCLUSIONS AND RELEVANCE Symptoms of depression follow a U-shaped pattern across adulthood. Older adults experience an increase in distress that is not due solely to declines in physical health or approaching death.
Depressive symptoms are a common mental disorder that is among the leading causes of disability worldwide.\(^1,2\) The burden of depression and depressive symptoms is pervasive and varied, ranging from decreased socioemotional well-being\(^3\) to impaired physical health\(^4\) to lower productivity in the workplace.\(^4\) Given that depressive symptoms are associated with important outcomes at every stage of life, there has been great interest in understanding the trajectory of depressive symptoms across adulthood.

Epidemiological evidence suggests that the prevalence of major depressive disorder declines with age.\(^5\) In contrast, depressive symptoms, after a midlife decline, may increase again at older ages.\(^6-8\) Longitudinal studies of depressive symptoms, however, have focused primarily on a single segment of the adult life span\(^9,10\) or on transition points (eg, from adolescence to young adulthood\(^11\)). Repeated assessments performed for a substantial period are needed to reliably estimate the trajectory of depressive symptoms across adulthood. In addition, it is likely that not everyone is changing in the same way. Previous research suggests that mean levels of depressive symptoms differ by sex,\(^12,13\) ethnicity,\(^14\) and educational level,\(^15,16\) but it is less clear whether these differences increase or decrease over time.\(^7,16-20\)

Depressive symptoms in older adulthood are linked to a number of consequential outcomes, including decreased quality of life,\(^21\) greater disease burden,\(^22\) less ability to cope with illness,\(^23\) and premature mortality.\(^23\) If depressive symptoms increase in older age, it is important to determine whether the increase is due primarily to declines in physical health. Although persons with chronic diseases\(^8\) and functional limitations\(^24\) are more prone to experiencing depressive symptoms, such burdens may not fully explain the increase in old age.\(^8\) Furthermore, neuroticism (ie, a general tendency to experience negative affect) tends to increase and well-being (eg, life satisfaction, happiness) tends to decline sharply with impending death.\(^25\) Thus, the uptick in depressive symptoms in old age may reflect end-of-life factors related to deteriorating health and/or proximity to death.

The present research uses more than 30 years of depressive symptom assessments from the Baltimore Longitudinal Study of Aging (BLSA). Using more than 10 000 repeated assessments of the Center for Epidemiologic Studies Depression (CES-D) scale performed during a 30-year period (mean [SD] assessments per participant, 4.7 [3.6]; range, 1-21), we examined the trajectory of depressive symptoms across the adult life span. In addition to the CES-D total scale score, we examine 3 subscales that tap into different types of depressive symptoms: depressed affect, somatic complaints, and interpersonal problems. These aspects of depressive symptoms may not necessarily follow the same trajectory over the life span. It is particularly important to separate the somatic aspects from other types of symptoms because such items may also reflect changes in physical health that are more prevalent with aging.\(^26\) We also examine differences in this trajectory across demographic characteristics (sex, ethnicity, and educational level) and the use of antidepressant medication.\(^27\) Finally, we test whether increases in depressive symptoms in old age could be accounted for by disease burden, functional limitations, and proximity to death.

### Methods

#### Participants and Procedure

A total of 2320 community-dwelling volunteers from the BLSA participated in the study. Started in 1958, the BLSA is an ongoing multidisciplinary study of aging administered by the National Institute on Aging. This study was approved by the local institutional review board, and all participants provided informed consent. The current sample is 47.0% female, 73.4% white (20.0% black and 6.6% other ethnicities; all self-reported), and well educated (mean [SD], 16.5 [2.4] years of education). The CES-D assessments started in 1979; data used in the present study were collected between January 10, 1979, and December 27, 2011, at regularly scheduled visits. As of 2011, the rate of attrition was approximately 15%. After we controlled for age, sex, ethnicity, and educational level, there were no differences in the CES-D total scale score or the subscale scores between participants who dropped out and those who stayed in the study (see Supplement for detailed attrition analyses).

The mean (SD) age at the first CES-D assessment was 58.1 (17.0) years (range, 19-95 years), and the mean age at the most recent assessment was 70.0 (15.9) years (range, 24-101 years). Participants completed up to 21 assessments of the CES-D (mean, 4.7 [3.6] assessments per participant; range, 1-21) for a total of 10 982 assessments of depressive symptoms across more than 30 years. The mean interval between administrations was 2.7 (2.2) years (range, 4 months to 21 years) (Table 1).

### Table 1. Mean Follow-up and Number of Assessments by Baseline Age in 2320 Participants

<table>
<thead>
<tr>
<th>Age at Baseline, y</th>
<th>Participants, %</th>
<th>Interval Between Assessments Mean (SD), y</th>
<th>Total Follow-up Mean (SD), y</th>
<th>No. of Assessments, Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;30</td>
<td>7.2</td>
<td>2.5 (1.1)</td>
<td>9.1 (7.4)</td>
<td>2.9 (1.6)</td>
</tr>
<tr>
<td>30-39</td>
<td>8.9</td>
<td>3.6 (2.5)</td>
<td>9.6 (8.3)</td>
<td>3.2 (2.3)</td>
</tr>
<tr>
<td>40-49</td>
<td>17.9</td>
<td>3.8 (3.3)</td>
<td>12.2 (6.8)</td>
<td>4.5 (2.6)</td>
</tr>
<tr>
<td>50-59</td>
<td>15.9</td>
<td>3.6 (2.6)</td>
<td>12.3 (7.1)</td>
<td>5.6 (3.8)</td>
</tr>
<tr>
<td>60-69</td>
<td>20.4</td>
<td>2.7 (2.0)</td>
<td>12.2 (7.2)</td>
<td>6.6 (4.4)</td>
</tr>
<tr>
<td>70-79</td>
<td>19.3</td>
<td>2.4 (1.9)</td>
<td>7.1 (6.2)</td>
<td>4.4 (3.8)</td>
</tr>
<tr>
<td>80-89</td>
<td>9.8</td>
<td>2.0 (1.6)</td>
<td>4.5 (4.5)</td>
<td>3.5 (2.9)</td>
</tr>
<tr>
<td>≥90</td>
<td>0.6</td>
<td>2.0 (2.4)</td>
<td>1.5 (1.6)</td>
<td>2.0 (1.2)</td>
</tr>
</tbody>
</table>
Depressive Symptoms

Depressive symptoms were measured with the CES-D scale.28 This 20-item scale assesses the frequency of a variety of depressive symptoms within the previous week. Items are rated on a 4-point scale from 0 (rarely) to 3 (most or all of the time). A score of 16 is typically considered the threshold for severe depressive symptoms.29 In addition to the total scale score, we examined 3 subscales that tap into different aspects of depressive symptoms,28,30 including depressed affect (7 items; eg, “I felt sad”), somatic complaints (7 items; eg, “My sleep was restless”), and interpersonal problems (2 items; eg, “I felt that people disliked me”). At baseline, the mean (SD) scores were 7.0 (6.9; range, 0-20) for depressed affect, 3.1 (2.9; range, 0-20) for somatic complaints, and 0.2 (0.7; range, 0-6) for interpersonal problems.

Antidepressant Medication

Information on antidepressant medication use was available for most visits (10,442 visits). Participants reported using antidepressant medication at approximately 8% of these visits (826 visits; 404 participants).

Illness Burden

Illness burden was assessed with the Charlson Comorbidity Index (CCI).31 The CCI is the weighted sum of 19 clinical conditions found to increase risk of mortality, including myocardial infarct, congestive heart failure, peripheral vascular disease, dementia, cerebrovascular disease, chronic pulmonary disease, connective tissue disease, ulcer disease, mild liver disease, diabetes mellitus, hemiplegia, moderate or severe renal disease, diabetes with end-organ damage, any tumor, leukemia, lymphoma, moderate or severe liver disease, metastatic solid tumor, and AIDS. We used an adapted version of the CCI, which defines each condition by the International Classification of Diseases, Ninth Revision diagnosis codes and combines leukemia and lymphoma with any tumor.22 This version consistently predicts mortality.33,34 We calculated the CCI from the medical history obtained by a certified nurse practitioner at each visit. For the morbidity analyses, we focused on 1482 participants aged 60 years or older at the time of assessment. The CCI and CES-D were available concurrently at 6523 visits. The mean (SD) CCI was 0.7 (1.1) diseases (range, 0-8) at the first assessment and 1.5 (1.5) diseases (range, 0-10) at the most recent assessment.

Functional Limitations

Data on difficulties with activities of daily living (ADLs)35; eg, bathing) and instrumental ADLs (IADLs36; eg, meal preparation) were available for a subset of 972 participants aged 60 years or older (2286 visits). At the first assessment, ADLs had a mean (SD) of 0.1 (0.5) limitations (range, 0-5) and IADLs had a mean of 0.2 (0.6; range, 0-7). At the most recent assessment, ADLs had a mean of 0.2 (0.8) limitations (range, 0-5) and IADLs had a mean of 0.3 (0.9; range 0-7).

Statistical Overview

We used hierarchical linear modeling (HLM)37,38 to estimate the trajectory of depressive symptoms across the adult life span; HLM is a flexible approach that can be applied to evaluate within-individual change or growth trajectories. In HLM analyses, the number and spacing of measurement observations may vary across persons, given that the time-series observations in each individual are used to estimate the individual trajectories (level 1), and the individual parameters are the basis of group estimates (level 2). Even data from individuals who were tested on only a single occasion can be used to stabilize estimates of the mean and variance. In this way, all available data can be included in the analyses. This is a major advantage of conducting analyses within the HLM framework; by contrast, missing data and varying timing pose major problems in conventional repeated measures analyses of variance.39 Furthermore, longitudinal HLM can estimate age trajectories over a broad age span with data collected in a relatively shorter time interval.

We conducted the analyses using HLM, version 6.40 To evaluate the longitudinal trajectories, we first defined the level 1 model and then tested possible level 2 predictors. At level 1, we fit a quadratic model for the CES-D total score and separately for each subscale to test for potential nonlinear changes in depressive symptoms across the life span.51-52 At level 2, we entered characteristics of the individual (sex, ethnicity, and educational level) as independent variables to explain between-subject variation in the intercept and linear and quadratic slopes. We centered age in decades on the grand mean age (66.4 years) to minimize the correlation between the linear and quadratic terms. Antidepressant medication use, illness burden, and functional limitations were entered at level 1 as time-varying covariates to test their effect on the trajectory of depressive symptoms.

Results

Trajectory of Depressive Symptoms

The estimates for the trajectory of depressive symptoms across adulthood are shown in Table 2 (the eTable in the Supplement shows the deviance statistics for all models). As depicted in Figure 1, depressive symptoms were the highest in early adulthood, declined in middle adulthood, and then increased in older adulthood (figure available from the corresponding author [http://med.fsu.edu/userFiles/file/SutinSupplementalMaterial.pdf] shows the scales in the raw metric and eFigure 1 in the Supplement shows spaghetti plots of the raw data). The intercept indicated that, at about age 66 years, participants scored approximately 5.8 on the CES-D scale. At the subscale level, depressed affect and interpersonal problems followed a similar trajectory to that of the total CES-D. Somatic complaints also followed a similar trajectory, but increased slightly more in older adulthood. The intercept, linear, and quadratic slope estimates were similar when sex, eth-
Predictors of the Trajectory of Depressive Symptoms

Demographics

We first tested the effect of sex, educational level, and ethnicity on the intercept and slopes of the CES-D scale and the subscales (Table 3 and Table 4). There was no effect of sex on the intercept of the CES-D, which indicated that men and women experienced depressive symptoms to a similar extent. The subscales, however, revealed that women reported more depressed affect than did men. We reported elsewhere that women had significantly more depressive symptoms than men. Indeed, in the present study, when the 4 positively valenced items were removed from the total scale score, women had significantly more depressive symptoms than men ($\beta = .43$ [SE = .18]; $P < .01$).

There was also a significant effect of sex on the slope of depressed affect (Figure 2). This interaction with age indicated that women experienced more negative affect in early adulthood, but men increased more in older adulthood. The trajectories of men and women converged by old age, such that after about age 70 years there were no longer differences in depressed affect between the sexes. There was no effect of sex on the slopes of the other 2 subscales.

Modest effects emerged for educational level and ethnicity. Education was associated with fewer symptoms of depression, particularly somatic complaints and interpersonal problems. African Americans and participants of other ethnicities had slightly higher mean levels of interpersonal problems, but scores for interpersonal problems increased less in older age for participants of other ethnicities than for white participants. Finally, scores for somatic complaints did not increase as much in older age in African Americans and participants of other ethnicities as in white participants (Tables 3 and 4).

Antidepressant Use

Not surprisingly, antidepressant medication use was associated with the intercept and trajectory of depressive symptoms (Tables 3 and 4). Participants who took antidepressants reported more depressive symptoms than those who did not and their depressive symptoms declined less across adulthood. The association of antidepressant use and the 3 subscales was similar to that for the overall CES-D score. As a supplementary analysis, we reanalyzed all models after excluding participants who reported ever taking antidepressant medication. The estimates were virtually identical to those for the entire sample. We also tested whether there was a difference in the trajectory of the 570 participants who had ever experienced severe depressive symptoms (CES-D score, $\geq 16$) at any point in the study. Indeed, these participants had an amplified curve compared with those who had not experienced severe depressive symptoms. That is, they reported more depressive symptoms in early adulthood and had a steeper decline across middle adulthood and a steeper increase in old age (Figure 2 in the Supplement).

Morbidity

We next tested whether disease burden or functional limitations could account for the uptick in depressive symptoms in old age (Tables 3 and 4). Morbidity was primarily associated with the intercept of depressive symptoms: participants with greater disease burden and more functional limitations reported more depressive symptoms than those with less morbidity, particularly depressed affect and somatic complaints. Disease burden was also associated with a greater increase in depressed affect in old age. The IADLs had a negative effect on the slope of the total CES-D and somatic complaints, such as

Table 2. HLM Coefficients and Variance Estimates of Intercept, Linear, and Quadratic Equations Predicting Depressive Symptoms From Age and Age Squared (in Decades) in 2320 Participants

<table>
<thead>
<tr>
<th>Scale</th>
<th>Intercept</th>
<th>Slope</th>
<th>Quadratic</th>
</tr>
</thead>
<tbody>
<tr>
<td>CES-D</td>
<td>5.78 (0.11)</td>
<td>0.32 (0.07)</td>
<td>0.43 (0.03)</td>
</tr>
<tr>
<td>Depressed affect</td>
<td>1.13 (0.04)</td>
<td>0.05 (0.02)</td>
<td>0.15 (0.01)</td>
</tr>
<tr>
<td>Somatic complaints</td>
<td>1.00 (0.01)</td>
<td>0.00 (0.01)</td>
<td>0.00 (0.01)</td>
</tr>
<tr>
<td>Interpersonal problems</td>
<td>0.17 (0.01)</td>
<td>0.02 (0.02)</td>
<td>0.20 (0.01)</td>
</tr>
<tr>
<td>CES-D (16 items)$^4$</td>
<td>4.18 (0.09)</td>
<td>0.43 (0.05)</td>
<td>0.38 (0.02)</td>
</tr>
</tbody>
</table>

Abbreviations: CES-D, Center for Epidemiologic Studies Depression scale; HLM, hierarchical linear modeling.

$^a$P < .01 except where otherwise indicated.
$^b$P < .05.
$^c$P > .05.
$^d$CES-D scale without the 4 positively worded items.

Figure 1. Scores for the Center for Epidemiologic Studies Depression Total Scale and 3 Subscales Across Adulthood

![Graph showing CES-D scale with 3 subscales across adulthood.](https://jamanetwork.com/)

Estimated trajectory of scores for the Center for Epidemiologic Studies Depression (CES-D) total scale and 3 subscales across adulthood. Raw-scoreredtransformed so that all scales could be plotted on the same axis. (eFigure 1 in the Supplement shows the estimated trajectories of each scale in the original metric.)
that depressive symptom scores increased less with age in participants with more limitations. This effect was driven by the effect of IADLs on the intercept. That is, those with functional limitations reported more depressive symptoms, but over time those who did not report IADLs increased significantly more in depressive symptoms so that they caught up to those reporting IADLs (eFigure 3 in the Supplement). Because of the reduced sample size and assessments of ADLs and IADLs, there was not enough power to test whether functional limitations were associated with the quadratic slope of depressive symptoms. Accounting for disease burden and functional limitations did not eliminate the increase in depressive symptoms in old age (table available from the corresponding author).

**Mortality**

We tested the effect of mortality on the trajectory of depressive symptoms in several ways. First, we entered a dummy-coded variable into the model that contrasted participants who died during the study with those who were still living at the time of analysis as a level 2 predictor of the intercept and slope (Tables 3 and 4). For the overall scale score, death was associated with a higher intercept but was unrelated to the slopes. The opposite pattern, however, emerged for somatic complaints: death was unrelated to the intercept of somatic complaints, but it predicted a steeper slope at older ages (Figure 3). Death was unrelated to interpersonal problems of depressed affect. Of note, the increase in depressive symptoms in late life remained after death was accounted for (table available from the corresponding author).

Second, we repeated the HLM analyses after excluding all CES-D assessments within 5 years of death. The linear slope estimates were slightly smaller, but the pattern of estimates was virtually identical to that of the total sample (table available from the corresponding author).

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### Table 3. Effect of Demographic Factors, Antidepressant Medication Use, Disease Burden, and Death on the Intercepts and Slopes of Depressive Symptoms Overall and Depressed Affect in 2320 Participants

<table>
<thead>
<tr>
<th>Factor</th>
<th>CES-D</th>
<th>Depressed Affect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intercept</td>
<td>Slope</td>
</tr>
<tr>
<td>Female sex&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.02 (0.23)</td>
<td>-0.23 (0.15)</td>
</tr>
<tr>
<td>Black ethnicity&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.33 (0.30)</td>
<td>0.31 (0.22)</td>
</tr>
<tr>
<td>&quot;Other&quot; ethnicity&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.32 (0.50)</td>
<td>-0.50 (0.37)</td>
</tr>
<tr>
<td>Educational level&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.13 (0.04)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-0.03 (0.03)</td>
</tr>
<tr>
<td>Medication&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>0.84 (0.39)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-0.32 (0.14)&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Disease burden&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0.33 (0.12)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-0.09 (0.19)</td>
</tr>
<tr>
<td>ADLS&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.08 (0.53)&lt;sup&gt;e&lt;/sup&gt;</td>
<td>-0.20 (0.25)</td>
</tr>
<tr>
<td>IADLS&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.68 (0.44)&lt;sup&gt;e&lt;/sup&gt;</td>
<td>-0.46 (0.20)&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>Death&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.44 (0.28)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.08 (0.22)</td>
</tr>
</tbody>
</table>

Abbreviations: ADLs, activities of daily living; CES-D, Center for Epidemiologic Studies Depression scale; IADLs, instrumental ADLs.

<sup>a</sup> Level 2 predictor.

<sup>b</sup> *P < .01.

<sup>c</sup> *P < .05.

<sup>d</sup> Time-varying covariate.

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### Table 4. Effect of Demographic Factors, Antidepressant Medication Use, Disease Burden, and Death on the Intercepts and Slopes of Somatic Complaints and Interpersonal Problems in 1128 Participants

<table>
<thead>
<tr>
<th>Factor</th>
<th>Somatic Complaints</th>
<th>Interpersonal Problems</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intercept</td>
<td>Slope</td>
</tr>
<tr>
<td>Female sex&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.20 (0.11)</td>
<td>-0.05 (0.06)</td>
</tr>
<tr>
<td>Black ethnicity&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.20 (0.14)</td>
<td>-0.15 (0.10)</td>
</tr>
<tr>
<td>&quot;Other&quot; ethnicity&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.05 (0.21)</td>
<td>-0.15 (0.16)</td>
</tr>
<tr>
<td>Educational level&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.04 (0.02)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-0.01 (0.01)</td>
</tr>
<tr>
<td>Medication&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>0.61 (0.13)&lt;sup&gt;e&lt;/sup&gt;</td>
<td>-0.18 (0.07)&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>Disease burden&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0.20 (0.05)&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0.03 (0.08)</td>
</tr>
<tr>
<td>ADLS&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.65 (0.27)&lt;sup&gt;e&lt;/sup&gt;</td>
<td>-0.18 (0.13)</td>
</tr>
<tr>
<td>IADLS&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.97 (0.22)&lt;sup&gt;e&lt;/sup&gt;</td>
<td>-0.31 (0.10)&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>Death&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.13 (0.13)</td>
<td>0.17 (0.10)</td>
</tr>
</tbody>
</table>

Abbreviations: ADLs, activities of daily living; IADLs, instrumental ADLs.

<sup>a</sup> Level 2 predictor.

<sup>b</sup> *P < .01.

<sup>c</sup> Analysis included 1482 participants and 6523 visits.

<sup>d</sup> Analysis included 972 participants and 2286 visits.

<sup>e</sup> The parameter was not estimated because there were not enough data for the subsample with the concurrent measure of ADLs and IADLs.
Third, we tested whether there was a terminal increase in depressive symptoms with proximity to death. We reanalyzed the data from 728 participants who had died during the study, using time to death as the metric rather than time since birth (ie, chronological age).44 We controlled for sex, ethnicity, and educational level, and we included age at each assessment as a time-varying covariate. In this case, the intercept represents the estimated depressive symptoms at the time of death, and the slope represents the estimated change in depressive symptoms every year before death. Thus, a negative slope indicates an increase in depressive symptoms every year approaching death (ie, each successive year before death had fewer depressive symptoms). The linear slopes of the CES-D and 2 of the 3 subscales (depressed affect and somatic complaints) were significant, which indicated an increase in depressive symptoms with approaching death (Table 5). The quadratic slope of the CES-D was also significant, but this was due to the positively worded items. The quadratic slope was not significant for any of the subscales, nor was it significant for the CES-D total score without the positively valenced items ($\hat{\beta}_3 = 0.00$ [SE = 0.00]; $P = .99$). These results suggested that although there was an increase in depressive symptoms with approaching death, the increase was not exponential.

To put the effect of death into context, we examined the corresponding change in depressive symptoms for long-lived participants. We selected 59 participants aged 90 years or older at their last CES-D assessment and estimated their trajectories. The mean age at death was 85 years, so we compared the increase in depressive symptoms across the last decade of life with the increase in depressive symptoms among the long-lived participants between the ages of 75 and 85 years. From the estimates based on the distance to death analysis, depressive symptom scores increased about 2.0 points in the decade before participants died. By comparison, scores in the long-lived participants increased about 1.9 points between the ages of 75 and 85 years. Somatic complaints, which might be expected to increase the most before death, increased by about 1.0 point in the last decade of life, whereas they increased by 1.7 points in the long-lived group. Thus, although there seems to be an increase in depressive symptoms with the approach of death, the increase is roughly similar to that seen with age among the most long-lived (and thus presumably healthier) participants.

Discussion

Using repeated assessments of the CES-D for 30 years, we estimated the trajectory of depressive symptoms across the adult life span. At about age 66 years, participants scored approximately 5.78 on the CES-D scale, which is in the range of scores for other large samples of similar age (eg, the mean CES-D score was 5.81 at a mean age of about 65 years in the Rotterdam Study45). Significant linear and quadratic slopes indicated that symptoms of depression tend to be highest in young adulthood, decrease across middle adulthood, and increase again in older age, with the most prominent change seen for those who had ever experienced severe depressive symptoms. Individual differences in the slopes of the trajectories suggested that not everyone is changing in the same way. The use of antidepressant medication had the largest association with the slope of depressive symptoms; the effects of the demographic factors, disease burden, and functional limitations were small to moderate by comparison. Finally, disease burden, functional limitations, and impending death explained only part of the increase in depressive symptoms in older adulthood.

Psychological health across the life span has been addressed in several ways, including age-related changes in the prevalence of major depression and other mood disorders, assessments of depressive symptoms, and various indexes of well-being. Large-scale studies have consistently documented declines in the 12-month prevalence of mood disorders across adulthood, including a further decline in older age.46-48 Consistent with smaller studies, our findings parallel these age trends until older adulthood, when, starting in about the seventh decade of life, depressive symptoms begin to rise. This uptick toward the end of life differs from age-related changes in prevalence, but the increase in old age is similar to findings in smaller longitudinal studies of depressive symptoms limited to older adulthood.8,10 Findings in subthreshold depression,49 and the trajectory of related con-
Structs, such as neuroticism. In the present study, the increase in depressive symptoms toward the end of life was relatively modest, with an estimated mean increase of 1.4 per decade points in the CES-D total scale score between the ages of 60 and 90 years. In contrast to clinical mood disorders, the increase in depressive symptoms in old age may be a general phenomenon that tends to occur across a broad segment of the population, not just in a few cases that cross the clinical threshold. Thus, although the prevalence of extreme depressive symptoms may decline, the mean number of depressive symptoms in the population may increase.

Symptoms of depression tend to be more severe among women, ethnic minorities, and persons with lower education. Our findings generally mirror these mean-level trends, except that, because women reported higher well-being as well as more depressed affect, sex was unrelated to the intercept of the CES-D total scale score. With age, there may or may not be sex differences in the trajectory of depressive symptoms. We found support for both positions: sex was associated with the slope of depressed affect but not with any other symptoms of depression. The convergence between men and women in older age was due mainly to a steeper increase in symptoms reported by men starting in their mid-60s.

In charting the trajectory of depressive symptoms into old age, it is important to distinguish between somatic and nonsomatic aspects of depressive symptoms. Our analysis at the subscale level indicated that the uptick in the CES-D total scale score in older adulthood was not due exclusively to somatic complaints. In addition to the increase in somatic complaints, which may be due in part to declines in physical health, older age was also associated with an increase in depressed affect. Although pain and other physical conditions increase substantially with age, the comorbid association between depression and physical ailment may not. Functional limitations may be associated with increases in depressive symptoms, but declines in physical health with aging do not account for all of the increases in depressive symptoms. Similarly, in the present study, neither disease burden nor functional limitations could completely explain the increase in depressive symptoms at older ages. More detailed assessments of physical functioning, however, are needed before ruling out that the increase in depressive symptoms with age is not due solely to declines in physical health.

In addition to disease burden, proximity to death may partially contribute to the end-of-life increase in depressive symptoms. Previous research has found that well-being declines exponentially with impending death; there may be a corresponding increase in depressive symptoms. We found partial support for this hypothesis. There was a small increase in depressive symptoms with approaching death when either age or distance to death was used as the time metric. There was not, however, any evidence of an exponential increase in depressive symptoms, and the increase was comparable to that of age-related changes estimated from the most long-lived participants in the sample. Taken together, previous research on well-being and the present study on depressive symptoms suggest that as death approaches, individuals may become less happy rather than experience more sadness. Similarly to disease burden and functional limitations, impending death did not fully account for all of the increase in depressive symptoms in old age.

Factors other than those tested in this study may contribute to the increase in depressive symptoms in older age. With age comes loss, and the loss of loved ones, social support networks, employment, and income can contribute to increases in depressive symptoms. Psychological factors, such as changes in perspective, feelings of obsolescence, and loss of personal control, as well as changes in coping styles and beliefs also may contribute to the increase in depressive symptoms toward the end of life. Thus, life circumstances and psychological processes may explain the increase in depressive symptoms in old age that is not accounted for by deteriorating physical health.

This study had several strengths, including a large sample with more than 30 years of assessments of one of the most commonly used measures of depressive symptoms in epidemiology across a broad age range. Despite these strengths, some limitations should be considered. For example, our sample was more educated than the general population. Our findings, however, were broadly consistent with cross-sectional studies of age-related changes in depressive symptoms. In addition, our analyses of impending death might be limited in 2 ways. First, because participants with a terminal illness may have missed assessments because they were too sick to continue participation in the study, we may have missed a critical time before death. Second, because our sample was fairly privileged, participants may have remained healthier longer, enduring a relatively shorter decline toward death. Thus, the increase in depressive symptoms with impending death may have been more modest than in more representative samples.

Despite these limitations, the present research provides useful information on changes in depressive symptoms across the adult life span. The overall trajectory was consistent with
the clinical literature until older adulthood, which suggests that older adults are susceptible to increased distress. These seemingly modest effects are nonetheless clinically meaningful. Previous research on subthreshold depression, for example, has suggested that scoring just 6 points on the CES-D is associated with a significant increase in functional limitations 3 to 4 years later and with more disability days and lower self-rated health and social support. Mild depressive symptoms also have been associated with slower physical and cognitive functioning. Thus, seemingly modest depressive symptoms may have a significant effect on many aspects of an individual's life in older adulthood. The divergence with clinical depression and the effect of even modest depressive symptoms on physical and cognitive functioning underscore the importance of assessing distress that does not pass a clinical threshold.

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Depressive Symptoms Across Adulthood


