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Prevalence, incidence, and persistence of major depressive symptoms in the cardiovascular health study

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Abstract

Purpose—To explore the association of major depressive symptoms with advancing age, sex, and self-rated health among older adults.

Design and methods—We analyzed 10 years of annual assessments in a longitudinal cohort of 5888 Medicare recipients in the Cardiovascular Health Study. Self-rated health was assessed with a single question, and subjects categorized as healthy or sick. Major depressive symptoms were assessed using the Center for Epidemiologic Studies Short Depression Scale, with subjects categorized as nondepressed (score < 10) or depressed (≥ 10). Age-, sex-, and health-specific prevalence of depression and the probabilities of transition between depressed and nondepressed states were estimated.

Results—The prevalence of a major depressive state was higher in women, and increased with advancing age. The probability of becoming depressed increased with advancing age among the healthy but not the sick. Women showed a greater probability than men of becoming depressed, regardless of health status. Major depressive symptoms persisted over one-year intervals in about 60% of the healthy and 75% of the sick, with little difference between men and women.

Implications—Clinically significant depressive symptoms occur commonly in older adults, especially women, increase with advancing age, are associated with poor self-rated health, and are largely intransigent. In order to limit the deleterious consequences of depression among older adults, increased attention to prevention, screening, and treatment is warranted. A self-rated health item could be used in clinical settings to refine the prognosis of late-life depression.

Keywords

self-rated health; mental health; epidemiology

Introduction

Fifty years ago, the psychiatrist Sir Martin Roth challenged a belief dating back to Galen that aging causes intractable sadness (Roth, 1955). By examining the natural history of depressed older patients, Roth found that many of them recovered fully, even when they were quite old. Subsequent research has explored the differences between younger and older adults in the incidence, prevalence, natural history, and treatment outcomes of depression

(Schneider, Reynolds, Lebowitz, & Friedhoff, 1994; Subramaniam & Mitchell, 2005), but among older adults the association of advancing age with depression is less clear.

Previous studies of aging and depression have utilized various approaches to identify depression, including a clinical diagnosis or symptoms above certain thresholds on scaled instruments. Depending on the definition, the prevalence of depression has been found either to increase with age (Roberts, Kaplan, Shema, & Strawbridge, 1997; Roberts, Lee, & Roberts, 1991), to be unassociated with advancing age (Luijendijk et al., 2008; Steffens et al., 2000; van't Veer-Tazelaar et al., 2008), to decline with age (McDougall et al., 2007; Samuelsson, McCamish-Svensson, Hagberg, Sundstrom, & Dehlin, 2005), or to decline and then increase among the oldest old (Heikkinen & Kauppinen, 2004). The diagnostic schemes used to define depression clearly impact prevalence estimates (Koenig, George, Peterson, & Pieper, 1997). It has been found that both the prevalence of major depression declines (to below 1% in some community samples), and the prevalence of depressive symptoms increase with advancing age (Blazer, 2008; Koenig & Blazer, 1992). Findings from research about the prognosis of depression with advancing age have also been mixed. Although major depression appears to persist for most older adults (Beekman, Deeg, Smit, & van Tilburg, 1995; Cui, Lyness, Tang, Tu, & Conwell, 2008; Unutzer et al., 2002), in other studies up to 80% older people with borderline depressive symptoms have shown no evidence of depression one year later (van Marwijk, Hermans, & Springer, 1998). Significant differences have been observed between older women and men in the prevalence and incidence of depression, with women showing up to twice the incidence compared with men (Heun & Hein, 2005; Luijendijk et al., 2008; McDougall et al., 2007).

Health status may be a key factor in the incidence and persistence of depressive symptoms with advancing age (Blazer, 2008; Schnittker, 2005). The prevalence of sickness increases with age (Diehr, Derleth, & Newman, 2007), and may confound effects of aging on mental health (Blazer, Burchett, Service, & George, 1991; Diehr et al., 2006). Sickness and poor health have been posited as a cause of depression in aging adults; as a recent textbook of geriatric mental health notes, "depressive symptoms can be a part of a reaction to medical illness, disability, and/or discomfort" (Zarit & Zarit, 2007). Epidemiological studies suggest that chronic health problems mediate the association between advancing age and depression (Roberts et al., 1997), and depression treatment trials suggest that medical comorbidities, which increase during aging, are risk factors for inferior treatment response (Subramaniam & Mitchell, 2005). Health status thus merits consideration in analyzing changes in mental health with advancing age.

We sought to explore the association of age and sex with depression in people aged between 65 and 90 in a large representative longitudinal cohort, the Cardiovascular Health Study (CHS). We analyzed the probabilities of transitions between states of self-rated health and depression, including death. We computed the association of advancing age, sex, and self-rated health with (1) the prevalence of clinically significant depressive symptoms and (2) the probability of becoming depressed or remaining depressed. The findings are important for understanding psychological changes during aging, for psychiatric epidemiology, and for organizing interventions to improve geriatric mental health.

Design and methods

Study population

The CHS is a twenty-year longitudinal study of risk factors for the development of heart disease and stroke in individuals aged 65 and older at the time of enrollment (Fried et al., 1991). Eligible subjects were identified from Medicare eligibility lists within four United States Communities, and recruited through a letter and subsequent telephone calls.

Individuals who were institutionalized, undergoing cancer treatment, or wheelchair bound at home were excluded. A total of 3654 participants were recruited starting in about 1990, along with 1547 other age-eligible persons from their households, for an initial cohort size of 5201. Starting in 1993, 687 additional African American subjects were enrolled, yielding a total of 5888 subjects. Participants underwent yearly evaluations until 1999 including a variety of medical, functional, social, and psychological assessments. Mortality was ascertained by surveillance and semiannual contacts with subjects and their families.

The CES-D

Major depressive symptoms among CHS subjects were assessed using the Center for Epidemiologic Studies Short Depression Scale (CES-D 10). This instrument asks about symptoms experienced during the last week, focusing on mood (five items), energy level (two items), irritability, concentration, and sleep (one item each). The response set is the same for each question, with four possible answers: “less than 1 day” (0 points), “1–2 days” (1 point), “3–4 days” (2 points), and “5–7 days” (3 points). A total score of 10 or greater on this shortened CES-D form has been found to be an appropriate cutoff for identifying major depression among all adults (Andresen, Malmgren, Carter, & Patrick, 1994). The cutoff of 10 on the CES-D to define major depressive symptoms is different from some other research on depression in the CHS, which used CES-D scores of seven (Steffens, Krishnan, Crump, & Burke, 2002) or eight (Arbelaez, Ariyo, Crum, Fried, & Ford, 2007). Other studies have used a score of 16 on the full CES-D (van’t Veer-Tazelaar et al., 2008), corresponding to eight on the short form. Using a score of 10 was more likely to select subjects more likely to have major depression rather than subthreshold symptoms or adjustment disorders. The CES-D has been the subject of extensive additional research among older adults, and is considered to be a valid screening tool for identifying clinically significant symptoms of depression in this group (Andresen et al., 1994; Beekman et al., 1997; Irwin, Artin, & Oxman, 1999). Hereafter we thus use “depression” to refer to the presence of major depressive symptoms as indicated by CES-D score.

Self-rated health

Self-rated health was assessed by a single item, asking subjects to rate their health with the following question: “Is your health excellent, very good, good, fair, or poor?” This measure, although entirely subjective, has been found to be strongly correlated with health and mortality outcomes. A meta-analysis of 27 studies showed that global self-rated health consistently and independently predicted mortality (Idler & Benyamini, 1997), with the association holding even after adjusting for other objective health status indicators, such as chronic disease severity, physiological measures, and treatments used. The self-rated health measure has been examined extensively in the CHS; the most complete analysis looking at the trajectories of self-rated health during aging, after serious health events, and prior to death, found that it was strongly associated with specific changes in health status and mortality (Diehr, Williamson, Patrick, Bild, & Burke, 2001).

Analysis

Subjects were categorized each year by major depressive symptoms and by self-rated health status. They were labeled as “depressed” if the CES-D score was 10 or greater, and “nondepressed” if the score was less than 10, and “healthy” if self-rated health was excellent, very good, or good, and “sick” if it was fair or poor. This yielded five total states: healthy nondepressed, healthy depressed, sick nondepressed, sick depressed, and dead.

To model prevalence, the percentage of depressed subjects was computed for each age and sex group, for the total study population, and for self-rated sick and healthy groups separately, combining data from all survey waves. To model incidence and persistence, we

conducted a transition probability analysis. This approach, related to Markov modeling, estimates the one-year probability of transition from one health state to any other health state at each age, and has been used to characterize population-level changes in self-rated health during aging in the CHS (Diehr & Patrick, 2001; Diehr, Yanez, Derleth, & Newman, 2008).

Graphs were generated from the age- and sex-specific transition probabilities of becoming or remaining depressed, using locally weighted smoothing. In order to determine the statistical significance of the association of age and sex with the prevalence, occurrence, and persistence of depression, generalized estimating equation regressions were computed with age as a covariate. This procedure accounted for the multiple observations on the same participants during the duration of the study (Lumley, Diehr, Emerson, & Chen, 2002). Nonlinear relationships were examined by including age-squared and log(age) in the models. Dichotomizing subjects as depressed or nondepressed does not account for various degrees of depressive symptoms, and might oversimplify the associations of age, sex, and health status with mood states. In order to estimate more generally how these variables effect changes in depressive symptoms, linear regression models including age, sex, and race were created including one-year change in CES-D score as the outcome variable.

About 15% of either self-rated health or CES-D observations were missing, usually together. Excluding the cases with missing data would have resulted in measuring only the transitions where starting and ending states were fully known, which could exaggerate associations between health-related factors and health states associated with nonresponse, for instance being unable to complete the annual review because of health problems or depression. The data were thus imputed for CES-D and self-rated health, using a subject's own values before and after the missing data, by linear interpolation (Engels & Diehr, 2003). If terminal or initial measures were missing, they were assumed to be unchanged from the most proximal observation recorded (last observation carried forward and first observation carried backwards). Last observation carried forward has been found to be an appropriate imputation technique in the CHS (Engels & Diehr, 2003), and single imputation in this dataset has been found to be little different from multiple imputation (Arnold & Kronmal, 2003). In order to ascertain if the findings were consequent to imputation techniques, separate analyses were conducted only for the data in which initial and final observations were recorded, and these were compared with the imputed results.

Data cleaning, imputation, and categorization were carried out using Perl scripts written for this project (ActiveState Perl). Statistical analyses were conducted in Stata version 9.0.

Results

There were 3393 (57.6%) women and 2495 (42.4%) men enrolled in the CHS cohort. The mean age at baseline was 73. About 28% had less than high school education, 62% had high school or college, and 10% had postgraduate education. At age 65, 14% of the living subjects described themselves as sick ("fair" or "poor" on self-rated health), and by age 90 this increased to 42%.

A total of 45,612 one-year transitions in health state were analyzed. Of these, 33,936 (74%) started healthy and 11,676 (26%) sick. Among women, 26.3% of the transitions started in a sick state, and among men, 24.4%; the difference was statistically significant (chi-square = 19.4, $p < 0.001$). About 37,208 (82%) of the transitions started nondepressed, and 8404 (18%) depressed. Among women, 21.6% of the transitions started depressed, and among men, 13.8%; the difference was highly statistically significant (chi-square = 437.9, $p < 0.001$).

Prevalence

Figure 1 represents the age-specific prevalence of depression, reported for the entire group, for healthy subjects, and for sick subjects. The sick had considerably higher prevalence of depression than the healthy, women had higher prevalence than men, and there was an increase in the prevalence of depression with advancing age. Table 1 shows the coefficients for age and sex in the regression models for prevalence. The p -values for all the age coefficients (<0.001) indicate that there was a significant association of increasing age with increased prevalence of a depressed state. Regression models including age-squared and $\log(\text{age})$ were not significant for these nonlinear terms, suggesting a linear trend for age.

The increased prevalence with age was considerably higher among the sick (0.79% increase per year of age) than among the healthy (0.43% increase per year of age). The increase in the entire group (0.82% per year of age) was larger than in either of the sub-groups, which can be explained by the increase in the percentage of subjects who were sick at older ages. A regression model including a term for “health state*age” showed a highly statistically significant interaction term ($Z = 3.74$, $p < 0.001$), suggesting that age has a significantly greater effect on depression prevalence among the sick than the healthy. Women showed significantly higher prevalence of depression than men in both the healthy (10.8% higher) and sick (6.7% higher) groups. Regression models including “health state * sex” and “age * sex” were not significant for the interaction terms, suggesting that the effects of sex did not differ considerably based on health status or age.

Probabilities of becoming or remaining depressed

The incidence and persistence of major depressive symptoms are shown Figures 2 and 3. The lines represent the one-year probability of entering or remaining in a depressed state, grouped by health status and sex. The self-rated health category (sick or healthy) is for the first year of the transition. Women showed a higher incidence of becoming depressed at all ages in the healthy group, and until about age 85 in the sick group. Women had a slightly higher persistence of depression across all ages, especially in the healthy group. Regression models for the probability of becoming or remaining depressed by health status and sex are presented in Table 2. The age coefficients represent the difference in the probability of the described transition for subjects measured one year apart. There were statistically significant effects of age for the healthy becoming depressed, the healthy remaining depressed, and the sick remaining depressed, with the largest increases with advancing age for remaining depressed. The probability of becoming depressed among the sick was not significantly associated with age. Women showed significantly higher probabilities of becoming depressed in both the healthy and sick, and of remaining depressed in the healthy, with rates about 3–5% higher than among men. Sick women were not significantly more likely to remain depressed than sick men.

Weighted regression models including age-squared and $\log(\text{age})$ did not show significance for nonlinear terms, suggesting overall linear trends (including for the sick female group in Figure 2, where there was no monotonic increase with age observed). Models including a term for the interaction of sex and age or sex and health state were not significant for these terms, indicating that sex was not associated with a differential effect across groups. Models including a term for age and health state (sick or depressed) were significant for the interaction terms ($Z = -2.19$, $p = 0.029$ for becoming depressed, and $Z = -5.14$, $p < 0.001$ for remaining depressed), indicating that age had a greater effect on these outcomes among the healthy than among the sick.

To illustrate the consequences of the various coefficients across age and sex groups, the estimated differences in incidence or persistence of depression between 65-year old and 90-

year old men and women are listed in the Table 3. When compared with 65-year olds, 90-year olds were estimated to have about a modest increased probability of becoming depressed, whether sick or healthy (3–4% greater among men, and 6–8% among women), but a much more increased probability of remaining depressed, particularly so among the healthy (23% greater among healthy men, 14% among sick men, 28% among healthy women, and 16% among sick women). The largest age effects are thus seen in the persistence of depressive symptoms among healthy men and women.

Incremental changes in CES-D

The analysis of change in CES-D score as a continuous outcome variable showed similar age and sex trends as those using dichotomous categories of depressed and nondepressed. For the whole group, each increased year of age was associated with a 0.010-point annual worsening in CES-D score, and the result was highly statistically significant ($Z = 6.7$, $p < 0.001$, 95% CI 0.007–0.013). For instance, a 90-year old would be computed to show on average a 0.25-point greater increase in CES-D per year than a 65-year old, or a one-point greater increase over 4 years. Among the healthy, the one-year CES-D worsening with each year of age was smaller (0.008 point change) than among the sick (0.013 point change), but both results were highly statistically significant ($p < 0.001$). An interaction term for age and health status ($Z = 2.51$, $p = 0.012$) suggested that the worsening in CES-D score with age was significantly greater in the sick than the healthy. Sick women showed a 0.16-point greater increase in CES-D score each year compared with sick men ($Z = 4.1$, $p < 0.001$), but healthy women were not statistically different than healthy men in CES-D change per year ($Z = 0.18$, $p = 0.856$). Interaction terms for sex and age and sex and health status were not significant.

The effects of the initial severity of depressive symptoms on change in these symptoms at one year were modeled by including a term for initial (at the start of the transition) CES-D score. For the whole group, each additional point on initial CES-D score was associated with a 0.62-point drop in CES-D score one year later ($Z = 143.5$, $p < 0.001$), suggesting that those with greater depression severity were more likely to show improvements in depressive symptoms. This effect was more pronounced among the healthy (0.55-point drop, $Z = 110.3$, $p < 0.001$) than among the sick (0.39-point drop, $Z = 53.8$, $p < 0.001$). Those who were categorized as not depressed (CES-D < 10) showed a slightly smaller effect of initial score on one-year change in CES-D score (0.49-point drop, $Z = 71.4$, $p < 0.001$) than those who were categorized as depressed (0.71-point drop, $Z = 56.0$, $p < 0.001$), but there was no significant interaction between depression category, initial CES-D score, and CES-D change. There was no difference between men and women in the effects of baseline CES-D score on its change.

Imputation

The effects of imputation on the prevalence, incidence, and persistence estimates were explored by repeating the analyses without any of the imputed cases. The nonmissing cases constituted 87% of all observations, 90% of observations starting in a healthy state, 79% of those starting in a sick state, 88% of those starting in a nondepressed state, and 82% of those starting in a depressed state. The coefficients from the weighted regression models from the nonimputed data were within 5% of the coefficients computed using the full imputed dataset, for both prevalence and incidence (data not shown). The statistical significance of the age-related trends (at both $\alpha = 0.05$ and $\alpha = 0.01$) was also not affected by using only nonimputed data.

Discussion

This study is, to our knowledge, the first to explore in detail the associations of advancing age, sex, and self-rated health with the prevalence of a depressed state, and the probability of entering into or persisting in a depressed state among community-dwelling older Americans. Unlike previous research which found no association of depression with age, or a decline in the prevalence of depression with advancing age, this study demonstrated age-related increases in the prevalence and persistence of major depressive symptoms, and an increase in their incidence among the healthy, but not the sick. Moreover, the average score on the CES-D worsened with advancing age, with a greater worsening among the sick than the healthy.

The most important finding for population health is the high probability, increasing with advancing age that clinically significant depressive symptoms persist among older adults, both the healthy and the sick, and in men and women (Figure 3). Consistent with research from other populations (Cui et al., 2008; Harris, Cook, Victor, DeWilde, & Beighton, 2006; Smalbrugge et al., 2006; van Marwijk et al., 1998), depression in older life seems in many ways to be an intransigent condition. Treatment trials confirm the high rate of persistence: less than one in five depressed older patients in usual care showed substantial (50% or greater) reduction in depressive symptoms at one year despite the fact that most received antidepressant prescriptions in primary care or referral to mental health specialists (Unutzer et al., 2002). Clinicians should not thus assume that depression will resolve spontaneously in older adults.

These results strongly argue for more aggressive identification and treatment of depressive states in older adults. Unlike other age-related conditions which may be clinically intractable or not amenable to specific therapy (as general poor self-rated health would be), depression can be treated successfully in older adults, including among those with significant comorbidities (Bogner, Morales, Post, & Bruce, 2007; Unutzer et al., 2002). Despite the age-related trends in depressive symptoms observed here, there is no evidence that current evidence-based treatments for geriatric depression, such as psychotherapy and medications are any less effective as persons advance in age (Cuijpers, van Straten, Smit, & Andersson, 2009; Unutzer et al., 2002). Clinically, these population-based findings strongly argue for more screening and active treatment of depression in persons aged 65 and above, even to very advanced ages. This may conflict with the preconceptions of clinicians, who often overlook psychological disorders in older adults (Quinn, 1987; Waxman & Carner, 1984), or who may expect that older people are disengaged, unproductive, and inflexible (Grant, 1996). The analysis of CES-D scores over time showed, to the contrary, that subjects with higher scores were more likely to show improvements at one year, arguing against a “fixed” set of depressive symptoms.

Self-rated health appeared as an important factor in discriminating older adults most at risk for becoming or remaining depressed (Figures 2 and 3). This is somewhat unexpected, because while self-rated health is strongly associated with mortality and health-related quality of life, it does not correspond directly with objective health status measures, such as age, number of chronic diseases, or medication use, or with mental health (Idler & Benyamini, 1997). Clinicians seeking to identify persons most at risk for the onset or persistence of mood disorders might thus consider using self-rated health as part of geriatric health assessment and as a tool for prognosis. Practically, the self-rated instrument is very easy to administer, involving a single, easily worded question that can be asked in writing or as part of a clinical interview. At the same time, even healthy subjects showed high persistence of depressive symptoms (above 50% for all ages), and not insignificant incidence (5–10% per year). Clinicians should not assume that depression in old age is entirely related to poor health, or that healthy older adults are immune to depression.

The higher prevalence and incidence of depressive symptoms in women compared with men comports with previous research on older adults, yet the high persistence in both sexes (Figure 3) argues against specifically targeting older women for treatment efforts. The lack of interactions between sex and age and between sex and self-rated health on the prevalence, incidence, and persistence of depressive symptoms (observed as the relatively parallel and equally spaced lines for groups of men and women in Figures 1–3, and in the regression analyses) suggests general differences in depressive symptomatology between men and women, but not effects contingent on advancing age or health status. The lack of a difference between men and women in the effects of initial CES-D score on declines in CES-D at one year implies that the course of depressive symptoms might not be markedly different in older men and women, although the number or severity of these symptoms may be higher in women. It is possible that gender differences in endorsing items on the CES-D contribute to the observed trends by sex, although other diagnostic schemes have generated similar results (Heun & Hein, 2005; Luijendijk et al., 2008).

Given the complex association of mental health with general health status, it is possible that depression confounded reports of self-rated health, for instance if depressed patients reported more health problems as a result of their low mood states. In this case, the sick depressed and sick nondepressed groups would be expected to have different objective health status, and thus to manifest different health transitions. We explored this potential effect by comparing the depressed and nondepressed groups in one-year mortality, which we considered to be a proxy for global health status, and in new onset functional limitations as measured by any decline in Instrumental Activities of Daily Living (IADL). In a weighted logistic regression model adjusting for age and sex, there was a 1.8 times greater one-year mortality associated with a depressed state compared with a nondepressed state among the healthy ($Z = 5.43$, $p < 0.001$), but not among the sick (1.0 times increased risk, $Z = -0.09$, $p = 0.851$). There was a 1.5 times greater probability of IADL decline associated with a depressive state among the healthy ($Z = 9.46$, $p < 0.001$), and a 1.2 times greater probability among the sick ($Z = 4.00$, $p < 0.001$). These findings suggest, provocatively, that depression might be a more significant marker for poor health and declining functional status among the healthy than among the sick. The associations between depression, self-rated health, comorbidity, mortality, and disability deserve further research.

Transition models can help to elucidate how the onset of sickness affects depressive symptoms, and vice versa. An exploratory analysis suggests that subjects who became sick were likely to become depressed at the same time, and that subjects who became depressed were more likely to become sick. From the group of healthy nondepressed, 10.8% became sick, 7.7% became depressed, and 1.7% became both sick and depressed. Of these who became depressed, 21.6% also became sick, and of these who became sick, 15.3% also became depressed. Depression and sickness were thus likely to co-occur at one year (chi-square 275.5, $p < 0.001$). Put another way, becoming sick doubles the probability of becoming depressed, and becoming depressed doubles the probability of becoming sick. While cause and effect can be difficult to ascertain (Dalle Carbonare et al., 2009), the longitudinal associations between depression and self-rated health deserve further research, and can help to clarify the roles mental and physical health status in advancing age.

Limitations

This study analyzed data from a large community-based longitudinal cohort, which was intended to be representative of the United States population aged 65 and above, but there may have been selection bias. At baseline, it excluded those who were not community-dwelling, or who had significant impairments or serious medical conditions, groups which may show different age-related trends in health and mood symptoms. Subjects who incurred these exclusion conditions after enrollment were kept in the study. Subjects were

dichotomized as depressed or nondepressed, which may have concealed differences between major and minor depression, although an analysis using CES-D as a linear variable confirmed the findings from the dichotomized analyses. Depressive symptoms may have influenced how subjects labeled their self-rated health, or poor health may have influenced mood states, and no objective measures of health status or functioning were applied in the primary analyses. The use of treatments for depression, such as antidepressant medications, was not examined because these data were not available. There may be age-related trends in the utilization of mental health services (such as less treatment in older subjects) that account for differences in prevalence, incidence, and persistence of depressive states, although prior treatment studies in real world health care settings indicate that depressed older patients show uniformly low rates of remission (Unutzer et al., 2002).

Conclusions

In a large longitudinal cohort of older adults that is roughly representative of the American population, the prevalence of major depressive symptoms increased with advancing age. The probability of becoming depressed increased with advancing age among the healthy (who had an overall probability of becoming depressed of about 7% each year), but not among the sick (who had an overall probability of becoming depressed of about 13% each year). The probability of remaining in a depressed state was high, with over 50% of the healthy and over 70% of the sick who were initially depressed remaining in a depressed state one year later, and this increased with advancing age. We conclude that many depressed older adults manifest an intransigent depression, with a declining probability of remission as they become older. These findings strongly argue for increased attention to preventing (Cuijpers & Smit, 2008; Reynolds, 2008), screening for, and treating depression in older populations. Given that initial treatments are often not effective, these findings also argue for systematic efforts to modify and intensify treatments until substantial improvements in depression are achieved, an approach that is consistent with recent recommendations for measurement-based stepped care (Zisook, Ganadjan, Moutier, Prather, & Rao, 2008), and for systematic efforts to engage in relapse prevention (Dobson et al., 2008; Reynolds et al., 1996).

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Figure 1. Prevalence of depressed state by age and sex, for the entire cohort and for those in a self-rated sick or healthy state.

Figure 2. Probability of becoming depressed by age and sex, for women and men starting in sick or healthy states.

Figure 3.
Probability of remaining depressed by age and sex, for subjects starting in sick or healthy states.

Table 1

Generalized estimating equation model for prevalence of depression.

	Number of transition pairs	Increased prevalence per additional year of age (95% CI)	Z	Increased prevalence in women compared with men (95% CI)	Z
Entire group	45,612	0.82% (0.73–0.91%)	18.2 [*]	8.0% (6.5–9.4%)	11.0 [*]
Healthy	33,936	0.43% (0.34–0.52%)	9.7 [*]	6.7% (5.4–7.8%)	10.9 [*]
Sick	11,676	0.79% (0.60–0.98%)	8.2 [*]	10.8% (8.1–13.7%)	7.6 [*]

^{*} Note: $p < 0.001$.

Table 2

Generalized estimating equation models for probability of becoming or remaining depressed.

Transition	Increased % making transition per year of age	Z	p	Increased % in women compared with men	Z	p
Healthy – becoming depressed	0.16	4.8	<0.001	3.8	9.8	<0.001
Sick – becoming depressed	0.12	1.5	0.135	3.0	3.0	0.003
Healthy – remaining depressed	0.92	5.8	<0.001	4.7	2.2	0.028
Sick – remaining depressed	0.56	3.9	<0.001	2.1	1.1	0.284

Table 3

Estimated increase in probability of becoming or remaining depressed for a 90-year old compared with 65-year old, grouped by health status and sex.

Group	Becoming depressed: 90- vs. 65-year old	Remaining depressed: 90- vs. 65-year old
Female-sick	5.9%	16.4%
Female-healthy	7.8%	27.7%
Male-sick	2.9%	14.3%
Male-healthy	4.0%	23.1%