

# Suicide Risk in Older Adults: Evaluating Models of Risk and Predicting Excess Zeros in a Primary Care Sample

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Research is needed that examines theory-based risk factors for suicide in older adults. The interpersonal theory of suicide (Joiner, 2005; Van Orden et al., 2010) provides specific hypotheses regarding variables that contribute to the development and variability in death ideation and suicide ideation; however, data suggest that older adults may not report suicide ideation in research settings or to treatment providers even when they experience it (Heisel et al., 2006). The purpose of this study was to test theory-based predictions regarding variables that contribute to death ideation (i.e., a passive wish to die) and suicide ideation in older adults. This study introduces the application of zero-inflated negative binomial regression (ZINB) to the study of suicidal behavior. ZINB was used to test theory-based predictions, while also testing a hypothesis regarding variables associated with denial of suicide ideation among participants who endorsed risk factors associated with suicide risk. Participants included 239 adults aged 60 and older recruited from primary care clinics who completed a variety of self-report instruments. The results of this study indicated that perceived burdensomeness and hopelessness were significantly associated with variability in death ideation. Additional results indicated that elevated scores on thwarted belonging, the interaction between perceived burdensomeness and hopelessness, and the interaction between thwarted belonging and perceived burdensomeness were associated with a significant reduction in the probability of a participant being a suicide ideator. These results offer substantial support for the interpersonal theory of suicide. The implications of these findings are discussed.

**Keywords:** older adults, interpersonal theory, suicide, zero-inflated negative binomial model

Compared with those in other age groups, older adults are at significant risk for death by suicide (CDC, 2012). The rate of death by suicide increases steadily from age 65 to 85, with the highest rate of suicide deaths among older adults ages 85 and older (CDC, 2012). Furthermore, the ratio of suicide attempts to deaths by suicide is in the range of 25:1 for all ages combined, whereas for adults over age 65 it is 4:1 (CDC, 2012), highlighting the pronounced risk for death by suicide in late life compared with younger cohorts. Paradoxically, previous research has also indicated that the rates of reported suicide ideation and suicide attempts decreases with increasing age in older adults (Duberstein et al., 1999; Lynch et al., 1999). As such, Witte et al. (2006) suggest that any endorsement of suicide ideation should be a strong indi-

cator of risk for suicide attempt and death by suicide in older adults. Given the low attempt to death ratio for older adults (i.e., 4:1), studies including primarily suicide attempters may not allow us to understand the multifaceted nature of suicide risk in older adults who die on a first or early suicide attempt. Therefore, it is critical that studies include community samples of older adults who represent a broad range of suicide risk.

Currently, our knowledge regarding older adult suicide risk is limited in two fundamental ways. First, more research is needed that examines theory-based risk factors for suicide in older adults using falsifiable predictions. Second, earlier research has suggested that older adults may not report suicide ideation in research settings or to treatment providers (e.g., mental health providers, primary care physicians), even when they experience it (Heisel et al., 2006). To date, the vast majority of studies have used continuous scales of suicide risk, assuming accuracy in reporting across the continuum. However, given that some individuals with low scores may be underreporting suicide ideation, this approach may be inadequate. Because older adults may still endorse other risk factors associated with suicide ideation (e.g., depressive symptoms, hopelessness), it may be informative to assess risk using an expanded set of indicators related to theory-based risk factors, allowing prediction of those who are at risk for ideation and those who are not. The current study addressed these limitations through the use of theory-based hypotheses regarding the prediction of death ideation and suicide ideation in older adults, and the use of a novel statistical approach for examining suicide risk among older adults.

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### Reporting of Suicide Ideation Among Older Adults

A critical consideration for any study examining suicide ideation in older adults is the potential for reporting bias, as noted above. This suggests a need for research that uses novel statistical procedures to identify two types of older adults: nonideators (i.e., individuals who deny suicide ideation and who report nonexistent risk on other variables associated with suicide ideation), and potential ideators (i.e., those who deny suicide ideation while simultaneously reporting other established risk factors for suicide).

To adequately examine variables that may be associated with nonideator or potential ideator status, community samples of older adults are necessary to ensure sufficient representation of the range of suicide risk in the population. The sampling of community participants, however, frequently results in a large percentage of respondents with zero (or equivalent) scores on the outcome measure (e.g., death ideation, suicide ideation). Common approaches to analyzing this type of data include multiple linear regression, Poisson regression, and negative binomial regression, but the use of these approaches results in misspecification, such that the regression coefficients for the predictor variables are unstable (cf., [Gurmu & Trivedi, 1996](#)). Binary logistic regression can be used with samples including a large percentage of zeros; however, this approach only predicts the presence or absence of an experience (e.g., suicide ideation vs. no suicide ideation), without explaining differences in severity when risk factors are present.

One approach that is used more frequently in other fields (e.g., economics, biometrics, health-care research, ecological studies; [Gurmu & Elder, 2008](#); [Hur, Hedeker, Henderson, Khuri, & Daley, 2002](#); [Lambert, 1992](#); [Minami, Lennert-Cody, Gao, & Román-Verdesoto, 2007](#)) is zero-inflated modeling, for instance, zero-inflated Poisson regression and zero-inflated negative binomial regression (ZINB). Recent publications have also described the application of these approaches to psychological sciences as well ([Atkins & Gallop, 2007](#); [Coxe, West, & Aiken, 2009](#)). As summarized by [Minami and colleagues \(2007\)](#), zero-inflated models accomplish two objectives regarding the prediction of the outcome variable in the presence of excess zeros. These models simultaneously estimate a binary logistic regression and a negative binomial or Poisson regression, while also accounting for the existence of two unique types of zeros. In relation to the current study, one type of zero (i.e., excess zeros) occurs in participants who deny suicide ideation and have little or no psychological distress (i.e., nonideators). It is important to note, given the *current* responses to questions pertaining to suicide-risk factors, individuals with this type of zero are highly unlikely to convert to nonzero on suicide ideation. The other type arises from participants who deny suicide ideation while reporting other empirically based risk factors (e.g., depression, hopelessness) for suicide ideation (i.e., potential ideators). The binary logistic portion of the model provides estimates of the likelihood of the dichotomous outcome (i.e., whether a participant is a nonideator or potential ideator). The negative binomial regression provides an estimate of the continuous relationship between the predictor variables and the outcome measure (i.e., death ideation, suicide ideation), having controlled for the effect of nonideators (i.e., excess zeros) on the estimation of ideation.

To date, no studies have used ZINB to identify variables associated with denial of suicide ideation among older adults. This

approach allows for differentiation between zero-ideation responses reflecting the absence of psychological distress associated with suicide risk, and zero-ideation responses occurring in participants who report distress variables that are correlated with suicide ideation. Therefore, we used this statistical approach, in combination with a theory-based model of risk factors (detailed below), to predict denial of suicide ideation.

### Risk Factors for Late-Life Suicide: Suicide Ideation, Death Ideation, Depression, and Hopelessness

Prior studies have suggested that suicide ideation is a significant risk factor for suicide deaths in older adults ([Conwell, Duberstein, & Caine, 2002](#); [Conwell, Van Orden, & Caine, 2011](#)). Researchers have also found increased risk for suicide in older adults reporting death ideation, symptoms of depression, and hopelessness (e.g., [Baca-Garcia et al., 2011](#); [Conwell et al., 1996](#); [Cukrowicz et al., 2009](#); [Rao, Denning, Brayne, & Huppert, 1997](#); [Suokas, Suominen, Isometsa, Ostamo, & Lonnqvist, 2001](#)). Although death ideation has historically been considered a less severe indicator of risk for suicide, several studies have concluded that adults reporting death ideation are similar to those reporting suicide ideation ([Baca-Garcia et al., 2011](#); [Rao et al., 1997](#); [Suokas et al., 2001](#)). For example, [Baca-Garcia and colleagues \(2011\)](#) examined death ideation and suicide ideation as predictors of suicide attempt using data from two large nationally representative surveys. The results indicated that the risk for lifetime suicide attempt was not significantly different for those with a history of death ideation, compared with those with a history of suicide ideation. This is consistent with other empirical findings examining outcomes for older adults reporting death ideation ([Rao et al., 1997](#); [Suokas et al., 2001](#)), suggesting that researchers should assess for death ideation in studies examining risk for suicide among older adults.

A significant body of literature has also found that depression and hopelessness are associated with suicide risk among older adults ([Conwell et al., 1996](#); [Conwell et al., 2002](#); [Cukrowicz et al., 2009](#); [Cukrowicz, Cheavens, Van Orden, Ragain, & Cook, 2011](#); [Scocco, Meneghel, Dello Buono, & De Leo, 2001](#); [Szanto et al., 2007](#); [Turvey et al., 2002](#)). These studies indicate that major depressive disorder is the most common psychiatric disorder in older adults who have died by suicide ([Conwell et al., 1996](#); [Conwell et al., 2002](#)). A large 10-year prospective study of predictors for late-life suicide found that depressive symptoms, perceived health status, medical status, cognitive difficulties, and affective functioning predicted suicide deaths ([Turvey et al., 2002](#)). Further, several studies have indicated significant associations between depressive symptoms and suicide ideation in community samples of older adults, as well as reduction in suicide ideation following reduction in depressive symptoms for depressed older adults participating in treatment ([Cukrowicz et al., 2009](#); [Cukrowicz et al., 2011](#); [Scocco et al., 2001](#); [Szanto et al., 2007](#); [Vannoy et al., 2007](#)). Likewise, numerous studies have indicated that hopelessness plays a significant role in suicide ideation and suicide deaths among older adults ([Britton et al., 2008](#); [Szanto, Reynolds, Conwell, Begley, & Houck, 1998](#)). These studies indicate that hopelessness is associated with the presence and severity of suicide ideation ([Britton et al., 2008](#)). In addition, hopelessness may remain high in older adult suicide attempters (compared with suicide ideators without attempt histories and nonsuicidal older

adults) even following medication treatment for depression (Szanto et al., 1998). Taken together, this research shows that death ideation, depressive symptoms, and hopelessness should all be included in studies examining risk for suicide among older adults.

The interpersonal theory of suicide (Joiner, 2005; Van Orden et al., 2010) has generated additional variables (i.e., *thwarted belonging* and *perceived burdensomeness*) that may contribute significantly to suicide or death ideation in older adults. Thwarted belonging is conceptualized as an absence of social relationships that results in feeling disconnected or without a sense of belonging (Joiner, 2005). Furthermore, thwarted belonging may develop when an individual lacks reciprocal caring relationships (i.e., lacking support in times of need or believing that he or she does not provide support to others; Van Orden et al., 2010). The second variable proposed by the interpersonal theory of suicide, perceived burdensomeness, is the perception that a person is a liability to others, which generates feelings of self-hatred (Van Orden et al., 2010). A person may feel like he or she is a burden on family members due to mental illness or physical disability, or due to the perception that he or she is not contributing to others because of unemployment or other limitations (Van Orden et al., 2010). It is important to note, empirical data examining older adult suicide risk supports significant associations between perceived burdensomeness and suicide ideation (Cukrowicz et al., 2011; Jahn, Cukrowicz, Linton, & Prabhu, 2011; Marty, Segal, Coolidge, & Klebe, 2012), as well as between thwarted belonging and suicide ideation (Marty et al., 2012; McLaren, Gomez, Bailey, & van der Horst, 2007).

### The Interpersonal Theory Provides Testable Models of Suicide Risk in Older Adults

Van Orden and colleagues (2010) made two predictions regarding the associations between interpersonal theory variables and death or suicide ideation. The first prediction specifically suggests that individuals who feel a lack of connection to others, or perceive themselves as a burden on others, may wish for death as a way to reduce these aversive states (Van Orden et al., 2010). For example, an individual who feels disconnected from others, and that others do not care about him or her, may feel that it would be easier to disappear or not wake up, rather than continue feeling a thwarted sense of belonging. In relation, individuals who perceive that their lives detract from the well-being of others may feel that others would be better off if they were dead. As such, Van Orden et al. (2010) predicted that the presence of *either* thwarted belonging or perceived burdensomeness would be associated with death ideation. The second prediction suggests that the simultaneous presence of thwarted belonging and perceived burdensomeness would be associated with suicide ideation (e.g., "I want to kill myself"), but only when an individual feels hopeless that these states will change (Van Orden et al., 2010).

While the empirical data outlined above has examined the interpersonal theory's constructs as correlates of suicide ideation, no research has yet examined these specific predictions in a multifaceted model of suicide risk in older adults. The present study tested these predictions in a model that also included depressive symptoms and hopelessness. The inclusion of empirically based risk factors for death ideation and suicide ideation (i.e.,

depressive symptoms, hopelessness, thwarted belonging, and perceived burdensomeness) allowed us to better account for the unique predictions proposed by the interpersonal theory (Van Orden et al., 2010).

Thus, our first hypothesis predicted that perceived burdensomeness, thwarted belonging, depressive symptoms, and hopelessness would each be significantly associated with death ideation. We further hypothesized that perceived burdensomeness and thwarted belonging would account for greater unique variance in death ideation than other included predictors. Our second hypothesis predicted the presence of a three-way interaction between thwarted belonging, perceived burdensomeness, and hopelessness, such that those with thwarted belonging and perceived burdensomeness would report the greatest suicide ideation if they also reported elevated hopelessness. Finally, we hypothesized a significant three-way interaction, such that elevated scores on thwarted belonging, perceived burdensomeness, and hopelessness would be associated with significantly reduced probability of being a non-ideator.

## Method

### Participants

Participants were 239 adults ages 60 and older ( $M = 72.4$ ,  $SD = 6.9$ ) recruited from a primary care setting at a southwestern university health-sciences center (cf. Cukrowicz et al., 2011; Jahn, Poindexter, Graham, & Cukrowicz, 2012; Van Orden, Cukrowicz, Witte, & Joiner, 2012). To identify potentially eligible participants, research personnel reviewed upcoming physician appointments for individuals aged 60 years and older from two primary care settings. Patients who met inclusion criteria (i.e., no physician note of bipolar disorder or mania, psychotic disorder, severe memory impairment, or cognitive difficulties, and had not previously participated or declined participation) were identified as potential participants. In order to maximize variability on study variables, this study did not select participants based on an elevated level of suicide ideation or death ideation, nor on a history of suicide attempt or self-injury. Potential participants were either mailed letters describing the study and subsequently contacted to determine their interest in the study or were approached at a scheduled medical appointment. A total of 436 letters were sent, with 105 patients agreeing to participate; 675 additional participants were approached at physician appointments, with 167 agreeing to participate. Participants came to the first author's research clinic for study participation or, if they were unable to travel to the clinic, research assistants conducted study sessions at participants' homes. Following consent, participants completed the Mini Mental Status Exam (MMSE; Folstein, Folstein, & McHugh, 1975), with a required minimum score of 25 for participation. Twenty-three participants were excluded due to MMSE scores and were provided referral information, four participants were missing a significant amount of data for the variables of interest in this study, and six participants with influential data points were dropped (see below).

The final sample consisted of 144 women (60.3%) and 95 men (39.7%). Marital status for this sample was: 66.7% married, 18.4% widowed, 7.9% divorced, 4.2% living with partner, 2.0% never married, 0.8% separated from spouse, and 0.8% in an intimate



relationship but not living with partner. Participants were 90.8% Caucasian, 6.3% Hispanic, 1.7% African American, and 1.2% other. The mean total years of education for this sample was 14.4 ( $SD = 3.5$ ). Fifty-eight participants (24.3%) reported a previous diagnosis of a psychological disorder. At the time of participation, 28 participants (11.7%) had a score greater than or equal to 16 on the Center for Epidemiological Studies Depression Scale (CES-D; Radloff, 1977), suggesting significant symptoms of depression. Within this sample, 12 participants (5.0%) had scores on the death-ideation and suicide-ideation variables greater than or equal to one standard deviation above the mean; 16 participants (6.7%) had scores indicating death ideation, but not suicide ideation, greater than or equal to one standard deviation above the mean, and 19 participants (7.9%) had suicide-ideation, but not death-ideation, scores greater than or equal to one standard deviation above the mean. Seven participants (2.9%) reported a history of suicide attempt. Sixty-four participants (26.8%) reported a lifetime diagnosis of a mental or psychological disorder. Diagnoses included depression ( $n = 44$ ; 18.4%), anxiety disorder ( $n = 8$ ; 3.3%), substance-use disorder ( $n = 4$ ; 1.7%), bipolar disorder ( $n = 3$ ; 1.3%), cognitive disorder ( $n = 1$ ; 0.4%), schizophrenia ( $n = 2$ ; 0.8%), and other or unknown ( $n = 2$ ; 0.8%). Twenty-three participants (9.6%) indicated that they had been diagnosed with a mental or psychological disorder within the past 12 months. Diagnoses included depression ( $n = 16$ ; 6.7%), anxiety disorder ( $n = 2$ ; 0.8%), bipolar disorder ( $n = 3$ ; 1.3%), substance-use disorder ( $n = 1$ ; 0.4%), and other ( $n = 1$ ; 0.4%).

## Procedure

All procedures for this study were in accordance with protocol approved by the university institutional review board. Older adults electing to take part in the study provided informed consent and completed self-report questionnaires as well as semistructured clinical interviews. Given that some questions pertained to current and past suicidal behaviors, all research personnel were trained in suicide-risk assessment. Researchers examined all participant responses related to suicide risk. In the event that a participant was identified as at risk, follow-up procedures and interventions were performed in accordance with the approved protocol. When participants completed the study, they were given a referral sheet that provided local mental health resources and were compensated for their time.

## Measures

**Beck Hopelessness Scale (BHS).** The BHS (Beck & Steer, 1988) is a 20-item true/false self-report questionnaire assessing negative cognitions and emotions about the future (Beck & Steer, 1988). Each item (e.g., "I might as well give up because I can't make things better for myself") is scored as either a 0 or 1; a sum total is computed (range 0 to 20), with higher scores reflecting greater hopelessness (Beck & Steer, 1988). Previous research has supported the reliability of this scale across a variety of populations (Glanz, Hass, & Sweeney, 1995). The BHS internal consistency in the current sample was good (Cronbach's  $\alpha = .85$ ).

**Center for Epidemiologic Studies Depression Scale.** The CES-D (Radloff, 1977) is a 20-item self-report questionnaire assessing severity of depressive symptoms. Participants were asked

to indicate the frequency of items (e.g., "I thought my life had been a failure") based on the last 7 days using a Likert scale ranging from 0 (*rarely or none of the time*) to 3 (*most or all of the time*). Increasing scores indicate more severe depressive symptoms. Research has supported the psychometric properties of this scale when used with older adults (Beekman et al., 1997; Lewinsohn, Seeley, Roberts, & Allen, 1997). Internal consistency in this sample was good (Cronbach's  $\alpha = .89$ ).

**Geriatric Suicide Ideation Scale (GSIS).** The GSIS (Heisel & Flett, 2006) is a 31-item self-report measure of suicide ideation designed specifically for use in older adults. It is comprised of four subscales: suicide ideation, death ideation, loss of personal and social worth, and perceived meaning in life (Heisel & Flett, 2006). For the purposes of the current study, only the suicide-ideation (10 items) and death-ideation (five items) subscales were utilized in analyses. In this study, one item was removed from the suicide-ideation subscale (i.e., "I frequently think that my family will be better off when I am dead") to reduce multicollinearity because it was related to perceived burdensomeness, resulting in a 9-item suicide-ideation subscale. Participants rated each statement (e.g., "I have seriously considered suicide more than once earlier in my life," "I welcome the thought of drifting off to sleep and never waking up"), using a five point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). For the suicide-ideation and death-ideation subscales, total scores range from 9 to 45 and 5 to 25, respectively, with higher scores indicating greater ideation and therefore greater risk. Analyses for this study included a suicide-ideation or death-ideation score with a low-end zero score. For suicide ideation, 9 points were subtracted from all scores; for death ideation, 5 points were subtracted from all scores. Studies with older adults have shown that these subscales have adequate internal consistency reliability (Heisel & Flett, 2006; Marty, Segal, & Coolidge, 2010). Internal consistency in the current sample was adequate for the suicide-ideation subscale (Cronbach's  $\alpha = .81$ ), as well as for the death-ideation subscale (Cronbach's  $\alpha = .67$ ).

**Interpersonal Needs Questionnaire (INQ).** The INQ (Van Orden et al., 2012) is a 15-item self-report questionnaire with two subscales, which measure thwarted belonging and perceived burdensomeness. The thwarted-belonging subscale consists of nine items that assess the degree of belonging that an individual experiences (e.g., "These days I am close to other people," which is reverse scored). The six-item perceived-burdensomeness subscale measures the extent to which one feels like a burden on others and perceives that his or her death is more valuable than his or her life (e.g., "These days I think I am a burden on society"). Participants rated each statement using a 7-point Likert scale ranging from 1 (*not at all true for me*) to 7 (*very true for me*; Van Orden et al., 2012). For each subscale, responses are then totaled such that higher scores indicate greater thwarted belonging and perceived burdensomeness. In this sample, Cronbach's alpha for the thwarted-belonging subscale was .84. For the perceived-burdensomeness subscale, Cronbach's alpha was .74.

## Data Analysis

We assessed for influential data points using recommendations for Cook's D (Cook & Weisberg, 1982), Mahalanobis distance (Stevens, 1984), and centered leverage (Chatterjee & Hadi, 1988). Six participants' data exceeded all three cutoff values. Inspection

of the death-ideation and suicide-ideation outcome-variable histograms showed relatively large numbers of zero-value responses as a proportion of the total sample size (death ideation = 66/239; suicide ideation = 104/239). The data from samples in suicide research often contain a relatively large number of zero or near-zero values, making traditional ordinary least-squares regression analysis inappropriate. There has been a growing trend in this literature to employ Poisson regression (e.g., Casey, Gemmell, Hiroeh, & Fulwood, 2012; Chan, Chiu, Lam, Leung, & Conwell, 2006; Fang et al., 2012; Kleiman, Miller, & Riskind, 2012); however, this approach fails to account for the presence of excess zero observations, which are common in community samples in which a large portion of the sample has low suicide risk. The existence of excess zeros may be the result of overdispersion (i.e., when the conditional variance exceeds the mean) or nonlinearities in responses (Gurmu & Trivedi, 1996). In the case of overdispersion, the use of an overdispersed Poisson regression, particularly negative binomial regression, is common (Cameron & Trivedi, 1998; Elhai, Calhoun, & Ford, 2008; Long, 1997); however, the use of an overdispersed Poisson regression does not account for the observed zeros that are the result of nonlinearities in responses (i.e., a large number of zero responses), and its use would lead to inconsistent parameter estimates.

One solution to this problem is the use of a two-part count model or hurdle model. These models treat the zero values of the outcome variable differently than the positive values by assuming that the zeros are the result of a different data-generating process than the nonzeros. For example, it is solely up to the individual whether or not to pursue treatment for a psychological disorder (zero counts vs. positive counts), because the number of treatment sessions is determined by both the patient and the therapist (the magnitude of positive count). These models require two distinct estimations: one for the zero-generating process (logit or probit) and one for the variability in positive counts (typically either Poisson or negative binomial regression). Although this approach is attractive for dealing with excess zeros in the data, the treatment of all zeros as arising from the same process may be inappropriate for our sample. An alternative modified count model capable of addressing this concern is the zero-inflated model (Greene, 2012), which is a more acceptable approach, given our assumptions about the data-generating process for our sample.

The zero-inflated modeling approach allows for simultaneous estimation of both the zero and positive responses in the data. This process assumes that some of the zeros are part of the natural distribution of zero responses (i.e., nonideators), whereas there are additional zeros that are explained by a different process than that yielding the distribution of positive responses (i.e., potential ideators; Atkins & Gallop, 2007). Due to the combination of overdispersion and excess zeros in the data, we employed ZINB regression. In addition, given the potential for bias in the binary logistic regression in the presence of heteroscedasticity, we used robust heteroscedastic standard errors. STATA/MP 12.0 (Stata-Corp, College Station, TX) was used to estimate the models. The predictor variables for death ideation were perceived burdensomeness, hopelessness, depression, and thwarted belonging. The same predictor variables were included in the model for suicide ideation; however, two-way and three-way interactions between perceived burdensomeness, hopelessness, and thwarted belonging were added to maintain consistency with the theorized relationships.

A statistical test was employed to verify the appropriateness of the ZINB regression for this data (Atkins & Gallop, 2007). Vuong's test (Vuong, 1989) was used to evaluate the existence of excess zeros by testing the ZINB regression against the standard negative binomial regression. Statistical significance of Vuong's test indicates that the zero-inflated model would be preferred.

## Results

Variable correlations, means, standard deviations, and internal reliability estimates are provided in Table 1.

### Death Ideation

Table 2 presents the results for the ZINB regression, with death ideation as the outcome variable. Within the dataset, there were 66 occurrences of zero for death ideation (27.6% of participants). The model with covariates was significant, with Wald  $\chi^2$  equal to 35.59,  $p < .001$ . Vuong's test (Vuong, 1989) was significant ( $p < .001$ ), supporting the use of the ZINB. No variables were significantly associated with excess zeros (i.e., nonideators) for death ideation. There was a statistically significant relation between the predictor variables and the level of death ideation. In the negative binomial model, the main effects of perceived burdensomeness (estimate = 0.03,  $p = .015$ ) and hopelessness (estimate = 0.04,  $p = .032$ ) were statistically significant, whereas the main effects of depression (estimate = 0.01,  $p = .092$ ) and thwarted belonging (estimate = 0.00,  $p = .900$ ) were not.

Presented in the table are the incidence-rate ratios (IRR). An IRR is the exponent of the parameter estimate and reflects the percentage change in the incidence rate of death ideation associated with a change in the predictor variable, holding the other variables constant. In other words, a 1-unit increase in perceived burdensomeness is associated with an approximately 3.5% increase in the incidence rate of death ideation, holding hopelessness, depression, and thwarted belonging constant. Similarly, a 1-unit increase in hopelessness, holding other variables constant, was associated with a 4.3% increase in death ideation.

### Suicide Ideation

The ZINB regression results for suicide ideation are presented in Table 3. Within this dataset, there were 104 occurrences of zero on suicide ideation (43.5% of participants). The model with covariates was significant, with Wald  $\chi^2$  equal to 113.78,  $p < .001$ . Vuong's test (Vuong, 1989) for the existence of excess zeros was

Table 1  
*Correlations and Descriptive Statistics for Variables of Interest*

Variable	1	2	3	4	5	<i>M</i>	<i>SD</i>	$\alpha$
1. Suicide ideation						11.39	3.60	.82
2. Death ideation	.68*					8.10	3.07	.67
3. Perceived burdensomeness	.62*	.46*				7.64	3.43	.80
4. Depression	.47*	.40*	.53*			7.04	7.96	.90
5. Beck Hopelessness Scale	.43*	.38*	.44*	.51*		2.28	2.63	.86
6. Thwarted belonging	.55*	.36*	.52*	.58*	.50*	17.88	8.25	.84

\*  $p < .01$ .

Table 2

*Zero-Inflated Negative Binomial Regression Results for Death Ideation*

Negative binomial regression	Estimate	Robust SE	z	Pr >  z	IRR
Predictor					
Perceived burden	0.03	0.01	2.44	0.015	1.04
Hopelessness	0.04	0.02	2.14	0.032	1.04
Depression	0.01	0.01	1.68	0.092	1.01
Thwarted belonging	0.00	0.01	-0.13	0.897	
Constant	1.12	0.08	13.64	0.000	3.08
Logistic regression for zero inflation					Odds ratio
Predictor					
Perceived burden	-0.26	0.15	-1.76	0.079	0.77
Hopelessness	0.03	0.10	0.35	0.725	
Depression	-0.04	0.05	-0.78	0.438	
Thwarted belonging	-0.05	0.04	-1.24	0.215	
Constant	-0.40	0.30	-1.34	0.182	

also significant, supporting the use of ZINB regression for this model.

Within the binary logistic regression for zero-inflation, the three predictors significantly associated with nonideation (i.e., excess zeros) were the main effect of thwarted belonging (estimate = -0.11,  $p = .021$ ), the interaction between perceived burdensomeness and hopelessness (estimate = 0.30,  $p = .033$ ), and the interaction between perceived burdensomeness and thwarted belonging (estimate = 0.10,  $p = .038$ ). The main effects of perceived burdensomeness (estimate = -2.57,  $p = .054$ ) and depression (estimate = -0.09,  $p = .078$ ), and the three-way

interaction between perceived burdensomeness, thwarted belonging, and hopelessness (estimate = -0.03,  $p = .068$ ) were not significant. The parameter estimates in Table 3 give the log of the change in odds that a participant is a nonideator for a 1-unit increase in the variable; therefore, the exponent of the estimate gives the odds ratio. For example, a 1-unit increase in thwarted belonging conditionally reduces the odds of an individual being a nonideator by 10.5% (whereas a 1-unit decrease in thwarted belonging directly increases the odds by 11.8%). However, if we want to evaluate the total effect of a change in thwarted belonging on the probability of an individual being a nonideator, the predicted value depends upon the level of all covariates.

The predicted probabilities for belonging to the nonideator group given changes in perceived burdensomeness are presented in Figure 1. The curves depicted reflect depressive symptoms held at the mean value for all curves, thwarted belonging at the mean and one standard deviation above the mean, and hopelessness at the mean and one standard deviation above the mean. Figure 2 presents the predicted probabilities of belonging to the nonideator group given changes in thwarted belonging. Again, depression is held at its mean value; hopelessness is at the mean and one standard deviation above the mean; and perceived burdensomeness is at one standard deviation below the mean, at the mean, and one standard deviation above the mean. Above, we noted that the two-way interaction between perceived burdensomeness and hopelessness significantly predicted nonideators. As is evident in Figures 1 and 2, as scores on both perceived burdensomeness and hopelessness simultaneously increase, the probability of being a nonideator (i.e., excess zero) decreases significantly. This suggests that, when individuals report elevated perceptions of being burdensome on others and also feel hopeless, these states are likely to change, and the individuals are much more likely to be potential ideators.

Table 3

*Zero-Inflated Negative Binomial Regression Results for Suicide Ideation*

Negative binomial regression	Estimate	Robust SE	z	Pr >  z	Odds ratio
Predictor					
Perceived burden	-0.03	0.08	-0.41	0.678	
Hopelessness	0.02	0.09	0.23	0.820	
Depression	0.01	0.01	0.75	0.455	
Thwarted belonging	0.03	0.02	1.23	0.219	
Perceived burden/hopelessness	0.01	0.01	0.59	0.558	
Thwarted belonging/hopelessness	0.00	0.00	-0.30	0.766	
Perceived burden/thwarted belonging	0.00	0.00	0.94	0.349	
Perceived burden/thwarted belonging/hopelessness	0.00	0.00	-0.37	0.710	
Constant	0.72	0.27	2.66	0.008	
Logistic regression for zero inflation					
Predictor					
Perceived burden	-2.57	1.34	-1.93	0.054	0.08
Hopelessness	-0.20	0.20	-0.99	0.322	
Depression	-0.09	0.05	-1.76	0.078	0.91
Thwarted belonging	-0.11	0.05	-2.31	0.021	0.89
Perceived burden/hopelessness	0.30	0.14	2.13	0.032	1.35
Thwarted belonging/hopelessness	0.00	0.02	0.28	0.776	
Perceived burden/thwarted belonging	0.10	0.05	2.08	0.038	1.11
Perceived burden/thwarted belonging/hopelessness	-0.03	0.02	-1.82	0.068	0.97
Constant	1.43	0.45	3.19	0.001	

Note. Vuong's test:  $z = 4.08$ ,  $Pr > z = 0.0000$ .

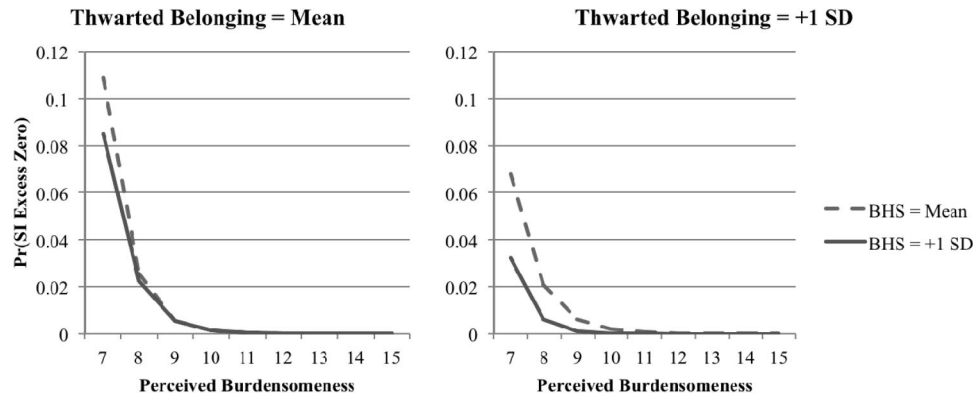


Figure 1. Probability of nonideator status (excess zero) as a function of thwarted belonging and hopelessness along the continuum of scores for perceived burdensomeness. BHS = Beck Hopelessness Scale.

Likewise, the significant two-way interaction between perceived burdensomeness and thwarted belonging suggests that, as perceived burdensomeness and thwarted belonging simultaneously increase, the probability of being a nonideator decreases significantly. This also suggests that those with higher scores on these variables are much more likely to be potential ideators.

As noted above, the tested three-way interaction was not significant ( $p = .068$ ). This may be due to limited power as a result of sample size. The pattern of results discussed below is based on the parameter estimates obtained from analyses described above; however, we would like to emphasize that the following should be interpreted with caution. Figure 1 depicts the change in probability of being a nonideator as a function of linearly increasing scores on perceived burdensomeness for individuals at differing levels of thwarted belonging and hopelessness. The pattern of results indicates that at lower levels of perceived burdensomeness and mean scores on thwarted belonging, those with hopelessness scores one standard deviation above the mean have a lower probability of being nonideators. Further, for those with thwarted belonging and hopelessness one standard deviation above the mean, the probability of being nonideators is lower. Figure 2 depicts the change in probability of being nonideators as a function of linearly increasing scores on thwarted belonging for individuals at differing reported levels of perceived burdensomeness and hopelessness. The patterns of results suggests that, at lower levels of thwarted belonging, an individual with scores at the mean or one standard

deviation above the mean on perceived burdensomeness and hopelessness may have a lower probability of being a nonideator. Taken together, as reported experiences of perceived burdensomeness, hopelessness, and thwarted belonging increase, the probability of the individual being a nonideator (i.e., excess zero) reduces substantially, suggesting that he or she is very likely to be experiencing suicide ideation, even if it is not reported. As with Figure 1, this figure suggests that elevated scores on all three variables are associated with a low probability of an individual being a nonideator (i.e., excess zero). Put another way, elevated scores on perceived burdensomeness, thwarted belonging, and hopelessness are associated with a much greater probability that the individual is experiencing suicide ideation, even if it is not reported.

Within the negative binomial regression portion of the model, none of the predictor variables for suicide ideation were statistically significant, suggesting that variations in these variables do not have a strong association with variations in suicide ideation.

## Discussion

A primary contribution of this research has been the use of advanced statistical procedures to identify nonideators (i.e., individuals who deny suicide ideation and who report nonexistent risk on other variables associated with suicide ideation), and potential ideators (i.e., those who deny suicide ideation while simultaneously reporting other established risk factors for suicide), which

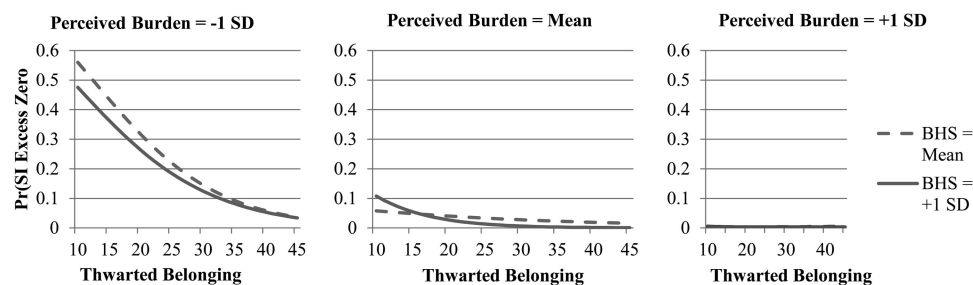


Figure 2. Probability of nonideator status (excess zero) as a function of perceived burdensomeness and hopelessness along the continuum of scores for thwarted belonging. TB = thwarted belonging, BHS = Beck Hopelessness Scale.



has significant clinical implications. This study introduced the use of zero-inflated statistical models to the study of suicidal behavior, which offers a wealth of advantages in answering research questions that are relevant to this field. As noted earlier, no research has utilized ZINB analyses to test hypotheses proposed by the interpersonal theory of suicide (Van Orden et al., 2010) in older adults. Our use of more advanced statistical techniques allowed for computation of both the binary logistic and negative binomial regression relations between predictor and outcome variables, as informed by our hypotheses. This allowed us to test theory-based predictions regarding variability in death ideation and suicide ideation, while also predicting participants' denial of suicide ideation, despite reporting experiences that are associated with suicide risk.

We hypothesized that death ideation would be significantly predicted by perceived burdensomeness, thwarted belonging, hopelessness, and depressive symptoms. Our results indicated that only perceived burdensomeness and hopelessness significantly predicted variation in death ideation in the negative binomial portion of the regression. This analysis was conducted to test the first prediction of Van Orden et al. (2010), that individuals who feel a lack of connection to others, or perceive themselves to be a burden on others, will develop a wish for death. Our results support the association of perceived burdensomeness with death ideation, but do not indicate that thwarted belonging was associated with death ideation. As such, these results provide partial support for the interpersonal theory's assertion that perceived burdensomeness and thwarted belonging are each associated with death ideation when experienced independent of each other. This may signify that thwarted belonging is exclusively associated with the development of suicide ideation in this population. Although it was surprising that depressive symptoms were not associated with death ideation, participants in this study had low scores on depressive symptoms, which may suggest that older adults in our sample were less likely to report feeling depressed, though they endorsed other psychological experiences. Taken together, the significant relations between perceived burdensomeness and death ideation, as well as between hopelessness and death ideation, may suggest that painful emotional experiences related to perceptions of detracting from others and having little hope for the future are associated with ideations related to death in older adults.

In addition, our pattern of results (though nonsignificant) is consistent with Van Orden et al. (2010)'s prediction that individuals with elevated perceived burdensomeness and thwarted belonging would develop suicide ideation when they feel hopeless that these states will change. These findings provide further support for the interpersonal theory of suicide. Neither the negative binomial regression nor the zero-inflation binary logistic regression that tested this three-way interaction was significant; however, the pattern of results from the logistic regression with zero-inflation indicates that increasing scores on these variables, and especially increasing scores on all three variables simultaneously, are associated with a reduced probability that an individual is a nonideator. Put another way, individuals reporting these states are more likely to be potential ideators. Although these results should be interpreted with caution, this is fascinating in that it may suggest that for older adults, these experiences may be associated with the presence or absence of suicide ideation, but are less important to determining the severity of thoughts of suicide.

It is noteworthy that the correlates of death ideation and suicide ideation were somewhat different. Specifically, none of the predictor variables predicted excess zeros on death ideation, whereas thwarted belonging, the interaction between perceived burdensomeness and hopelessness, and the interaction between perceived burdensomeness and thwarted belonging predicted excess zeros on suicide ideation. Although this is speculative, it may suggest more of a presence/absence relationship among correlates of suicide ideation, whereby experiences such as feeling a thwarted sense of belonging trigger the onset of thoughts of suicide, but do not impact the severity of these thoughts. In contrast, the predictors of death ideation were associated with the severity of death ideation rather than the presence of excess zeros. This suggests that these predictors may not lead to the onset of death ideation (thoughts that are more common among older adults), but instead influence the severity of death ideation. In addition, it was surprising that thwarted belonging was not significantly associated with death ideation in either analysis. This could indicate that thwarted belonging is a psychological state so painful that it is associated with an active wish to take one's own life, rather than a more passive desire for death.

There are several very important implications to these findings. The results suggest that variables included in the interpersonal theory should be key targets in the determination of whether an older adult might be experiencing thoughts of suicide, regardless of whether the older adult is reporting such thoughts. As we noted above, increasing scores on thwarted belonging, perceived burdensomeness, and hopelessness are all associated with a much greater probability that an individual is experiencing thoughts of suicide, whether or not they are reported. The figures especially highlight this, indicating that the probability is near zero that an individual is *not* experiencing thoughts of suicide if they are reporting elevated experiences related to these constructs. This information is very important from an assessment perspective. As noted earlier, data suggest that older adults may underreport thoughts of suicide (Heisel et al., 2006); therefore, the identification of variables that are associated with the probability of suicide ideation (but that are not direct questions regarding suicide ideation) may prove invaluable for mental health practitioners and primary care physicians seeking to evaluate suicide risk in older adults who might not directly report suicide ideation. In addition to the assessment implications of these findings, the results of this study indicate that mental health practitioners should target perceptions of being a burden, the sense of thwarted belonging, and hopelessness in older adults in an effort to reduce their risk of developing suicide ideation. This study is the first study to attempt to identify such variables using statistical approaches such as zero-inflated negative binomial regression.

This study, although valuable, has limitations that must be noted. First, the cross-sectional design prevents inference of causal relationships. As such, we have been able to identify variables that are associated with death ideation, as well as patterns of variables that are associated with a decreased probability that an individual is currently not experiencing suicide ideation, but we have not been able to draw conclusions about the role of these variables in the development and maintenance of death ideation or suicide ideation. Longitudinal examinations of the Van Orden et al. (2010) model may provide further elucidation of the relations between variables. Furthermore, investigation of other variables not exam-



ined in this study (e.g., acquired capability for suicide, emotion inhibition) may offer additional explanation of the differential increased risk among older adults with greater risk for death by suicide (i.e., older adult men). In addition, limited racial diversity, relatively high education levels, and limited geographic dispersion of the sample all limit generalizability.

In summary, it appears that perceived burdensomeness and hopelessness are critical risk factors for death ideation in older adults. Furthermore, the ZINB results suggest that the experiences of thwarted belonging, perceived burdensomeness, and hopelessness are critical to the identification of older adults who may be experiencing suicide ideation, but are not directly reporting it. Providers should use this information in developing efficient and effective screening methods for suicide ideation, as well as for ensuring accurate assessment of older adults who might underreport to direct questions regarding suicide ideation. Participants who deny a thwarted sense of belonging, perceptions of burdensomeness, and hopelessness are unlikely to be experiencing suicide ideation; however, those who indicate elevated thoughts and emotions related to these variables may be experiencing suicide ideation, at least at a low level, even as they deny it.

## References

- Atkins, D. C., & Gallop, R. J. (2007). Rethinking how family researchers model infrequent outcomes: A tutorial on count regression and zero-inflated models. *Journal of Family Psychology*, 21, 726–735. doi:10.1037/0893-3200.21.4.726
- Baca-Garcia, E., Perez-Rodriguez, M. M., Oquendo, M. A., Keyes, K. M., Hasin, D. S., Grant, B. F., & Blanco, C. (2011). Estimating risk for suicide attempt: Are we asking the right questions? Passive suicidal ideation as a marker for suicidal behavior. *Journal of Affective Disorders*, 134, 327–332. doi:10.1016/j.jad.2011.06.026
- Beck, A. T., & Steer, R. A. (1988). *Manual for the Beck Hopelessness Scale*. San Antonio, TX: Psychological Corp.
- Beekman, A. T. F., Deeg, D. J. H., Van Limbeek, J., Braam, A. W., De Vries, M. Z., & Van Tilburg, W. (1997). Criterion validity of the Center for Epidemiologic Studies Depression scale (CES-D): Results from a community-based sample of older subjects in the Netherlands. *Psychological Medicine*, 27, 231–235. doi:10.1017/S0033291796003510
- Britton, P. C., Duberstein, P. R., Conner, K. R., Heisel, M. J., Hirsch, J. K., & Conwell, Y. (2008). Reasons for living, hopelessness, and suicide ideation among depressed adults 50 years or older. *The American Journal of Geriatric Psychiatry*, 16, 736–741. doi:10.1097/JGP.0b013e31817b609a
- Cameron, A. C., & Trivedi, R. K. (1998). Regression analysis of count data. *Econometric Society Monograph No. 30*. Cambridge, MA: Cambridge University Press. doi:10.1017/CBO9780511814365
- Casey, P., Gemmell, I., Hiroeh, U., & Fulwood, C. (2012). Seasonal and socio-demographic predictors of suicide in Ireland: A 22 year study. *Journal of Affective Disorders*, 136, 862–867. doi:10.1016/j.jad.2011.09.020
- Chan, S. M. S., Chiu, F. K. H., Lam, C. W. L., Leung, P. Y. V., & Conwell, Y. (2006). Elderly suicide and the 2003 SARS epidemic in Hong Kong. *International Journal of Geriatric Psychiatry*, 21, 113–118. doi:10.1002/gps.1432
- Chatterjee, S., & Hadi, A. S. (1988). *Sensitivity analysis in regression*. New York, NY: Chapman & Hall. doi:10.1002/9780470316764
- Conwell, Y., Duberstein, P. R., & Caine, E. D. (2002). Risk factors for suicide in later life. *Biological Psychiatry*, 52, 193–204. doi:10.1016/S0006-3223(02)01347-1
- Conwell, Y., Duberstein, P. R., Cox, C., Herrmann, J. H., Forbes, N. T., & Caine, E. D. (1996). Relationships of age and Axis I diagnoses in victims of completed suicide: A psychological autopsy study. *The American Journal of Psychiatry*, 153, 1001–1008. Retrieved from <http://ajp.psychiatryonline.org/journal.aspx?journalid=13>
- Conwell, Y., Van Orden, K., & Caine, E. D. (2011). Suicide in older adults. *Psychiatric Clinics of North America*, 34, 451–468. doi:10.1016/j.psc.2011.02.002
- Cook, R. D., & Weisberg, S. (1982). *Residuals and influence in regression*. New York, NY: Chapman & Hall.
- Coxe, S., West, S. G., & Aiken, L. S. (2009). The analysis of count data: A gentle introduction to Poisson regression and its alternatives. *Journal of Personality Assessment*, 91, 121–136. doi:10.1080/00223890802634175
- Cukrowicz, K. C., Cheavens, J. S., Van Orden, K. A., Ragain, R. M., & Cook, R. L. (2011). Perceived burdensomeness and suicide ideation in older adults. *Psychology and Aging*, 26, 331–338. doi:10.1037/a0021836
- Cukrowicz, K. C., Duberstein, P. R., Vannoy, S. D., Lynch, T. R., McQuoid, D. R., & Steffens, D. C. (2009). Course of suicide ideation and predictors of change in depressed older adults. *Journal of Affective Disorders*, 113, 30–36. doi:10.1016/j.jad.2008.05.012
- Duberstein, P. R., Conwell, Y., Seidlitz, L., Lyness, J. M., Cox, C., & Caine, E. D. (1999). Age and suicidal ideation in older depressed inpatients. *The American Journal of Geriatric Psychiatry*, 7, 289–296. doi:10.1097/00019442-199923740-00003
- Elhai, J. D., Calhoun, P. S., & Ford, J. D. (2008). Statistical procedures for analyzing mental health services data. *Psychiatry Research*, 160, 129–136. doi:10.1016/j.psychres.2007.07.003
- Fang, F., Fall, K., Mittleman, M. A., Sparen, P., Ye, W., Adami, H.-O., & Valdimarsdottir, U. (2012). Suicide and cardiovascular death after a cancer diagnosis. *The New England Journal of Medicine*, 366, 1310–1318. doi:10.1056/NEJMoa1110307
- Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). Mini-mental state: A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, 12, 189–198. doi:10.1016/0022-3956(75)90026-6
- Glanz, L. M., Hass, G. L., & Sweeney, J. A. (1995). Assessment of hopelessness in suicidal patients. *Clinical Psychology Review*, 15, 49–64. doi:10.1016/0272-7358(94)00040-9
- Greene, W. H. (2012). *Econometric analysis* (7th ed.). Upper Saddle River, NJ: Prentice Hall.
- Gurmu, S., & Elder, J. (2008). A bivariate zero-inflated count data regression model with unrestricted correlation. *Econometric Letters*, 100, 245–248. doi:10.1016/j.econlet.2008.02.001
- Gurmu, S., & Trivedi, P. K. (1996). Excess zeros in count models for recreational trips. *Journal of Business & Economic Statistics*, 14, 469–477. doi:10.1080/07350015.1996.10524676
- Heisel, M. J., Duberstein, P. R., Conner, K. R., Franus, N., Beckman, A., & Conwell, Y. (2006). Personality and reports of suicide ideation among depressed adults 50 years and older. *Journal of Affective Disorders*, 90, 175–180. doi:10.1016/j.jad.2005.11.005
- Heisel, M. J., & Flett, G. L. (2006). The development and initial validation of the Geriatric Suicide Ideation Scale. *The American Journal of Geriatric Psychiatry*, 14, 742–751. doi:10.1097/01.JGP.0000218699.27899.f9
- Hur, K., Hedeker, D., Henderson, W., Khuri, S., & Daley, J. (2002). Modeling clustered count data with excess zeros in health care outcomes research. *Health Services and Outcomes Research Methodology*, 3, 5–20. doi:10.1023/A:1021594923546
- Jahn, D. R., Cukrowicz, K. C., Linton, K., & Prabhu, F. (2011). The mediating effect of perceived burdensomeness on the relation between depressive symptoms and suicide ideation in a community sample of older adults. *Aging & Mental Health*, 15, 214–220. doi:10.1080/13607863.2010.501064

- Jahn, D. R., Poindexter, E. K., Graham, R. D., & Cukrowicz, K. C. (2012). The moderating effect of recent negative life events on the relation between intrinsic religiosity and death ideation in older adults. *Suicide and Life-Threatening Behavior*, 42, 589–601. doi:10.1111/j.1943-278X.2012.00114.x
- Joiner, T. E., Jr. (2005). *Why people die by suicide*. Cambridge, MA: Harvard University Press.
- Kleiman, E. M., Miller, A. B., & Riskind, J. H. (2012). Enhancing attributional style as a protective factor in suicide. *Journal of Affective Disorders*, 143, 236–240. doi:10.1016/j.jad.2012.05.014
- Lambert, D. (1992). Zero-inflated Poisson regression, with application to defects in manufacturing. *Technometrics*, 34, 1–14. doi:10.2307/1269547
- Lewinsohn, P. M., Seeley, J. R., Roberts, R. E., & Allen, B. (1997). Center for Epidemiologic Studies Depression Scale (CES-D) as a screening instrument for depression among community-residing older adults. *Psychology and Aging*, 12, 277–287. doi:10.1037/0882-7974.12.2.277
- Long, J. S. (1997). *Regression models for categorical and limited dependent variables: Advanced quantitative techniques in the social sciences*. Thousand Oaks, CA: Sage.
- Lynch, T. R., Johnson, C. S., Mendelson, T., Robins, C. J., Krishnan, K. R. R., & Blazer, D. G. (1999). Correlates of suicidal ideation among an elderly depressed sample. *Journal of Affective Disorders*, 56, 9–15. doi:10.1016/S0165-0327(99)00022-1
- Marty, M. A., Segal, D. L., & Coolidge, F. L. (2010). Relationships among dispositional coping strategies, suicide ideation, and protective factors against suicide in older adults. *Aging & Mental Health*, 14, 1015–1023. doi:10.1080/13607863.2010.501068
- Marty, M. A., Segal, D. L., Coolidge, F. L., & Klebe, K. J. (2012). Analysis of the psychometric properties of the Interpersonal Needs Questionnaire (INQ) among community-dwelling older adults. *Journal of Clinical Psychology*, 68, 1008–1018. doi:10.1002/jclp.21877
- McLaren, S., Gomez, R., Bailey, M., & van der Horst, R. K. (2007). The association of depression and sense of belonging with suicidal ideation among older adults: Applicability of resiliency models. *Suicide and Life-Threatening Behavior*, 37, 89–102. doi:10.1521/suli.2007.37.1.89
- Minami, M., Lennert-Cody, C. E., Gao, W., & Román-Verdesoto, M. (2007). Modeling shark bycatch: The zero-inflated negative binomial regression model with smoothing. *Fisheries Research*, 84, 210–221. doi:10.1016/j.fishres.2006.10.019
- Radloff, L. S. (1977). The CES-D Scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement*, 1, 385–401. doi:10.1177/014662167700100306
- Rao, R., Denning, T., Brayne, C., & Huppert, F. A. (1997). Suicide thinking in community residents over eighty. *International Journal of Geriatric Psychiatry*, 12, 337–343. doi:10.1002/(SICI)1099-1166(199703)12:3<337::AID-GPS498>3.0.CO;2-T
- Scocco, P., Meneghel, G., Dello Buono, M., & De Leo, D. (2001). Hostility as a feature of elderly suicide ideators. *Psychological Reports*, 88, 863–868. doi:10.2466/pr0.2001.88.3.863
- Stevens, J. P. (1984). Outliers and influential data points in regression analysis. *Psychological Bulletin*, 95, 334–344. doi:10.1037/0033-2909.95.2.334
- Suokas, J., Suominen, K., Isometsa, E., Ostamo, A., & Lonnqvist, J. (2001). Long-term risk factors for suicide mortality after attempted suicide—Findings of a 14-year follow-up study. *Acta Psychiatrica Scandinavica*, 104, 117–121. doi:10.1034/j.1600-0447.2001.00243.x
- Szanto, K., Mulsant, B. H., Houck, P. R., Dew, M. A., Dombrovski, A., Pollock, B. G., & Reynolds, C. F. III. (2007). Emergence, persistence, and resolution of suicidal ideation during treatment of depression in old age. *Journal of Affective Disorders*, 98, 153–161. doi:10.1016/j.jad.2006.07.015
- Szanto, K., Reynolds, III, C. F., Conwell, Y., Begley, A. E., & Houck, P. (1998). High levels of hopelessness persist in geriatric patients with remitted depression and a history of attempted suicide. *Journal of the American Geriatrics Society*, 46, 1401–1406. Retrieved from [http://onlinelibrary.wiley.com/journal/10.1111/\(ISSN\)1532-5415](http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1532-5415)
- Turvey, C. L., Conwell, Y., Jones, M. P., Phillips, C., Simonsick, E., Pearson, J. L., & Wallace, R. (2002). Risk factors for late-life suicide: A prospective, community-based study. *The American Journal of Geriatric Psychiatry*, 10, 398–406. doi:10.1176/appi.ajgp.10.4.398
- United States Department of Health and Human Services, Centers for Disease Control and Prevention. (2012). *Center for Disease Control's National Center for Injury Prevention and Control (NCIPC): US injury mortality statistics*. Retrieved from <http://www.cdc.gov/ncipc/factsheets/suifacts.htm>
- Vannoy, S. D., Duberstein, P., Cukrowicz, K., Lin, E., Fan, M.-Y., & Unutzer, J. (2007). The relationship between suicide ideation and late-life depression. *The American Journal of Geriatric Psychiatry*, 15, 1024–1033. doi:10.1097/JGP.0b013e3180cc2bfl
- Van Orden, K. A., Cukrowicz, K. C., Witte, T. K., & Joiner, T. E. (2012). Thwarted belongingness and perceived burdensomeness: Construct validity and psychometric properties of the Interpersonal Needs Questionnaire. *Psychological Assessment*, 24, 197–215. doi:10.1037/a0025358
- Van Orden, K. A., Witte, T. K., Cukrowicz, K. C., Braithwaite, S. R., Selby, E. A., & Joiner, T. E., Jr. (2010). The interpersonal theory of suicide. *Psychological Review*, 117, 575–600. doi:10.1037/a0018697
- Vuong, Q. H. (1989). Likelihood ratio tests for model selection and non-nested hypotheses. *Econometrica*, 57, 307–333. doi:10.2307/1912557
- Witte, T. K., Joiner, Jr., T. E., Brown, G. K., Beck, A. T., Beckman, A., Duberstein, P. R., & Conwell, Y. (2006). Factors of suicide ideation and their relation to clinical and other indicators in older adults. *Journal of Affective Disorders*, 94, 165–172. doi:10.1016/j.jad.2006.04.005

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