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RESEARCH ARTICLE

# Does baseline depression increase the risk of unexplained and accidental falls in a cohort of community-dwelling older people? Data from The Irish Longitudinal Study on Ageing (TILDA)

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**Background:** Depression independently increases the risk of falls in older people, but the mechanism for this relationship, as well as the specific falls type involved, remains unclear. Accidental falls (AFs) are due to slips or trips, while the cause of unexplained falls (UFs) is not immediately apparent and can include unrecognised syncope.

**Method:** This longitudinal study examines the relationship between baseline depression and subsequent falls, both accidental and unexplained, at 2-year follow-up in a cohort of community dwelling adults aged ≥50 years.
Baseline depression was defined as a score ≥16 on The Centre for Epidemiological Studies Depression Scale. At follow-up, participants were assessed regarding falls since last interview.

**Results:** One-third (228/647) of the depressed group had fallen at follow-up, compared with 22% (1388/6243) of the nondepressed group ($P < .001$).
Multiple logistic regression models demonstrated that depression was associated with an odds ratio of 1.58 (1.31-1.89) $P < .001$; 1.24 (1.00-1.52), $P = .046$; and 1.89 (1.45-2.46), $P < .001$ for total falls, AFs and UFs, respectively, after controlling for relevant covariates.
Participants with depression who fell were more likely to have prior falls, functional impairment and slower gait when compared with depressed participants who did not fall.

**Discussion:** The risk of falls associated with depression in older adults is more marked for UFs, with the association for AFs approaching borderline significance only.
This finding is important because UFs require focused clinical assessment with attention to potential causes such as cardiac arrhythmia or orthostatic hypotension.

**KEYWORDS**

accidental falls, depression, falls, late life depression, unexplained falls

## 1 | BACKGROUND

Over 1 quarter of community-dwelling older people fall each year.[1] Between 0.85% and 1.5% of total healthcare expenditure is dedicated to medical care related to falls,[2] and falls can have significant adverse consequences for the individual involved, including hip fracture[3] and serious intracranial injury,[4] as well as strongly predicting admission to nursing home care.[5]

Depression is also common in later life, affecting 1 in 6 community-dwelling older people.[6] It is a more complex illness than depression presenting earlier in life and independently increases the risk of several adverse outcomes, including dementia,[7] cardiovascular events such as stroke and myocardial infarction,[8] and all-cause mortality.[9]

Depression also independently increases the risk of falls in older people.[10] A meta-analysis with a pooled analysis of 14 prospective studies reported that depressive symptoms increased the risk of falls by almost 50%.[11] Older fallers are twice as likely to have significant depressive symptoms compared to non-fallers[12] and depression is also a strong predictor of falls in nursing home resident.[13] In older people with depression, both fear of falling and depression diagnosis are negatively correlated with activity restriction, further increasing the risk of falls.[14]

Despite this, the mechanism for this relationship remains unclear. Antidepressant use,[15] has been suggested as a primary cause of falls in depression but prior studies have shown that depression diagnosis increases falls risk independent of antidepressant use.[16] Other

  

proposed mediating factors include coexisting cognitive impairment,[17] orthostatic hypotension,[18] and gait disorders[19]; however, no studies to date have specifically examined why there is an increased risk of falls in depression.

Furthermore, there has been limited research to date aimed at exploring the specific falls type associated with depression in an older population. Accidental or mechanical falls are terms used to describe falls due to slipping or tripping[20] while unexplained or non-accidental falls (AFs) cannot be explained by simple trips or slips, and can be caused by unrecognised syncope, seizures, and associated with loss of consciousness.[21] Assessment of older fallers is complicated by the fact that older patients regularly have amnesia for loss of consciousness[22] and falls due to syncope can therefore be incorrectly classified as accidental. Given the very different underlying causes of different falls types, it is important therefore to distinguish between the two when attempting to examine associations or identify causes of falls.

With this in mind, the aim of this study is to clarify the longitudinal relationship between baseline depression and falls, divided into AFs and unexplained falls (UFs).

**Key points**

- This study demonstrates that depression significantly increases the risk of unexplained falls, with the association for accidental falls approaching borderline significance only.
- This finding is important because cardiovascular disease has been implicated in the aetiology of late-life depression, and unexplained falls are more likely to be due to underlying cardiovascular disease or syncope.
- Given the significant adverse consequences falls can have in later life, depressed patients may be an appropriate target for falls prevention interventions.

## 2 | METHODS

### 2.1 | Study design

This is a longitudinal study in a cohort of community-dwelling participants, examining the relationship between baseline depression and subsequent falls at 2-year follow-up.

The Irish Longitudinal Study on Ageing (TILDA) is a study of a nationally representative sample of community-dwelling older adults aged 50 years and over. The TILDA study design has been outlined previously.[23] We analysed data from the first and second waves of TILDA collected between 2009 and 2012.

At baseline, participants completed a computer-assisted personal interview (CAPI) in their own homes which involved collection of detailed data on health, social, and economic factors. Each participant was also invited to a health centre for a comprehensive health assessment or a modified assessment in their own home.

All assessments were conducted by trained research nurses. The study was approved by the Faculty of Health Sciences Research Ethics Committee at Trinity College Dublin, and all participants gave informed written consent. All experimental procedures adhered to the Declaration of Helsinki.

### 2.2 | Inclusion/exclusion criteria

People with known or suspected dementia were excluded. This was based on prior doctor's diagnosis of dementia.

Participants were included in this study if they were aged 50 years or more at baseline, underwent a comprehensive health assessment at baseline, and completed 2-year follow-up.

### 2.3 | Depression

The Centre for Epidemiological Studies Depression Scale (CES-D) was used to measure depressive symptoms.[24] The CES-D is a 20-item screening test with response values on 4-point Likert scales,[25] with a score of 16 or more used to define depression at Wave 1.

### 2.4 | Falls

As part of the CAPI at both Waves 1 and 2, participants were asked specifically about falls either in the preceding 12 months (Wave 1) or since the last interview (Wave 2). They were asked "Have you had any falls in the last year / since the last interview?"; "Were any of these falls non-accidental, i.e. with no apparent or obvious reason?"; and "Have you had any faints or blackouts in the last year / since the last interview?"

Unexplained or non-accidental fallers were defined as those who fell with no apparent or obvious reason for the fall. This excludes participants who give a recognised history of syncope or fainting but may include some with amnesia for a syncopal event. All other falls were defined as accidental. Participants were placed in the UFs group if they had 1 or more UFs, regardless of any other falls that may have been accidental in nature.

### 2.5 | Statistical analysis

Data were analysed using Stata (Satatcorp). Categorical variables were compared using the chi-square test. Normally distributed continuous variables were described as means and standard deviations and analysed using the Student *t* test.

Binary logistic regression, reporting odds ratios, was used to control for several important covariates. Functional impairment was defined as having 1 or more impairment in activities of daily living (ADL), including dressing, washing, bathing, eating, getting in and out of bed, and using the toilet. Participants were asked directly whether they had any problems with each of these tasks, as well as being asked about their highest level of educational attainment. Gait disturbance was defined as a score of 12 seconds or more on the Timed-Up-And-Go test (TUG).[26] Participants were also asked "Are you afraid of falling?," in addition to prior history of falling. Cognitive impairment was defined as a score of 24 or less on the Mini Mental State Examination.[27] Visual disturbance was defined as a self-report of glaucoma, age-related macular degeneration, or cataracts. Self-report was also elicited for diabetes and medication records were examined to record current use of

antidepressant medication. Cardiovascular disease was defined as self-report of myocardial infarction, angina, cardiac arrhythmia, cardiac failure, or use of antihypertensive medication on examination of medication records, as a composite count variable.

## 3 | RESULTS

A total of 6890 participants were included in the study. See Figure 1 for flow diagram of study recruitment.

About 9.4% (647/6890) of the study population were classified as depressed based on a CES-D score ≥ 16. The baseline characteristics of the study groups are shown in Table 1.

The depressed group had a higher incidence of total falls, AFs and UFs at 2-year follow-up at Wave 2. See Figure 2.

There was also a higher burden of depressive symptoms in fallers at Wave2 in general. Overall, participants who had fallen by Wave 2 had a higher baseline CES-D score than those who did not fall irrespective of diagnosis of depression [7.3 (6.9-7.7) vs 5.3 (5.1-5.5), $P < .001$, $t = -9.77$]. This was also the case for those with non-AFs [8.6 (7.8-9.5) vs 5.6 (5.4-5.7), $P < .001$, $t = -9.05$].

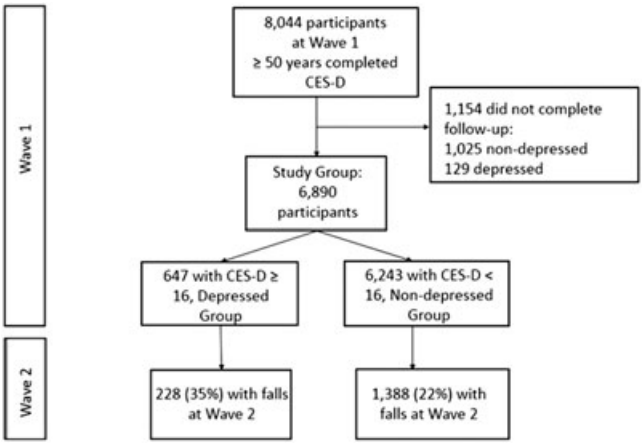


**FIGURE 1** Flow diagram of study recruitment. CES-D, Centre for Epidemiological Studies Depression Scale

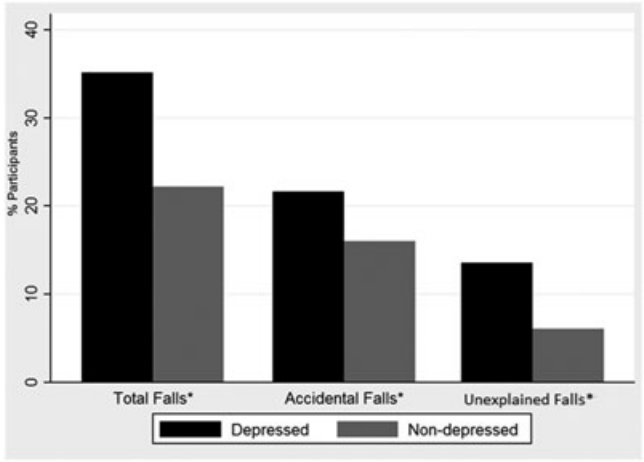


**FIGURE 2** Falls at Wave 2 by study group at Wave 1

Multiple binary logistic regression models demonstrated that depression at baseline was a predictor of subsequent falls, with odds ratios of 1.69 (1.41-1.90), 1.28 (1.04-1.57), and 2.08 (1.60-2.69) for total, AFs and UFs, respectively, after controlling for age, gender, visual disturbance, prior falls, functional impairment, diabetes, and educational attainment. See Table 2.

While addition of fear of falling to the statistical model attenuated these associations slightly, further adjustment for cognitive impairment, cardiovascular disease including hypotension and use of antidepressants and antipsychotic medication did not further attenuate the associations significantly.

Older age, female gender, prior falls, fear of falling, and cardiac disease were also significant predictors of falls at Wave 2 in regression models. See Appendix 1.

**TABLE 1** Baseline characteristics by study group

| | Depressed n = 647 | Non-depressed n = 6243 | Statistical Test |
|---|---|---|---|
| Age, y (95% CI) | 61.9 (61.2–62.6) | 63.5 (63.3–63.8) | $t = 4.14$, $P < .001$ |
| Age ≥ 75 y (%) | 11.3 (73/647) | 15.2 (947/6243) | $\chi^2 = 7.02$, $P = .008$ |
| Females, % (n) | 67.4 (436/647) | 52.8 (3294/6243) | $\chi^2 = 50.50$, $P < .001$ |
| ADL impairment, % (n) | 22.9 (148/647) | 6.5 (406/6243) | $\chi^2 = 212.51$, $P < .001$ |
| TUG, seconds (95% CI) | 10.2 (9.6–10.8) | 9.0 (8.9–9.1) | $t = -6.92$, $P < .001$ |
| TUG ≥12 s | 40.5 (262/647) | 28.8 (1795/6243) | $\chi^2 = 38.60$, $P < .001$ |
| Falls in prior 12 months, % (n) | 27.4 (177/647) | 18.5 (1154/6243) | $\chi^2 = 29.59$, $P < .001$ |
| Fear of falling, %(n) | 41.4 (268/647) | 20.5 (1282/6243) | $\chi^2 = 146.56$, $P < .001$ |
| MMSE (95% CI) | 28.0 (27.8–28.3) | 28.4 (28.4–28.5) | $t = 3.72$, $P < .001$ |
| MMSE ≤24 | 13.6 (88/647) | 9.6 (599/6243) | $\chi^2 = 10.48$, $P = .001$ |
| CES-D (95% CI) | 23.2 (22.7–23.8) | 4.0 (3.9–4.1) | $t = -1.1e + 02$, $P < .001$ |
| Visual disturbance, % (n) | 16.1 (104/647) | 12.9 (806/6243) | $\chi^2 = 5.12$, $P = .024$ |
| Diabetes, % (n) | 9.4 (61/647) | 7.2 (449/6243) | $\chi^2 = 4.28$, $P = .039$ |
| Cardiovascular disease, % (n) | 44.7 (289/647) | 40.4 (2521/6243) | $\chi^2 = 4.46$, $P = .035$ |
| Antidepressant use, % (n) | 7.0 (45/647) | 6.6 (413/6242) | $\chi^2 = 0.11$, $P = .742$ |

Abbreviations: CES-D, Centre for Epidemiological Studies Depression Scale; CI, confidence interval; MMSE, Mini Mental State Examination; TUG, Timed-Up-And-Go Test.

**TABLE 2** Multiple logistic regression reporting odds ratios (with 95% confidence interval) of diagnosis of depression for different fall types

| | Model 1 | Model 2 + Fear of Falling | Model 3 + Cognition | Model 4 + Cardiovascular | Model 5 + Medications |
|---|---|---|---|---|---|
| Total falls | 1.69 (1.41–2.02) *P* < .001 Z 5.68 | 1.58 (1.32–1.90) *P* < .001 Z 4.93 | 1.58 (1.32–1.90) *P* < 0.001 Z 4.90 | 1.58 (1.31–1.86) *P* < .001 Z 4.87 | 1.58 (1.31–1.89) *P* < .001 Z 4.87 |
| Accidental falls | 1.28 (1.04–1.57) *P* = .019 Z 2.35 | 1.23 (1.00–1.51) *P* = .053 Z 1.93 | 1.24 (1.01–1.52) *P* = .045 Z 2.01 | 1.24 (1.00–1.52) *P* = .047 Z 1.99 | 1.24 (1.00–1.52) *P* = .046 Z 1.99 |
| Unexplained falls | 2.08 (1.60–2.69) *P* < .001 Z 5.54 | 1.93 (1.48–2.50) *P* < .001 Z 4.90 | 1.90 (1.46–2.47) *P* < .001 Z 4.79 | 1.89 (1.45–2.46) *P* < .001 Z 4.75 | 1.89 (1.45–2.46) *P* < .001 Z 4.75 |

N = 6890

Model 1 controls for age ≥ 75 years, gender, disorders of vision (glaucoma, cataracts, age-related macular degeneration), Timed-Up-And-Go ≥ 12 seconds, Diabetes, impairment in one or more activities of daily living, third level educational attainment and history of prior falls at Wave 1. Model 2 controls for Model 1 covariates as well as fear of falling. Model 3 controls for Model 2 covariates, as well as cognitive impairment (defined as MMSE ≤ 24). Model 4 controls for Model 3 covariates, as well as history of myocardial infarction, angina, congestive cardiac failure, arrhythmia or hypertension (based on use of antihypertensive medications). Model 5 controls for Model 4 covariates, as well as antidepressant use.

Further subgroup analysis within the depressed group, stratified by falls, showed that depressed participants at Wave 1 who had fallen by Wave 2 were older with a history of prior falls in the preceding 12 months, more likely to have impairments in ADL and vision, as well as having a longer TUG, marginally lower scores on the Mini Mental State Examination and higher rates of cardiovascular disease. See Table 3.

## 4 | DISCUSSION

This study demonstrates that participants with depression, defined by CES-D at baseline, have a significantly increased risk of falls at 2-year follow-up, after adjustment for relevant covariates including prior history of falls. When analysed by falls type, this association is more robust for UFs, with the association for AFs approaching borderline significance only.

Our findings are supported by several prior studies that have demonstrated that depression increases falls risk, but in general, the majority of studies to date have reported overall falls burden rather than subdividing into accidental and unexplained.[28] There is some existing cross-sectional evidence that depression increases the risk of syncope[29] and UFs, however,[30] and our study confirms a strong longitudinal relationship between the two.

This finding is important because UFs are associated with significant intracranial injury[31] and are more likely due to syncope[32] or underlying cardiovascular disease. Our findings also demonstrate that baseline cardiovascular disease is also a significant predictor of UFs and investigation of these events requires a different stream of assessment, including heart rhythm monitoring and possibly carotid sinus massage. A recent point prevalence study demonstrated that over one-third of patients admitted to an orthopaedic ward had non-AFs.[30] This association is even more relevant when we consider that depression, as well as antidepressant use,[33] is independently

**TABLE 3** Baseline (Wave 1) characteristics of participants with depression by falls history at Wave 2

| | Depressed, No Falls n = 419 | Depressed, Falls n = 228 | Statistical Test |
|---|---|---|---|
| Age, y (95% CI) | 61.1 (60.2–61.9) | 63.5 (62.3–64.7) | $t$ = −3.33, $P$ < .001 |
| Females, % (n) | 66.4 (279/419) | 69.3 (158/228) | $\chi^2$ = 0.58, $P$ = .445 |
| ADL impairment, % (n) | 16.5 (69/419) | 34.7 (79/228) | $\chi^2$ = 27.67, $P$ < .001 |
| TUG, seconds (95% CI) | 11.5 (10.2–12.9) | 9.5 (9.0–10.0) | $t$ = −3.40, $P$ < .001 |
| Falls in prior 12 months, % (n) | 22.4 (94/419) | 50.4 (115/228) | $\chi^2$ = 52.95, $P$ < .001 |
| Fear of falling, % (n) | 36.8 (154/419) | 50.0 (114/228) | $\chi^2$ = 10.68, $P$ = .001 |
| MMSE (95% CI) | 28.4 (28.2–28.6) | 27.4 (27.0–27.8) | $t$ = 4.65, $P$ < .001 |
| Visual disturbance, % (n) | 11.9 (50/419) | 23.7 (54/228) | $\chi^2$ = 15.11, $P$ < .001 |
| Diabetes, % (n) | 9.3 (39/419) | 9.7 (22/228) | $\chi^2$ = 0.02, $P$ = .887 |
| Cardiovascular disease, % (n) | 41.8 (175/419) | 50.0 (114/228) | $\chi^2$ = 4.05, $P$ = .044 |
| Antidepressant use, % (n) | 7.4 (31/419) | 6.1 (14/228) | $\chi^2$ = 0.36, $P$ = .548 |

Abbreviations: ADL, activities of daily living; CI, confidence interval; MMSE, Mini Mental State Examination; TUG, Timed-Up-And-Go test.

associated with osteoporosis,[34] further increasing the risk of fractures in this vulnerable cohort.

The mechanism-linking depression specifically with falls remains unclear however. Factors previously suggested as potential mediators of this relationship include cardiovascular disease, which has an established bidirectional relationship with late-life depression,[35] cardiac effects of antidepressant use,[36] and coexisting cognitive impairment.[37] We controlled for these factors in our analysis without any significant attenuation of the association. It must also be noted that older age, female gender, prior falls, and fear of falling were strong predictors of falls risk, but unlike depression, none of these conditions are modifiable apart from fear of falling.

Other factors which may account for this association include neutrally mediated syncope[39] and psychogenic syncope,[38] which can both cause UFs and are more common in depressed patients. An alternative explanation may be that in older people with cerebral hypoperfusion,[39] recurrent episodes lead to white matter hyperintensities (WMH), which have been implicated in late life depression,[40] as well as increasing falls risk.[41] Later on, cerebral hypoperfusion may progress from a subclinical entity (causing asymptomatic WMH only) to causing symptoms such as syncope or UFs. Higher WMH burden is also seen in patients with seizure disorders,[42] and seizures may also present as UFs in the older person.[43]

Subgroup analysis within the depressed group of participants showed that those with falls during the 2-year follow-up period were more likely to have several clinical features, including a longer TUG at baseline, impairment in ADLs and a history of prior falls. While there were no differences between depressed fallers and non-fallers in terms of antidepressant use, it must also be noted that antidepressant use overall in this population is relatively low, at less than 7% overall with no statistical difference in prescription rates between the depressed and nondepressed groups. The low rate of recognition and treatment of depression in later life is well recognised.[6] Additionally, antidepressants are regularly used in the setting of other illnesses such as chronic pain[44] or anxiety disorders.[45]

There are some limitations to this study that must also be noted. Diagnosis of falls was based on self-report and may therefore be subject to recall bias, as well as the fear of stigma around reporting these events. Because of this, some falls that were non-accidental in nature may be misclassified as accidental or vice versa as collateral histories or eye-witness accounts were not obtained.[46] Furthermore, our cardiovascular disease variable also relied on self-report of established diagnoses cardiac disease. It could be that apparently silent or as yet undiagnosed cardiovascular illness may have contributed to syncope burden in this cohort. Equally, it may be that, given the association with lower health literacy in mood disorders,[47] participants with depression are less likely to present earlier with conditions such as chest pain or breathlessness and therefore may be left undiagnosed.

The strengths of this study are that it involves a large sample size, with a rich dataset allowing us to control for a wide range of covariates including fear of falling, and physical measure such as cognition and gait speed. Furthermore, this is the first study to specifically examine falls in depression by falls subtype, rather than the overall falls burden.

In conclusion, this study demonstrates that baseline depression independently significantly increases the risk of UFs at 2-year follow-up in a cohort of community dwelling older people. Depression also marginally increases the risk of AFs. Depressed patients may therefore represent an appropriate target population for falls prevention programmes, especially those with clinical features such as a prior history of falls, restricted mobility, or impairment in ADLs. Furthermore, patients with depression who fall are more likely to require investigations targeted at identifying the underlying cause of UFs, including heart rhythm monitoring.

Further studies examining the role of cerebral hypoperfusion and white matter disease in this association are also warranted.

## CONFLICT OF INTEREST

The authors report no conflict of interests.

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## APPENDIX

Logistic regression reporting odds ratios, with 95% Confidence Intervals (CIS), of variables of interest for different falls types

| | Total Falls | | Accidental Falls | | Unexplained Falls | |
|---|---|---|---|---|---|---|
| | OR (95% CI) | *P* Value | OR (95% CI) | *P* Value | OR (95% CI) | *P* Value |
| Depression Wave 1[a] | 1.58 (1.31–1.89) | <.001 | 1.24 (1.00–1.52) | .046 | 1.89 (1.45–2.46) | <.001 |
| Age ≥ 75 years | 1.41 (1.19–1.67) | <.001 | 1.23 (1.01–1.49) | .037 | 1.51 (1.17–1.95) | .001 |
| Male gender | 0.79 (0.70–0.89) | <.001 | 0.78 (0.68–0.90) | <.001 | 0.89 (0.72–1.08) | .240 |
| Third-level education | 1.04 (0.92–1.18) | .553 | 1.02 (0.89–1.18) | .747 | 1.05 (0.85–1.29) | <.001 |
| Visual disturbance[b] | 1.14 (0.96–1.35) | .131 | 1.03 (0.85–1.25) | .785 | 1.26 (0.98–1.63) | .072 |
| TUG ≥ 12 s | 1.11 (0.97–1.26) | .130 | 0.96 (0.83–1.11) | .563 | 1.39 (1.13–1.72) | .002 |
| Diabetes | 1.20 (0.97–1.49) | .095 | 0.98 (0.77–1.26) | .899 | 1.56 (1.15–2.11) | 1.56 |
| Prior falls[c] | 2.96 (2.60–3.38) | <.001 | 2.57 (2.21–2.95) | <.001 | 2.30 (1.88–2.82) | <.001 |
| Fear of falling | 1.45 (1.27–1.66) | <.001 | 1.28 (1.10–1.50) | .002 | 2.30 (1.88–2.82) | .004 |
| Cognitive impairment[d] | 1.03 (0.85–1.25) | .746 | 0.81 (0.65–1.02) | .073 | 1.50 (1.14–1.96) | .004 |
| Cardiac disease[e] | 1.18 (1.04–1.33) | .011 | 1.09 (0.95–1.25) | .241 | 1.30 (1.06–1.60) | .013 |
| Antidepressant use | 0.98 (0.78–1.24) | .888 | 1.04 (0.81–1.35) | .754 | 0.86 (0.58–1.29) | .476 |

N = 6890

Abbreviations: CES-D, Centre for Epidemiological Studies Depression Scale; OR, odds ratio; TUG, Timed-Up-And-Go test.

[a]Depression at Wave 1 defined as CES-D score ≥ 16.

[b]Visual disturbance defined as glaucoma, age-related macular degeneration, or cataract.

[c]Prior falls defined as self-report of falls within the last 12 months.

[d]Cognitive impairment defined as Mini Mental State Examination score ≤ 24.

[e]Cardiac disease defined as self-report of prior myocardial infarction, current cardiac failure, cardiac arrhythmia, hypertension, or angina.