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Special Report from the CDC: Antidepressant Subclass Use and Fall Risk in Community-Dwelling Older Americans

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Abstract

Introduction: Falls among older adults are a significant health concern affecting more than a quarter of older adults (age 65+). Certain fall risk factors, such as medication use, increase fall risk among older adults (age 65+).

Aim: The aim of this study is to examine the association between antidepressant-medication subclass use and self-reported falls in community-dwelling older adults.

Methods: This analysis used the 2009–2013 Medicare Current Beneficiary Survey, a nationally representative panel survey. A total of 8,742 community-dwelling older adults, representing 40,639,884 older Medicare beneficiaries, were included. We compared self-reported falls and psychoactive medication use, including antidepressant subclasses. These data are controlled for demographic, functional, and health characteristics associated with increased fall risk. Descriptive analyses and multivariate logistic regression analyses were conducted using SAS 9.4 and Stata 15 software.

Results: The most commonly used antidepressant subclass were selective serotonin reuptake inhibitors (SSRI) antidepressants (13.1%). After controlling for characteristics associated with increased fall risk (including depression and concurrent psychoactive medication use), the risk of

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Special Report from the CDC: The Journal of Safety Research has partnered with the Office of the Associate Director for Science, Division of Injury Prevention, National Center for Injury Prevention and Control at the CDC in Atlanta, Georgia, USA, to briefly report on some of the latest findings in the research community. This report is the 63rd in a series of "From the CDC" articles on injury prevention.

falling among older adults increased by approximately 30% among those who used a SSRI or a serotonin norepinephrine reuptake inhibitors (SNRI) compared to non-users. The adjusted risk ratio (aRR) for SSRI was 1.29 (95% CI=1.13, 1.47) and for SNRI was 1.32 (95% CI= 1.07, 1.62).

Conclusion: SSRI and SNRI are associated with increased risk of falling after adjusting for important confounders. Medication use is a modifiable fall risk factor in older adults and can be targeted to reduce risk of falls.

Practical Applications: Use of selective serotonin reuptake inhibitors and serotonin norepinephrine reuptake inhibitors increased the risk of falling in older adults by approximately 30%, even after controlling for demographic, functional, and health characteristics, including depression. Health care providers can work towards reducing fall risk among their older patients by minimizing the use of certain medications when potential risks outweigh the benefits.

Keywords

Elderly; older adults; falls; antidepressants; depression; psychoactive medications

Introduction

Falls among older adults are a significant health and economic concern affecting more than a quarter of the adult population aged 65 and older, with medical costs reaching $50 billion in the United States each year.[1,2] Multiple characteristics are associated with an increased risk of falling in older adults.[3,4] These include advancing age, female sex, functional limitations, certain health conditions (such as depression, non-rheumatoid arthritis, coronary heart disease, diabetes), and psychoactive medication use.[1,4–9] Some characteristics, such as medication use, are potentially modifiable; targeted strategies may lower the risk of falling among older adults.[3,10–12]

Prescription medication use is common in older adults and has increased considerably in recent years.[13] Psychoactive medications, a subset of prescription medications, are often associated with physical and cognitive decline and increased risk of adverse drug events, including orthostatic hypotension, sedation, and falls in older adults.[14–16] Psychoactive medication use in older adults is common, with more than half (53%) of older adults using a medication in at least one psychoactive class in 2013.[17] The American Geriatric Society's (AGS) Beers Criteria highlights medication classes to avoid in older adults who have a history of falls and fractures.[18] These classes are commonly used to address pain disorders (e.g. opioid analgesics, antidepressants), sleep disorders (e.g. benzodiazepines, sedative-hypnotics), anxiety (e.g. benzodiazepines, antidepressants), epilepsy (e.g. anticonvulsants), and mood disorders (e.g. antipsychotics and antidepressants).

In this study, we examine the association between antidepressant subclass use and a reported fall in community-dwelling older Americans, controlling for other characteristics associated with increased fall risk including demographic, functional, and health characteristics and concurrent psychoactive medication use.

Methods

Study Population

This analysis used the 2009–2013 Medicare Current Beneficiary Survey (MCBS) Cost and Use files from the Centers for Medicare and Medicaid Services (CMS). MCBS is an ongoing panel survey of a nationally representative sample of Medicare beneficiaries that is selected from Medicare enrollment files. Survey participants are interviewed three times per year over a four-year period. Data are collected from each participant or a proxy using computer-assisted in-person interviews three times each year, and include demographic, functional, health, and medication use information.

Study Design

Data were combined from two waves of the survey to increase analytic power after running analyses on each wave separately to confirm comparability of results. The first wave included participants interviewed in 2010 as their baseline year. The second wave included participants interviewed in 2012 as their baseline year. The variables used from the baseline years included demographics, functional limitations, health conditions, and medication use. Demographics are collected when the older adult joins the study. Medication use, health conditions, and functional limitations are collected three times each year and are summarized to create annualized variables (Supplemental Table). As falls questions are asked only in the Fall quarter of odd years, we used participants' responses on odd years to the question, "Have you fallen down in the past year?" to determine whether the subject fell. History of a fall was collected from the 2009 and 2011 surveys for the two waves. The dependent variable fall after medication use was collected from 2011 and 2013 surveys.

Baseline data used included combined demographic, functional, and health characteristics, and medication use information from the entire baseline years. Subjects were included in this study if they were surveyed in consecutive years (2009–2011 or 2011–2013), survived throughout the study period, and met the following inclusion criteria: (1) were aged 65 years or over at baseline year, (2) were community dwelling throughout the calendar years (i.e., did not live in a long-term care facility at any time during the year), and (3) had complete survey results, including full prescription medication data. A total of 8,742 respondents met these criteria representing 40,639,884 older Medicare beneficiaries.

Measures

Using the combined cohort, we measured the following characteristics: (1) demographic characteristics (sex, age, race, education level), (2) self-reported history of a fall (2009/2011), (3) health status, (4) functional characteristics, (5) self-reported diagnosis of eight health conditions associated with falls or fall-injury severity (non-rheumatoid arthritis,[5] coronary heart disease,[8] diabetes,[9] dementia,[19] depression,[20] osteoporosis,[21] Parkinson's disease,[22] and stroke[23]), and (6) medication use. Functional characteristics included limitations in activities of daily living (ADL) (defined as bathing/showering, dressing, eating, getting in/out of bed or chair, getting on/off the toilet), limitations in instrumental activities of daily living (IADL) (defined as managing money, shopping, preparing meals, using the telephone, doing light housework), difficulty hearing (defined as little trouble, lot

of trouble, deaf), and difficulty seeing (defined as little trouble, lot of trouble, blind). For medication use information, MCBS participants are asked to save prescription containers and payment receipts to show the interviewer at the time of the survey. This minimizes underreporting of medication use and increases validity of self-reported medication use

To measure medication use, we classified prescription medications using guidance from the AGS Beers Criteria which highlights medications to avoid in older adults with a history of falls and fractures.[18] Medications are classified in MCBS by their First Databank generic. We created six drug classes for psychoactive medications: opioids, benzodiazepines, sedative-hypnotics (non-benzodiazepines limited to zaleplon, zolpidem, and eszopiclone), antipsychotics, anticonvulsants, and antidepressants. As described in the AGS Beers Criteria, the antidepressant class was further classified into subcategories: tricyclic antidepressants (TCA), selective serotonin reuptake inhibitors (SSRI), serotonin norepinephrine reuptake inhibitors (SNRI),[18] and three additional groupings not included in the AGS Beers Criteria: serotonin modulators (SM) (defined as vortioxetine, trazodone, nefazodone, and vilazodone), monoamine oxidase inhibitors (MAOI), and atypical antidepressants (defined as mirtazapine, atomoxetine, and bupropion). Medications were categorized into pharmacologic class by a pharmacist using package inserts and Lexicomp. We adjusted for participants using medication in multiple psychoactive medication classes in the year during analysis.

Statistical Analysis

Descriptive and multivariate logistic regression analyses were conducted. All analyses considered the complex survey design elements including strata, primary sampling units, and weights to generate estimates representative of the U.S. Medicare population. We used Chi-square tests to compare differences in fall or no fall in baseline year by characteristic. We reported unadjusted risk ratios (RRs) and 95% confidence intervals (CIs) for individual variables that differed significantly between fallers and non-fallers. We also reported adjusted RRs (aRRs) based on logistic regression models that controlled for demographics, functional and health characteristics, fall history, and concurrent use of other psychoactive medications. We included an additional model adjusted for concurrent use of psychoactive medications (excluding the antidepressants subclasses), demographic, functional, and health characteristics (including depression). We also conducted a bivariate analysis to describe self-reported diagnosis of depression and antidepressant medication use for years 2010 and 2012. We used SAS software (Version 9.4. Cary, NC: SAS Institute Inc; 2014) to perform data manipulations and descriptive analyses and Stata Statistical Software (Release 15. College Station, TX: StataCorp LLC; 2017) to conduct multivariate logistic regression analyses to calculate risk ratios.

Results

Table 1 shows baseline demographic, functional, and health characteristics of the population and compares fallers and non-fallers. Approximately one-quarter of older adults reported a fall (22.8%, 95% CI=22.2%, 24.5%) (Table 1). Of those who reported a previous year fall, 41.3% (95% CI=39.0, 43.5) reported a subsequent fall compared to 17.2% (95% CI=16.2,

18.2) of those not reporting a previous year fall. The percent of older adults reporting a fall increased with age from 20.4% (95% CI= 19.1, 21.8) of those 65–74 years to 23.6% (95% CI=22.0, 25.2) of those 75–84 years, and 30.9% (95% CI=28.9, 33.3) of those 85 years and over. Women were more likely to report a fall (24.5%, 95% CI=23.0, 25.9) compared with men (20.7%, 95% CI=19.3,22.1). Older adults who reported being told they had depression were more likely to report a fall (33.7, 95% CI=31.3, 36.2) than those not reporting depression (20.0%, 95% CI=19.0, 21.0).

Table 2 lists medications used by whether the participant fell after medication use. The most commonly used antidepressants were SSRI (13.1%, 95% CI= 12.1, 14.1). For all antidepressant subclasses and psychoactive medication classes, a higher percentage of those using the medication reported a fall compared to non-users ($p \leq 0.05$) (Table 2).

Table 3 shows the crude and adjusted risk ratios for demographic, functional, and health characteristics, fall history, and medication use associated with subsequent falls. In the unadjusted analyses, all antidepressant medications and other psychoactive medications significantly increased the risk of falling. However, after adjusting for potential confounders, including depression and concurrent use of multiple psychoactive or antidepressant medications, only SSRI (aRR= 1.29; 95% CI=1.13, 1.47) and SNRI (aOR= 1.32; 95% CI=1.07, 1.62) remained significantly associated with increased risk of falling. The risk of falling among older adults increased by approximately 30% among those who used a SSRI or a SNRI compared to non-users.

For health conditions, in the adjusted model, only coronary heart disease (aRR= 1.22; 95% CI=1.08, 1.38), diabetes (aRR= 1.13; 95% CI=1.03, 1.25), non-rheumatoid arthritis (aRR= 1.15; 95% CI=1.05, 1.26), and stroke (aRR=1.15; 95% CI=1.02, 1.30) remained significant (Table 3). Depression was no longer significant after adjusting for all potential confounders including concurrent antidepressant use (aRR=1.06; 95% CI=0.94, 1.20). However, in a model excluding antidepressants but adjusting for the remaining characteristics (demographic, functional, health, fall history, psychoactive medication use (excluding antidepressants), depression remained significant (aRR=1.20; 95% CI=1.09, 1.32) (**Data not shown**).

More than a third of all older adult participants using antidepressant medications, reported they had not been diagnosed with depression. By subclass, more than half of older adults using TCA medications (58.5%) reported they had not been diagnosed with depression compared to 31.6% of SSRI users, 35.2% of SM users, 24.3% of SNRI users, and 29.3% of atypical antidepressant users (Figure 1).

I. Discussion:

This study uses a nationally representative survey of older adult Medicare beneficiaries to assess the association of antidepressant use and risk of falling. Approximately one in five older adults used one or more types of antidepressant medications. The most commonly used subclasses were the SSRI and SNRI. After adjusting for concurrent high-risk psychoactive medication use, age, sex, race, past year fall, functional characteristics, and

health conditions, including depression, the risk of falling among older adults increased by approximately 30% among those who used a SSRI or a SNRI, compared to non-users.

Our findings are consistent with previous literature that has shown SSRI and SNRI to be associated with increased fall risk in older adults.[18,24,25] However, our study goes a step further to control for multiple potential confounders not always considered such as diagnosis of depression, functional limitations, and concurrent psychoactive medication use including the concurrent use of other antidepressant subclasses.

SSRI were previously found to be associated with a 3.5 times increase in the likelihood of having recurrent falls.[24] SNRI were also found to increase fall risk in older adults by two-fold.[25] Use of SSRI or SNRI for treatment of depression was evaluated in controlled clinical trials that suggested similar overall efficacy but greater tolerability (without regard to fall risk) compared to older highly anticholinergic TCA agents.[26] However, these antidepressants are not without risk. Potential adverse drug events associated with SSRI and SNRI include impaired level of alertness, drowsiness, sleep disturbance, blurred vision, physical impairment, orthostatic hypotension and diminished mental energy.[27–29] These adverse events are also risk factors for older adult falls.[30] In 2019, the AGS updated the Beers Criteria by including SNRI (in addition to TCA and SSRI) on the list of antidepressant medications to avoid in patients with a history of falls or fractures with a recommendation to use them only based on potential benefits and the lack of safer alternatives.[18]

Depression and depressive symptomology have been previously identified as risk factors for falls in older adults.[20,31] Depressive symptoms were found to increase risk of falling by 50% in older adults.[32] Symptoms of depression are similar to risk factors for falls in older adults including poor balance, psychomotor retardation or slow reaction time, weakness, cognitive impairment, and low energy and activity levels.[4,33,34] Although depression is associated with falls, the pharmacological treatment with antidepressants has also been found to be associated with increased risk of falls.[18,35] Our findings indicate that self-reported depression is a significant risk factor for falls when adjusting for demographic, functional and health characteristics and use of psychoactive medications excluding antidepressants. However, when antidepressants were included in the model, depression was no longer a significant risk factor. Therefore, providers will have to balance the need to treat depression with the possible adverse effects of the medications prescribed.

Additionally, our study found that approximately one-third of SSRI and SNRI were used by older adults who did not report a diagnosis of depression, thus suggesting that antidepressants are being used to treat other health conditions. Antidepressant therapy are commonly used for treatment of anxiety, sleep disturbances, neuropathic pain, among other health conditions. As in all situations, it is important that clinicians balance the benefits of treating other conditions or symptoms with antidepressants with the risk of falling, particularly among older adults with a history of falls or fractures.

Prescribing decisions about antidepressant medications in older adults are partly driven by adverse drug event profiles and tolerability.[35] TCA were some of the first antidepressant medications developed for the treatment of depressive symptomology including dysphoria,

hopelessness, and psychomotor dysfunction.[36] These antidepressants became a mainstay of treatment for depression, generalized anxiety disorder, and other psychiatric disorders for many years until the development of SSRI.[36] Due to the TCA's highly anticholinergic activity and their toxic cardiac effects,[37,38] there was a shift in prescribing of antidepressants from TCA to SSRI. Between 1996 and 2013, TCA use decreased by 25% while SSRI use increased by 300% in older adults.[17] However, previous research has found that this preferential prescribing of SSRI over TCA did not decrease fall risk in older adults.[35] This is consistent with our findings. If an antidepressant is needed, it is recommended to limit use the lowest effective possible dose for the shortest duration.

For older adults on multiple medications associated with increased fall risk, regular review of all medications to assess need for continuation is beneficial and may reduce potential adverse events. Additionally, if SSRI or SNRI antidepressants are indicated, providers may consider reducing the use of other psychoactive medications also associated with fall risk, such as benzodiazepines. The use of multiple psychoactive medications (psychoactive polypharmacy) further increases the risk of falls.[39] Providers and patients may also want to discuss the best approach to discontinuing medications to avoid discontinuation symptoms and unintended side effects. Weighing the risks and benefits of adjusting medications for individual patients before changing medication regimens or dose may reduce risk of falls.

The Centers for Disease Control and Prevention's STEADI (Stopping Elderly Accidents, Deaths, and Injuries) Initiative provides clinicians with tools to screen older adults for fall risk, and educates them on how to assess for fall risk factors, and intervene with evidence-based interventions for each modifiable risk factor identified (www.cdc.gov/steadi). The STEADI Algorithm for Fall Risk Screening, Assessment, and Intervention outlines how to implement the three core elements of the study (screen, assess, and intervene) and can be adapted for different clinical practice settings. Older adults who screen at risk for falls may benefit from a comprehensive assessment of current medications to identify any that may increase fall risk. The STEADI SAFE (Screen, Assess, Formulate, and Educate) Medication Review Framework describes how providers can develop individualized plans to stop or switch medications when possible or to reduce the medication to the lowest effective dose to lower the risk of adverse events, including falls. Healthcare providers can use the STEADI SAFE Medication Review Framework to optimize medication use in older adults.

Our study has potential limitations. First, medication use was assessed as any use during the year, without regard to potential discontinuation, dose and duration of use, or dose change during the year. Second, MCBS data on falls, health indicators, functional limitations, and reported diagnoses may be biased by self-report. Except for medications prescribed, MCBS does not validate the accuracy of self-reported data. For depression, there is particular potential for underreporting due to the associated stigma.[40,41] While we controlled for medications, and demographic, functional, and health characteristics, we could not control for other confounding factors that may be associated with increased risk of falls such as self-treatment of depression with alcohol or other substances.[42] Third, it is possible that medication use did not always occur prior to the self-reported fall. The fall question is collected in the autumn of odd years. Respondents are asked about falls in the prior 12 months, which may have overlap with the prior year's medication data which are based on

the calendar year. Albeit these limitations, there are inherent strength in our results. Our study used a nationally representative survey of Medicare beneficiaries and followed them longitudinally. This allows for generalizability of findings to the Medicare population in the United States. While medication use is self-reported, the information is validated by the interviewer comparing reported medication use with empty medication containers and payment receipts. This limits potential for recall bias and ensures medications were filled. Additionally, our study controlled for numerous factors and conditions known to increase risk of falls thus reducing the potential for confounding.

Conclusion

SSRI and SNRI were the most commonly used among the antidepressant subclasses in older adults. They were associated with increased risk of falling after adjusting for important confounders, including depression and concurrent psychoactive medication use. The older adult population is increasing in the United States and the number of older adults will reach 74 million by 2030.[43] Among this population, the rate of fall-related injuries treated in an emergency department is also increasing,[44] and changing prescribing patterns may be a contributing factor.[17] Medication use is a modifiable fall risk factor in older adults. Healthcare providers may reduce the risk of falls among their older patients by managing chronic health conditions and when possible minimizing use of psychoactive medications, particularly SSRI and SNRI when the risks outweigh the benefit for older adults at risk for falls. While valuable for the treatment of certain health conditions, antidepressant therapy should be reserved for patients when no safer alternatives to treat the target condition exist.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Author Biographies

Dr. Haddad is a consultant pharmacist and TJFACT contactor at the U.S. Centers for Disease Control and Prevention’s National Center for Injury Prevention and Control. She received her Pharm.D. from the University of Maryland School of Pharmacy, and her M.P.H in Prevention Science from Emory University Rollins School of Public Health. Dr. Haddad holds a board certification in geriatric pharmacy. Her areas of concentration are older adult injury prevention and effects of medications and polypharmacy on older adult safety.

Dr. Luo is a Health Economist in CDC’s Division of Injury Prevention. Dr. Luo’s primary research interests include socioeconomic determinants and consequences of injury and violence, evaluations of injury and violence prevention policies and programs, and associations of injury and violence with physical and mental health outcomes. His research

works span a wide range of injury and violence topics such as adverse childhood experiences, dating violence, opioid poisoning, suicidal behaviors, older adult falls, etc.

Dr. Bergen has been a behavioral scientist at the U.S. Centers for Disease Control and Prevention's National Center for Injury Prevention and Control since 2009. Prior to that, she was an injury data fellow at the CDC's National Center for Health Statistics. Gwen's work is in the areas of falls and older adult mobility. She received her Ph.D. in health policy and management at the Johns Hopkins Bloomberg School of Public Health and her M.P.H. in social and behavioral sciences from the Emory University Rollins School of Public Health.

Dr. Legha has served as a medical officer at the National Center for Injury Prevention and Control at the Centers for Disease Control and Prevention since 2019. Prior to that, she was a practicing internist in a public hospital setting in New York City from 2003–2018. She received her M.D. and M.P.H. degrees from Columbia University in 2003. Interests include fall prevention, healthy aging, overdose prevention, and adverse childhood experiences.

Dr. Atherly is the Founder and Director of the Center for Health Services Research at the Larner College of Medicine at the University of Vermont. Dr. Atherly's research targets health economics, with an emphasis on the economics of aging and consumer decisions regarding health plan choice. His research spans numerous methodological and topical areas, including healthcare spending and expenditure modeling, scale development and psychometric analysis, evaluation of efforts to improve quality of care and patient safety and cost-effectiveness analysis. Dr. Atherly holds a Ph.D. in Health Services Research, Policy and Administration from the University of Minnesota.

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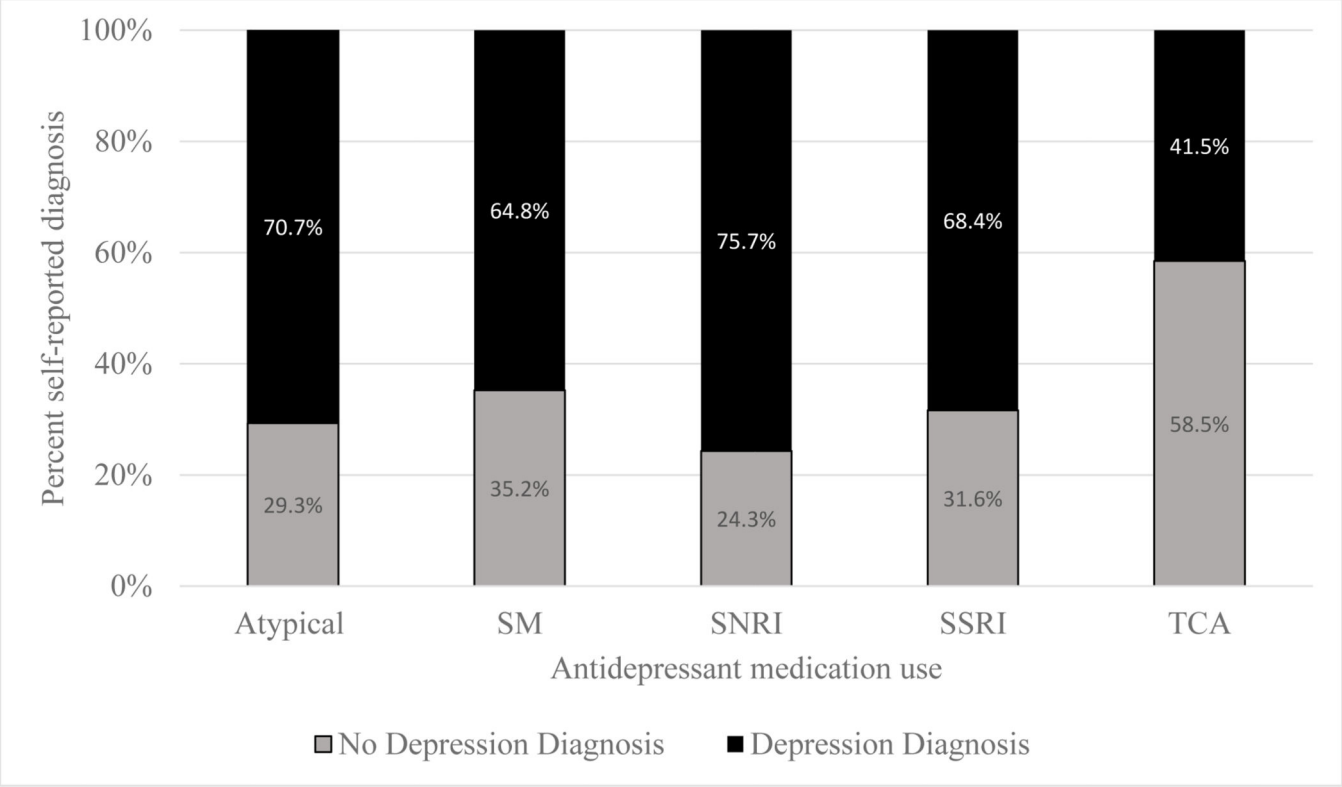

Figure 1:

Antidepressant medication use by self-reported depression diagnosis, Medicare beneficiaries age ≥65, Medicare Current Beneficiary Surveys, 2009–2013.

Atypicals including mirtazapine, atomoxetine, bupropion

SM = Serotonin modulators including vortioxetine, trazodone, nefazodone, vilazodone

SNRI = Serotonin norepinephrine reuptake inhibitors

SSRI = Selective serotonin reuptake inhibitors

TCA = Tricyclic antidepressants

Table 1.

Characteristics of community-dwelling Medicare beneficiaries aged ≥65 by fall status– Medicare Current Beneficiary Surveys, 2009–2013.

	Total				Reported a fall				Did not report a fall				p value*
Demographic characteristics	**n**[a]	**Column %**[b]	**95% CI**[c]		**n**[a]	**Row %**[b]	**95% CI**[c]		**n**[a]	**Row %**[b]	**95% CI**[c]		
Total	8742	-	-	-	2074	22.8	22.2	24.5	6668	77.2	76.3	78.1	
Age													**<0.0001**
65–74	3821	53.4	52.2	54.5	794	20.4	19.1	21.8	3027	79.6	78.2	80.9	
75–84	3531	34.5	33.6	35.4	855	23.6	22.0	25.2	2676	76.4	74.8	78.0	
85+	1390	12.2	11.5	12.9	425	30.9	28.4	33.3	965	69.1	66.7	71.6	
Sex													**0.0006**
Men	3841	44.2	42.9	45.5	847	20.7	19.3	22.1	2994	79.3	77.9	80.7	
Women	4901	55.8	54.5	57.1	1227	24.5	23.0	25.9	3674	75.5	74.1	77.0	
History of a fall in previous year													**<0.0001**
No	6628	76.6	75.5	77.8	1192	17.2	16.2	18.2	5436	82.8	81.8	83.8	
Yes	2114	23.4	22.2	24.5	882	41.3	39.0	43.5	1232	58.7	56.5	61.0	
Race/Ethnicity													**<0.0001**
non-Hispanic Black	788	8.3	6.9	9.7	133	15.7	13.6	17.9	655	84.3	82.1	86.4	
Hispanic	220	2.2	1.8	2.6	45	18.7	13.7	23.8	175	81.3	76.2	86.3	
non-Hispanic other/ unknown	255	3.5	2.8	4.2	50	19.0	13.2	24.7	205	81.0	75.3	86.8	
Non-Hispanic White	7479	86.0	84.5	87.4	1846	23.7	22.7	24.8	5633	76.3	75.2	77.3	
Education													0.7504
<High School/ unknown	2077	21.4	19.9	22.9	505	23.0	21.0	25.0	1572	77.0	75.0	79.0	
High School	2385	26.8	25.5	28.1	578	23.4	21.5	25.4	1807	76.6	74.6	78.5	
Some college	2323	27.9	26.5	29.2	531	22.0	20.3	23.7	1792	78.0	76.3	79.7	
College or graduate	1957	24.0	22.4	25.6	460	22.8	20.7	24.9	1497	77.2	75.1	79.3	
Body mass index													**0.0003**
<18.5 (underweight)	227	2.5	2.1	2.8	61	27.9	21.5	34.3	166	72.1	65.7	78.5	
18.5–24.9 (normal)	2867	31.6	30.5	32.7	702	23.5	22.0	25.1	2165	76.5	74.9	78.0	
25.0–29.9 (overweight)	3268	37.9	36.8	39.1	701	20.4	18.9	21.8	2567	79.6	78.2	81.1	
≥30 (obese)	2255	26.6	25.6	27.7	584	25.1	23.2	27.0	1671	74.9	73.0	76.8	
Refused/unknown	125	1.3	1.1	1.6	26	19.6	12.1	27.2	99	80.4	72.8	87.9	
Self-reported health status													**<0.0001**
Excellent/ Very Good	4571	54.0	52.6	55.4	898	18.7	17.4	20.0	3673	81.3	80.0	82.6	
Good	2670	29.6	28.4	30.7	655	23.9	22.1	25.7	2015	76.1	74.3	77.9	

	Total				Reported a fall				Did not report a fall				p value*
Demographic characteristics	**n**[a]	**Column %**[b]	**95% CI**[c]		**n**[a]	**Row %**[b]	**95% CI**[c]		**n**[a]	**Row %**[b]	**95% CI**[c]		
Fair	1168	12.6	11.8	13.3	389	32.7	29.9	35.5	779	67.3	64.5	70.1	
Poor	311	3.7	3.2	4.1	123	39.2	32.8	45.6	188	60.8	54.4	67.2	
Refused/unknown	22	0.2	0.1	0.3	<20	-	-	-	<20	-	-	-	
Functional limitations													
ADL limitations[d]													**<0.0001**
None	6155	72.8	71.5	74.0	1168	18.4	17.4	19.4	4987	81.6	80.6	82.6	
1 +	2587	27.2	26.0	28.5	906	34.6	32.7	36.5	1681	65.4	63.5	67.3	
IADL limitations[e]													**<0.0001**
None	7266	84.7	84.7	84.7	1529	20.4	19.4	21.3	5737	79.6	78.7	80.6	
1 +	1476	15.3	14.2	16.4	545	36.3	33.8	38.8	931	63.7	61.2	66.2	
Difficulty hearing[f]													**<0.0001**
No	4657	55.3	53.6	57.0	970	20.2	19.0	21.4	3687	79.8	78.6	81.0	
Yes	4085	44.7	43.0	46.4	1104	26.0	24.6	27.4	2981	74.0	72.6	75.4	
Difficulty seeing[g]													**<0.0001**
No	5784	67.1	65.7	68.4	1187	19.9	18.8	21.0	4597	80.1	79.0	81.2	
Yes	2958	32.9	31.6	34.3	887	28.8	27.2	30.3	2071	71.2	69.7	72.8	
Health Conditions													
Coronary Heart Disease													<0.0001
No	7733	88.7	87.9	89.5	1772	21.9	20.9	22.9	5961	78.1	77.1	79.1	
Yes	1009	11.3	10.5	12.1	302	30.0	26.8	33.2	707	70.0	66.8	73.2	
Dementia/Alzheimer's Disease													<0.0001
No	8282	95.3	94.8	95.8	1912	22.2	21.2	23.2	6370	77.8	76.8	78.8	
Yes	460	4.7	4.2	5.2	162	35.2	30.7	39.7	298	64.8	60.3	69.3	
Depression													<0.0001
No	6974	79.7	78.7	80.8	1475	20.0	19.0	21.0	5499	80.0	79.0	81.0	
Yes	1768	20.3	19.2	21.3	599	33.7	31.3	36.2	1169	66.3	63.8	68.7	
Diabetes													<0.0001
No	6478	74.0	72.9	75.1	1444	21.3	20.1	22.5	5034	78.7	77.5	79.9	
Yes	2264	26.0	24.9	27.1	630	27.0	25.1	28.8	1634	73.0	71.2	74.9	
Non-rheumatoid Arthritis													<0.0001
No	3481	41.5	40.1	42.9	645	17.7	16.5	18.9	2836	82.3	81.1	83.5	
Yes	5261	58.5	57.1	59.9	1429	26.4	25.0	27.8	3832	73.6	72.2	75.0	
Osteoporosis													<0.0001
No	6741	78.4	77.4	79.4	1497	21.2	20.3	22.2	5244	78.8	77.8	79.7	
Yes	2001	21.6	20.6	22.6	577	28.5	26.0	30.9	1424	71.5	69.1	74.0	

	Total				Reported a fall				Did not report a fall				p value*
Demographic characteristics	**n**[a]	**Column %**[b]	**95% CI**[c]		**n**[a]	**Row %**[b]	**95% CI**[c]		**n**[a]	**Row %**[b]	**95% CI**[c]		
Parkinson's Disease													<0.0001
No	8619	98.7	98.5	98.9	2021	22.5	21.6	23.5	6598	77.5	76.5	78.4	
Yes	123	1.3	1.1	1.5	53	42.6	33.2	52.1	70	57.4	47.9	66.8	
Stroke													<0.0001
No	7844	90.4	89.8	91.0	1770	21.7	20.7	22.7	6074	78.3	77.3	79.3	
Yes	898	9.6	9.0	10.2	304	33.6	30.4	36.8	594	66.4	63.2	69.6	

*p-value – Chi-square tests to compare difference in fall or no fall by characteristic

-= Data not available due to small sample size

[a]n = unweighted number

[b]% = weighted percent to the US Medicare population of characteristic

[c]CI= 95% confidence interval

[d]Defined as limitations in bathing or showering, dressing, eating, getting in or out of bed or chair; getting on/off the toilet

[e]Defined as limitations in managing money, shopping, preparing meals, using the telephone, doing light housework

[f]Difficulty hearing defined as little trouble, lot of trouble, or deaf

[g]Difficulty seeing defined as little trouble, lot of trouble, or blind

Table 2.

Medication use among community-dwelling Medicare beneficiaries aged ≥65 by fall status – Medicare Current Beneficiary Surveys, 2009—2013.

Medication Classes	Total n= 8,742				Reported a fall n= 2,074				Did not report a all n= 6,668				p value*
	n[a]	%[b]	95% CI[c]		n[a]	%[b]	95% CI[c]		n[a]	%[b]	95% CI[c]		Fell vs. Did not Fall
Antidepressants													
Atypicals[d]													**0.0345**
No	8635	98.8	98.5	99.0	2039	22.7	21.7	23.6	6596	77.3	76.4	78.3	
Yes	107	1.2	1.0	1.5	35	31.8	22.6	41.0	72	68.2	59.0	77.4	
MAOI[e]													-
No	8741	100.0	100.0	100.0	-	-	-	-	-	-	-	-	
Yes	<20	0.0	0.0	0.0	-	-	-	-	-	-	-	-	
SM[f]													**<.0.0001**
No	8524	97.4	97.0	97.8	1994	22.4	21.5	23.4	6530	77.6	76.6	78.5	
Yes	218	2.6	2.2	3.0	80	36.5	29.9	43.1	138	63.5	56.9	70.1	
SNRI[g]													**<.0.0001**
No	8481	96.8	96.4	97.3	1966	22.2	21.2	23.1	6515	77.8	76.9	78.8	
Yes	261	3.2	2.7	3.6	108	42.0	35.3	48.6	153	58.0	51.4	64.7	
SSRI[h]													**<.0.0001**
No	7616	86.9	85.9	87.9	1666	20.8	19.8	21.7	5950	79.2	78.3	80.2	
Yes	1126	13.1	12.1	14.1	408	36.3	33.2	39.5	718	63.7	60.5	66.8	
TCA[i]													**0.0003**
No	8481	97.1	96.7	97.4	1983	22.5	21.5	23.4	6498	77.5	76.6	78.5	
Yes	261	2.9	2.6	3.3	91	33.0	27.2	38.9	170	67.0	61.1	72.8	
Other Psychoactive													
Anticonvulsants													**<.0.0001**
No	7805	89.6	88.9	90.3	1762	21.6	20.6	22.6	6043	78.4	77.4	79.4	
Yes	937	10.4	9.7	11.1	312	33.4	30.0	36.8	625	66.6	63.2	70.0	
Antipsychotics													**0.0003**
No	8555	98.0	97.6	98.3	2011	22.5	21.6	23.4	6544	77.5	76.6	78.4	
Yes	187	2.0	1.7	2.4	63	36.3	27.7	44.8	124	63.7	55.2	72.3	
Benzodiazepines													**<.0.0001**
No	7800	89.4	88.7	90.2	1772	21.6	20.7	22.6	6028	78.4	77.4	79.3	
Yes	942	10.6	9.8	11.3	302	32.7	29.5	35.9	640	67.3	64.1	70.5	
Opioids													**<.0.0001**
No	5966	68.9	67.8	70.0	1278	20.6	19.5	21.6	4688	79.4	78.4	80.5	
Yes	2776	31.1	30.0	32.2	796	27.8	26.2	29.3	1980	72.2	70.7	73.8	

Medication Classes	Total n= 8,742				Reported a fall n= 2,074				Did not report a all n= 6,668				p value*
	n[a]	%[b]	95% CI[c]		n[a]	%[b]	95% CI[c]		n[a]	%[b]	95% CI[c]		Fell vs. Did not Fall
Sedative-hypnotics													0.0275
No	8258	994.33.8	93.8	94.9	1934	22.5	21.6	23.5	6324	77.5	76.5	78.4	
Yes	484	5.7	5.1	6.3	140	27.3	23.1	30.9	344	72.7	69.1	76.9	

*p-value – Chi-square tests to compare difference in fall or no fall by medication use

-= Data not available due to small sample size

[a]n = unweighted number

[b]% = weighted percent to the US Medicare population of characteristic

[c]CI= 95% confidence interval

[d]Atypicals including mirtazapine, atomoxetine, bupropion

[e]MAOI = Monoamine oxidase inhibitors

[f]SM = Serotonin modulators including vortioxetine, trazodone, nefazodone, vilazodone

[g]SNRI = Serotonin norepinephrine reuptake inhibitors

[h]SSRI = Selective serotonin reuptake inhibitors

[i]TCA = Tricyclic antidepressants

Table 3:

Crude and adjusted risk ratio of characteristics and falls Medicare beneficiaries age ≥65 - Medicare Current Beneficiary Surveys, 2009–13.

Variables		Crude risk ratio (RR)			Adjusted risk ratio (aRR)[a]		
Antidepressant medications	**n[b]**	**RR**	**95% CI[c]**		**aRR**	**95% C[c]**	
(Reference=No use)							
Atypicals[d]	107	**1.40**	**1.04**	**1.88**	1.03	0.77	1.39
SM[e]	218	**1.63**	**1.35**	**1.96**	1.03	0.83	1.29
SNRI[f]	261	**1.89**	**1.61**	**2.23**	**1.32**	**1.07**	**1.62**
SSRI[g]	1126	**1.75**	**1.59**	**1.93**	**1.29**	**1.13**	**1.47**
TCA[h]	261	**1.47**	**1.22**	**1.76**	1.03	0.84	1.27
Other psychoactive							
(Reference=No use)							
Anticonvulsants	937	**1.55**	**1.38**	**1.74**	1.14	0.99	1.29
Antipsychotics	187	**1.61**	**1.27**	**2.04**	1.06	0.80	1.40
Benzodiazepines	942	**1.51**	**1.36**	**1.68**	1.08	0.96	1.22
Opioids	2776	**1.35**	**1.26**	**1.45**	1.06	0.98	1.14
Sedative-hypnotics	585	**1.20**	**1.02**	**1.40**	0.94	0.79	1.13
Demographic characteristics							
Age							
65–74 (Reference)	3821	-	-	-	-	-	-
75–84	3531	**1.15**	**1.05**	**1.26**	**1.10**	**1.01**	**1.21**
85+	1390	**1.50**	**1.36**	**1.65**	**1.28**	**1.14**	**1.43**
Sex							
Men (Reference)	3841	-	-	-	-	-	-
Women	4901	**1.18**	**1.07**	**1.30**	1.01	0.92	1.11
History of a fall in previous year							
No (Reference)	6628	-	-	-	-	-	-
Yes	2114	**2.40**	**2.20**	**2.62**	**1.96**	**1.79**	**2.15**
Race/ethnicity							
non-Hispanic Black	788	**0.66**	**0.57**	**0.76**	**0.70**	**0.61**	**0.81**
Hispanic	220	0.79	0.60	1.03	**0.67**	**0.52**	**0.88**
non-Hispanic other/unknown	255	0.80	0.58	1.09	0.84	0.61	1.14
Non-Hispanic White (Reference)	7479	-	-	-	-	-	-
Body mass index							
<18.5 (underweight)	227	1.19	0.93	1.51	1.07	0.84	1.37
18.5–24.9 (normal) (Reference))	2867	-	-	-	-	-	-
25.0–29.9 (overweight)	3268	**0.87**	**0.79**	**0.95**	**0.88**	**0.81**	**0.97**

Variables		Crude risk ratio (RR)			Adjusted risk ratio (aRR)[a]		
Antidepressant medications	**n**[b]	**RR**	**95% CI**[c]		**aRR**	**95% C**[c]	
≥30 (obese)	2255	1.07	0.96	1.19	0.95	0.85	1.06
Refused/unknown	125	0.83	0.56	1.24	0.80	0.55	1.16
Self-reported health status							
Excellent/ Very good (Reference)	4571	-	-	-	-	-	-
Good	2670	**1.26**	**1.14**	**1.39**	1.02	0.92	1.13
Fair	1168	**1.70**	**1.53**	**1.88**	**1.14**	**1.00**	**1.30**
Poor	311	**1.99**	**1.68**	**2.35**	1.09	0.87	1.35
Refused/unknown	22	**2.17**	**1.41**	**3.35**	**1.89**	**1.27**	**2.82**
Functional limitations[i]							
(Reference=No self-reported limitation)							
ADL limitations[j]	2587	**1.88**	**1.74**	**2.03**	**1.21**	**1.11**	**1.33**
IADL limitations[k]	1476	**1.78**	**1.65**	**1.92**	**1.10**	**1.01**	**1.21**
Difficulty hearing[l]	4085	**1.29**	**1.19**	**1.39**	1.06	0.98	1.14
Difficulty seeing[m]	2958	**1.45**	**1.35**	**1.55**	**1.16**	**1.08**	**1.25**
Health conditions							
(Reference=No self-reported diagnosis)							
Coronary Heart Disease	1009	**1.37**	**1.22**	**1.55**	**1.22**	**1.08**	**1.38**
Dementia/ Alzheimer's Disease	460	**1.59**	**1.38**	**1.83**	1.05	0.89	1.24
Depression	1768	**1.69**	**1.54**	**1.85**	1.06	0.94	1.20
Diabetes	2264	**1.26**	**1.15**	**1.39**	**1.13**	**1.03**	**1.25**
Non-Rheumatoid Arthritis	5261	**1.49**	**1.37**	**1.63**	**1.15**	**1.05**	**1.26**
Osteoporosis	2001	**1.34**	**1.22**	**1.48**	1.05	0.94	1.17
Parkinson's Disease	123	**1.89**	**1.52**	**2.36**	1.25	0.97	1.62
Stroke	898	**1.55**	**1.39**	**1.73**	**1.15**	**1.02**	**1.30**

Bold = significant at p≤0.05.

[a] Adjusted Risk ratios for history of a fall in the previous year by medication use were adjusted for psychoactive medication use, sex, age, ethnicity. self-reported health statuses, body mass index, functional limitations, and health conditions

[b] n = unweighted number

[c] CI= 95% confidence interval

[d] Atypicals including mirtazapine, atomoxetine, bupropion

[e] SM = Serotonin modulators including vortioxetine, trazodone, nefazodone, vilazodone

[f] SNRI = Serotonin norepinephrine reuptake inhibitors

[g] SSRI = Selective serotonin reuptake inhibitors

[h] TCA = Tricyclic antidepressants

[i] Each type of functional limitation was examined as a separate binary variable.

[j] Defined as limitations in bathing or showering, dressing, eating, getting in or out of bed or chair; getting on/off the toilet.

[k] Defined as limitations in managing money, shopping, preparing meals, using the telephone, doing light housework.

[l] Difficulty hearing defined as little trouble, lot of trouble, or deaf.

[m] Difficulty seeing defined as little trouble, lot of trouble, or blind.