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RESEARCH PAPER

Potentially serious alcohol–medication interactions and falls in community-dwelling older adults: a prospective cohort study

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Abstract

Objective: To investigate the association between potentially serious alcohol–medication interactions (POSAMINO criteria), hypothesised to increase the risk of falls in older adults, and falls in community-dwelling older adults at two and 4 years follow-up.
Design: A prospective cohort study.
Setting: The Irish Longitudinal Study on Ageing.
Subjects: A total of 1,457 community-dwelling older adults aged ≥65 years, with a complete alcohol and regular medication data to allow for the application of the POSAMINO criteria.
Outcomes: Self-reported falls at 2 and 4 years follow-up, any falls (yes/no), injurious falls (yes/no) and number of falls (count variable).
Results: The number of participants who reported falling since their baseline interview at 2 and 4 years were 357 (24%) and 608 (41.8%), respectively; 145 (10%) reported an injurious fall at 2 years and 268 (18%) at 4 years. Median (IQR) number of falls was 1 (1–2) at 2 years and 2 (1–3) at 4 years. Exposure to CNS POSAMINO criteria, hypothesised to increase the risk of falls due primarily to increased sedation, was associated with a significantly increased risk for falling (adjusted relative risk (RR) 1.50, 95% confidence interval (CI) 1.21–1.88) and for injurious falls (adjusted RR 1.62, 95% CI: 1.03–2.55) at 4 years. These equate to an absolute risk of 19% for falling (95% CI: 5–33%) and 8% for injurious falls (95% CI, 4–20%) at 4 years.
Conclusions: Assessment and management strategies to prevent falls in community-dwelling older adults should consider patients' alcohol consumption alongside their assessment of patient medications, particularly among those receiving CNS agents.

Keywords: falls, alcohol, older people, alcohol–medication interactions, potentially serious alcohol–medication interactions in older adults (POSAMINO)

Key points

- This study investigates potentially serious alcohol–medication interactions as a risk factor for falls in older adults.
- Exposure to potentially serious alcohol–medication interactions involving central nervous system (CNS) agents was associated with a 19% increase in risk for falling and an 8% increase in injurious falls at 4 years.
- Assessment and management strategies to prevent falls in community-dwelling older adults should consider patients' alcohol consumption alongside their assessment of patient medications, particularly among those receiving CNS agents.

Introduction

Falls are the leading cause of injury-related morbidity and mortality among older adults, with an estimated 33,000 fall-related deaths reported among older community-dwelling adults in the United States in 2015 [1]. Moreover, the risk of falling increases with age making older adults vulnerable to the immediate and longer-term sequelae of falls including, hospital admissions, loss of independence, functional decline, reduced quality of life and premature nursing home admissions [2, 3]. The burden of falls on health services is also high, with the cost of fall-related hospital admissions among older adults estimated to be approximately £1 billion per annum in the United Kingdom [4]. In light of the projected changes in global demographics, with ageing populations worldwide, the burden of falls on patients and health care systems is set to further increase.

The 2018 US Preventive Services Task Force (USPSTF) recommends that clinicians selectively offer multifactorial interventions to prevent falls in community-dwelling older adults at risk of falling [5]. The USPSTF recommends that these multifactorial interventions include an initial assessment of modifiable risk factors, including an assessment of patient medications [5]. The National Institute for Health and Clinical Excellence in the United Kingdom also recommend a medication review with modification or withdrawal of medications as appropriate [6]. Although a number of studies have identified medications that are associated with an increased risk of falls in older adults [7–9], no cohort studies have considered drug–alcohol interactions. This is surprising, given the prevalence of alcohol consumption among community-dwelling older adults, estimated at between 57% and 63%, and the high propensity for concurrent use of alcohol with medications among older adults [10].

Even at relatively low levels of alcohol consumption, older adults are vulnerable to alcohol-related harms, with exposure to multiple medications exacerbating these harms, due to changes in absorption, distribution and metabolism of alcohol and other medications with age [11, 12]. Alcohol–medication interactions may increase the risk of hypoglycaemia, hypotension, sedation, gastrointestinal bleeding and liver damage [12]. We recently developed the POSAMINO criteria (potentially serious alcohol–medication interactions in older adults), using a two-step process involving a systematic review and a two-round Delphi consensus methodology [13]. There are 23 of the 38 criteria that are hypothesised to increase the risk of falls in older adults due to increased sedation, increased orthostatic or exaggerated hypotension or enhanced hypoglycaemic effects. The aim of this study was to test the longitudinal association between POSAMINO criteria hypothesised to increase the risk of falls, and falls in community-dwelling older adults at 2 and 4 years follow-up.

Methods

The Strengthening of Reporting of Observational Studies in Epidemiology guidelines were used for the reporting of this study.

Study population

The Irish Longitudinal Study on Ageing (TILDA) is a nationally representative population-based prospective cohort study of community-dwelling adults aged 50 years or older. Full details of the survey and its sampling procedure are described elsewhere [14, 15]. Patient interviews are repeated every 2 years, with a clinical assessment component repeated every 4 years. The current study uses data from the first three waves of TILDA: wave 1 (2009–2011; referred to hereafter as baseline), wave 2 (2012–2013) and wave 3 (2014–2015). At baseline, the total number of eligible participants aged ≥65 years was 2,700. Those with incomplete data for alcohol consumption or regular medications were excluded from the analytic sample ($n = 598$), as were those lost to follow-up ($n = 571$) and those with proxy interviews or nursing home residents at follow-up ($n = 74$). This provided approximately 2 and 4 years of follow-up information for 1457 participants. Ethical approval for TILDA was approved by the Faculty of Health Sciences Research Ethics Committee at Trinity College Dublin and all participants gave informed written consent.

Outcome variables

The following falls outcomes were assessed prospectively, at approximately 2 and 4 years follow-up; any falls (yes/no), injurious falls (yes/no) and number of falls (count variable). Participants were asked at both follow-up waves if they had fallen since their last interview, the number of falls they experienced since their last interview and if they injured themselves seriously enough to require medical treatment (injurious falls).

Exposure: application of POSAMINO criteria

POSAMINO criteria, 23 of the 38, are hypothesised to increase the risk of falls in older adults (Table 1), and were identified at baseline using respondents' information on medication and alcohol consumption. Interviewers recorded all medications taken on a regular basis by viewing medication packages at each wave. Medications were assigned World Health Organisation Anatomical Therapeutic Chemical (ATC) classification codes. Alcohol consumption was measured via a self-completion questionnaire. Quantity and frequency of alcohol consumption were harmonised across the three waves, to the number of standard drinks consumed per week, where one standard Irish drink is equal to 10 g of alcohol [16]. As the POSAMINO criteria discriminate between 'any alcohol consumption' and 'heavy alcohol

Table 1. POSAMINO criteria hypothesised to increase the risk of falling in community-dwelling older adults (n = 23)

Cardiovascular system (n = 7)
- Heavy alcohol consumption with multiple antihypertensive combinations
- Heavy alcohol consumption with both regular and as required nitrates (e.g. glyceryl trinitrate, isosorbide dinitrate and isosorbide mononitrate)
- Heavy alcohol consumption with the vasodilatory medication nicorandil
- Heavy alcohol consumption with the combined use of both nitrates and vasodilator medication (e.g. nicorandil)
- Heavy alcohol consumption with diuretics (e.g. loop diuretics (furosemide), thiazide diuretics (bendroflumethiazide) and potassium sparing diuretics (amiloride))
- Heavy alcohol consumption with alpha-blockers (e.g. terazosin)
- Heavy alcohol consumption with centrally acting antihypertensives (e.g. clonidine or methyldopa)

Respiratory system (n = 1)
- Any alcohol consumption with first-generation antihistamines (e.g. promethazine)

Central nervous system (n = 12)
- Heavy alcohol consumption with benzodiazepines (e.g. diazepam) and benzodiazepine related medications (e.g. zopiclone)
- Heavy alcohol consumption with opioids
- Heavy alcohol consumption with all anti-psychotics
- Any alcohol consumption with barbiturates
- Heavy alcohol consumption with anti-epileptic drugs (AEDs)
- Any alcohol consumption with tricyclic anti-depressants (TCAs)
- Any alcohol consumption with tetracyclic antidepressants
- Any alcohol consumption with mirtazapine
- Heavy alcohol consumption with gabapentin (when used for neuropathic pain)
- Heavy alcohol consumption with pramipexole or amantadine
- Heavy alcohol consumption with Apomorphine
- Heavy alcohol consumption with levodopa (alone or in combination with carbidopa)

Musculoskeletal (n = 1)
- Heavy alcohol consumption with muscle relaxants

Endocrine (n = 1)
- Heavy alcohol consumption with insulin

Infections (n = 1)
- Any alcohol consumption with metronidazole or tinidazole

consumption' depending on the medication, we further categorised participants as current drinkers (any alcohol consumption) at each wave if they reported drinking alcohol, or heavy drinkers if they reported drinking ≥6 standard drinks per drinking occasion or >11 standard drinks/week for women and >17 standard drinks/week for men.

Potential confounders

Established risk factors for falls in community-dwelling older adults were identified from the recent USPSTF recommendations [5] and a recent systematic review of risk factors for falls in community-dwelling older adults [17]. Age, history of falls, history of syncope, fear of falling, incontinence, walking-aid use and self-reported unsteadiness during walking were assessed at baseline. Other confounders measured at baseline included, disability (limitations in activities of daily living (ADLs) or instrumental activities of daily living (IADLS)) [18, 19], cognitive function assessed with the Montreal Cognitive Assessment (MoCA) [20] and depression using the Centre for Epidemiological Studies-Depression (CES-D) scale [21] The presence of chronic pain was also assessed. Visual impairment was identified as having one or more of the following: cataracts, glaucoma and age-related macular degeneration. Polypharmacy was defined as the regular use of five or more medications [22], with other fall risk-increasing drugs that were not contained in the 23 POSAMINO criteria also included in the analysis (SSRIs (ATC: N06AB), Venlafaxine (ATC: N06AX16) and Desvenlafaxine (ATC: N06AX23) [9].

Statistical analysis

The longitudinal association between any POSAMINO criteria and falls was estimated at 2 and 4 years follow-up (model 1). The further analysis investigated a dose–response association, replacing the binary POSAMINO with a categorical variable regarding the number of POSAMINO criteria 0, 1, ≥2 (model 2). Sub-group analyses investigating cardiovascular (CVS) and central nervous system (CNS) agents, separately, were also conducted (model 3 and 4). Baseline exposure to the POSAMINO criteria was used in each model as the primary exposure of interest. A multilevel analysis showed that participants' exposure to the POSAMINO criteria remained stable over time (adjusted Odds Ratio (aOR) 1.03, 95% confidence interval (CI) 0.91–1.15, P = 0.67). Similarly, participants' exposure in terms of the number of POSAMINO criteria did not vary over time (adjusted Incidence Rate Ratio (aIRR) 1.06, 95% CI 0.95–1.19, P = 0.3). These effects were observed after adjusting for age, gender, number of medications and number of chronic conditions at baseline. To estimate relative risks (RRs) for any fall and injurious falls, we used modified Poisson regression estimating robust standard errors for the 95% CI.

Absolute risk differences were also calculated. Negative binomial regression models were used to calculate incident rate ratios (IRR) and 95% CIs for number of falls at 2 and 4 years follow-up. Number of falls was capped at five for both the 2 and 4-year follow-up to reduce recall bias. All models were adjusted for established risk factors for falls, gender and time between interviews. All statistical analysis was carried out using Stata version 14.0.

Results

Descriptive statistics

A cohort of 1457 community-dwelling adults aged ≥65 years had sufficient data to determine exposure to POSAMINO criteria at baseline, and falls data at follow-up. Table 2 displays baseline characteristics for the cohort. The mean age at baseline was 71.6 years (SD 5.42), with 51% (n = 742) women. Sixty-four per cent (n = 939) of participants consumed alcohol at baseline, with a higher proportion of men consuming alcohol compared to women (70% vs. 59%). The overall prevalence of POSAMINO was 12% (n = 175) at baseline, with 7% (n = 105) of older adults at risk of one potentially serious falls-related drug–alcohol interaction, and 5% (n = 70) at risk of two or more. Almost one-in-ten participants were identified as at risk of falls due to their concurrent use of alcohol with CVS agents (n = 138), with 3% (n = 50) exposed to CNS POSAMINO criteria hypothesised to increase their risk of falls. Comparative analysis between the total sample and analytic sample indicated that participants not included in the analysis at both 2- and 4-year follow-up were more likely to be older, non-drinkers, fallers at baseline, have poor self-rated health and current smokers at baseline.

At 2 years follow-up, almost one in four participants (n = 357; 24%) reported falling since their baseline interview; this increased to 41.8% (n = 608) at 4 years. Similarly, the proportion of participants reporting an injurious fall since their baseline interview increased from 10% (n = 145) at 2 years to 18% (n = 268) at 4 years. The median number of falls (IQR) among those who fell was 1 [1–2] and 2 [1–3] at two and 4 years, respectively. Baseline alcohol consumption was not associated with falls at 2 or 4 years follow-up.

Association between POSAMINO and falls

In the adjusted model for any falls, the presence of any POSAMINO was not associated with falling at 2 or 4 years (Table 3). Similarly, when a number of criteria was considered, no significant association was observed at 2 or 4 years. A similar pattern was observed in the adjusted models for injurious falls and number of falls at 2 and 4 years. The subgroup analysis did, however, identify a significant association between CNS POSAMINO and any falls at 4 years (aRR 1.50, 95% CI 1.21–1.88). Exposure to CNS POSAMINO was also associated with an increased risk of injurious falls at 4 years (aRR 1.62, 95% CI: 1.03–2.55). These equate to an absolute risk of 19% for falling (95% CI: 5–33%) and 8% for injurious falls (95% CI: 4–20%) at 4 years. Exposure to CNS POSAMINO was also associated with an increase in the number of falls reported at 4 years (IRR 1.71, 95% CI 1.13–2.59); however, these effects did not remain independently significant after adjusting for established risk factors for falls (aIRR 1.48, 95% CI 0.97–2.25). Sensitivity analyses without capping number of falls at five were also carried out with no significant differences observed.

Discussion

In this cohort study of 1,457 community-dwelling older adults aged ≥65 years, exposure to CNS POSAMINO criteria, which were hypothesised to increase the risk of falls, had an absolute risk increase of 19% for falling at 4 years and an 8% absolute risk increase for experiencing an injurious fall at 4 years. The corresponding estimates at 2 years, although not statistically significant, were in the same direction. It is plausible that this study was underpowered to detect an effect at two-years due to the relatively small number of falls experienced. In contrast, exposure to CVS POSAMINO criteria, which were hypothesised to increase the risk of falls, was not associated with falls at 2 or 4 years.

This is the first longitudinal study to examine the risk of falls associated with potentially serious alcohol–medication interactions in community-dwelling older adults using a randomly sampled nationally representative dataset; only those POSAMINO criteria, hypothesised to increase the risk of falls due to increased sedation, increased orthostatic and exaggerated hypotension or enhanced hypoglycaemic effects were considered to ensure biological plausibility. Although baseline exposure to the POSAMINO criteria was assessed, the risk of misclassification bias due to changes in exposure over time is considered to be low as our multilevel analysis indicated exposure to POSAMINO did not vary over time. Nevertheless, our study had potential limitations. In observational studies of this sort, the possibility of residual confounding or confounding by indication may remain a problem, therefore associations identified here should be viewed principally as hypothesis-generating and our observed associations should be subject to testing and verification in other national cohorts. Furthermore, exposure to POSAMINO criteria is likely to be underestimated in this study, particularly for those involving CNS agents, as previous studies have shown in-home inventories of medications such as analgesics and psychotropics are lower when compared to pharmacy dispensing records [23]. In addition, alcohol consumption was based on self-report, which may have led to misclassification of participants, particularly for those criteria involving heavy drinking, as older adults are more likely to under-report heavy consumption [24]. However, levels of alcohol consumption reported in this study are similar to those reported in previous population

Table 2. Baseline characteristics of participants reporting a fall at 2- and 4-year follow-up (N = 1457)

Baseline characteristics	N	2-Year follow-up			4-Year follow-up		
		No falls (N = 1100; 75.5%)	At least one fall (N = 357; 24.5%)	P value	No falls (N = 848;58.2%)	At least one fall (N = 609;41.8%)	P value
Age							
65–69	642 (44%)	487 (76%)	155 (24%)	0.21	391 (61%)	251 (39%)	0.001
70–74	420 (29%)	315 (75%)	105 (25%)		253 (60%)	167 (40%)	
75–79	259 (18%)	204 (79%)	55 (21%)		146 (56%)	113 (44%)	
80+	136 (9%)	94 (69%)	42 (31%)		58 (43%)	78 (57%)	
Gender							
Male	715 (49%)	572 (80%)	143 (20%)	<0.001	466 (65%)	249 (35%)	<0.001
Female	742 (51%)	528 (71%)	214 (29%)		382 (51%)	360 (49%)	
Falls							
No Falls	1162 (80%)	935 (80%)	227 (20%)	<0.001	736 (63%)	426 (37%)	<0.001
Falls	295 (20%)	165 (56%)	130 (44%)		112 (38%)	183 (62%)	
Fear of falls							
Not afraid of falls	1087 (75%)	856 (79%)	231 (21%)	<0.001	685 (63%)	402 (37%)	<0.001
Fear of falls	368 (25%)	242 (66%)	126 (34%)		162 (44%)	206 (56%)	
Chronic Pain							
No Pain/Mild	1105 (76%)	858 (78%)	247 (22%)	0.001	673 (61%)	432 (39%)	<0.001
Moderate/Severe Pain	350 (24%)	240 (69%)	110 (31%)		174 (50%)	176 (50%)	
Self-reported unsteadiness when walking							
No	1190 (82%)	934 (78%)	256 (22%)	<0.001	735 (62%)	455 (38%)	<0.001
Yes	264 (18%)	164 (62%)	100 (38%)		113 (43%)	151 (57%)	
Walking aid use							
None	1447 (99%)	1095 (76%)	352 (24%)	0.03	845 (58%)	602 (42%)	0.13
Walking aid use	9 (1%)	4 (44%)	5 (56%)		3 (33%)	6 (67%)	
Eye conditions							
None	1145 (79%)	875 (76%)	270 (24%)	0.12	686 (60%)	459 (40%)	0.01
1 or more	312 (21%)	225 (72%)	87 (28%)		162 (52%)	150 (48%)	
Additional FRIDs							
No	1397 (96%)	1065 (76%)	332 (24%)	0.002	829 (59%)	568 (41%)	<0.001
Yes	60 (14%)	35 (58%)	25 (425)		19 (32%)	41 (68%)	
Disability							
No ADLS/IADLs	1281(88%)	988 (77%)	293 (23%)	<0.001	768 (60%)	513 (40%)	<0.001
ADLs/IADLs reported	176 (12%)	112 (64%)	64 (36%)		80 (45%)	96 (55%)	
Polypharmacy							
No	1032 (71%)	798 (77%)	234 (23%)	0.01	619 (60%)	413 (40%)	0.03
Yes	425 (29%)	302 (71%)	123 (29%)		229(54%)	196 (46%)	
POSAMINO falls criteria							
No	1282 (88%)	968 (76%)	314 (24%)	0.98	700 (59%)	495 (41%)	0.54
Yes	175 (12%)	132 (75%)	43 (25%)		148 (56%)	114 (44%)	
Depression (using CES-D scale)							
None	1136 (79%)	871 (76%)	265 (23%)	0.02	676 (60%)	460 (40%)	0.03
Subclinical	220 (15%)	159 (72%)	61 (28%)		120 (55%)	100 (45%)	
Clinical	81 (6%)	52 (64%)	29 (36%)		37 (46%)	44 (54%)	
Incontinence							
No	1271 (87%)	971 (76%)	300 (24%)	0.06	761 (60%)	510 (40%)	0.001
Yes	184 (13%)	129 (70%)	55 (30%)		87 (47%)	97 (53%)	
History of Blackouts or Fainting							
No	1179 (81%)	910 (77%)	26 (23%)	0.002	706 (60%)	473 (40%)	0.007
Yes	278 (19%)	190 (68%)	88 (32%)		142 (51%)	136 (49%)	
MoCA (Mean (SD))	24.63 (3.37)	24.59 ± 3.42	24.78 ± 3.16	0.53	24.74 ± 3.3	24.48 ± 3.5	0.39

studies of older adults, with older men consuming more alcohol compared to women [25, 26]. Furthermore, self-reported falls rely on the participants' ability to recall past events, which may lead to recall bias. Finally, our findings may also be subject to attrition bias as older participants, non-drinkers, smokers, fallers and those with poor self-rated health at baseline were more likely to be lost to follow-up.

Although a number of previous studies have examined the prevalence of potential alcohol–drug interactions in older adults, few studies have assessed adverse outcomes; with only three studies, all cross-sectional, reporting on falls [27–29]. One study involving a postal questionnaire of 2,100 older adults in the Espoo population register in Finland found that older adults who reported being heavy drinkers and taking alcohol interactive medications (13.8%)

Table 3. Association between falls-related POSAMINO criteria and any falls, injurious falls and number of falls at 2 and 4 years follow-up

	Any falls (RR, 95% CI)			Injurious falls (RR, 95% CI)			Number of falls (IRR, 95% CI)		
	N[‡]	Unadjusted	Adjusted[†]	N[‡]	Unadjusted	Adjusted †	Mean falls (SD)	Unadjusted	Adjusted †
2-Year follow-up									
Any POSAMINO Falls criteria (vs. none)[a]	43 (25%)	1.00 (0.76–1.32)	1.01 (0.75–1.36)	15(9%)	0.85 (0.51–1.41)	0.97 (0.55–1.69)	0.41 (0.89)	0.99 (0.70–1.41)	0.87 (0.59–1.27)
Number of POSAMINO Falls criteria (vs. zero)[b]									
1	25 (24%)	0.97 (0.68–1.39)	1.07 (0.74–1.54)	8 (8%)	0.75 (0.38–1.49)	0.97 (0.46–2.07)	0.38 (0.88)	0.93 (0.59–1.46)	1.05 (0.65–1.69)
≥ 2	18 (26%)	1.05 (0.70–1.58)	0.93 (0.60–1.45)	7 (10%)	0.99 (0.48–2.03)	0.96 (0.43–2.12)	0.44 (0.91)	1.09 (0.64–1.84)	0.64 (0.35–1.16)
CVS POSAMINO Falls criteria (vs. none)[c]	31 (22%)	0.91 (0.66–1.26)	0.85 (0.59–1.23)	10 (7%)	0.71 (0.38–1.31)	0.73 (0.36–1.51)	0.38 (0.87)	0.94 (0.63–1.39)	0.72 (0.46–1.12)
CNS POSAMINO Falls criteria (vs. none)[d]	18 (36%)	1.49*(1.02–2.19)	1.44 (0.98–2.10)	7 (14%)	1.43 (0.71–2.89)	1.61(0.76–3.39)	0.56 (0.95)	1.39 (0.77–2.50)	1.21 (0.66–2.33)
4-Year follow-up									
Any POSAMINO Falls criteria (vs. none)[a]	78 (45%)	1.08 (0.90–1.29)	1.16 (0.96–1.40)	31 (18%)	0.96 (0.68–1.35)	1.15 (0.80–1.66)	0.97 (1.41)	1.18 (0.92–1.51)	1.10 (0.84–1.43)
Number of POSAMINO Falls criteria (vs. zero)[b]									
1	47 (45%)	1.08 (0.87–1.35)	1.27 (1.02–1.57)	20 (19%)	1.03 (0.68–1.55)	1.47 (0.99–2.18)	0.92 (1.34)	1.13 (0.82–1.55)	1.29 (0.93–1.80)
≥ 2	31 (44%)	1.07 (0.82–1.40)	1.01 (0.75–1.37)	11 (16%)	0.85 (0.49–1.48)	0.71 (0.35–1.42)	1.03 (1.52)	1.25 (0.86–1.82)	0.83 (0.55–1.27)
CVS POSAMINO Falls criteria (vs. none)[c]	56 (41%)	0.97 (0.78–1.20)	0.99 (0.78–1.25)	20 (14%)	0.77 (0.51–1.17)	0.86 (0.53–1.39)	0.88 (1.40)	1.05 (0.79–1.39)	0.90 (0.66–1.23)
CNS POSAMINO Falls criteria (vs. none)[d]	30 (60%)	1.46*(1.15–1.84)	1.50*(1.21–1.88)	13 (26%)	1.43 (0.89–2.32)	1.62*(1.03–2.55)	1.4 (1.60)	1.71*(1.13–2.59)	1.48 (0.97–2.25)

[a]Model 1; [b]Model 2; [c]Model 3; [d]Model 4. [†]Adjusted for age, gender, the time between interviews, history of falls, fear of falls, chronic pain, unsteadiness, walking aid use, eye conditions, disability, polypharmacy, Fall risk increasing drugs not included in the POSAMINO, depression, incontinence, history of syncope and cognition using the MoCA scale. [‡]Number of people exposed to POSAMINO who experienced the specified falls outcome. *$P < 0.05$.

were significantly more likely to report falling compared to low-risk or non-drinkers taking alcohol interactive medications (4.1%). These findings must be interpreted with caution due to the cross-sectional nature of the study and the fact that their analysis did not adjust for potential confounders [29]. Wong *et al.*'s [27] study involving a convenience sample of older adults in the United States is also problematic, as it does not assess the risk of falls associated with the concurrent use of alcohol and alcohol interactive medications. Firstly, they did not examine alcohol interactive medications, rather they included any prescribed or OTC medication. Secondly, their analysis of falls was restricted to participants who reported concurrent alcohol and medication use and did not adjust for potential confounders. Finally, Sheahan *et al.*'s [28] cross-sectional study of older adults in America, which included patients from congregate-care facilities, found that the concurrent use of alcohol and psychotropic medications was not associated with falls. However, alcohol consumption was assessed using a frequency measure (number of days alcohol consumed in the past year) which may have resulted in a biased estimate.

Assessment and management strategies to prevent falls in community-dwelling older adults stress the importance of a comprehensive risk assessment, including an assessment of patient medications [5, 6, 30]. Our findings suggest that clinicians should also consider a patient's level of alcohol consumption, particularly when prescribing CNS agents hypothesised to increase the risk of sedation when combined with alcohol. However, there is some limited evidence that review of patient's medications does not trigger alcohol-related discussions in clinical practice. A baseline analysis of 3,305 older adults involved in the Project Senior Health and Alcohol Risk Education randomized controlled trial in the United States found that the probability of alcohol-related discussions between patients and clinicians were not influenced by patient medications that may interact with alcohol. Furthermore, alcohol-related discussions reduced with patient age [31]. Discussing the risks of alcohol more broadly and drug/alcohol interactions more specifically at the point of prescribing with patients may reduce the risk of falls arising from the concurrent use of alcohol and CNS agents. For many patients, it may be that they are simply unaware of the potential risk [32], and once informed may reduce their alcohol consumption. Recent studies have identified health precautions as one of the most commonly cited reasons for reducing alcohol consumption among older adults [33]. Others may require a brief intervention or referral to specialist services.

Exposure to potentially serious alcohol–medication interactions involving CNS agents was associated with the risk of falling and injurious falls among community-dwelling older adults at 4 years follow-up. Assessment and management strategies to prevent falls in community-dwelling older adults should consider patients' alcohol consumption alongside their assessment of patient medications, particularly among those receiving CNS agents.

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