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AF is associated with self-reported syncope and falls in a general population cohort

Sofie Jansen[1], John Frewen[2], Ciaran Finucane[3], Sophia E. de Rooij[1], Nathalie van der Velde[1], Rose Anne Kenny[2]

[1]Internal Medicine, Section of Geriatric Medicine, Academic Medical Center, Amsterdam, Netherlands
[2]Department of Medical Gerontology, Trinity College, Dublin, Ireland
[3]Medical Physics and Bioengineering, St James's Hospital, Dublin, Ireland

Address correspondence to: S. Jansen. Tel: (+31) 20566599; Fax: (+31) 205669325. Email: s.jansen@amc.uva.nl

Abstract

Background: syncope is an important, but underestimated clinical problem in older persons. It is often overlooked in clinical practice or mistaken for falls. Atrial fibrillation (AF) is the most common cardiac arrhythmia, but little evidence exists regarding the association between AF, falls and syncope in the general population.
Methods: cross-sectional analyses within a population sample of people aged 50+, taken from The Irish Longitudinal Study on Ageing. Ten-minute electrocardiogram recordings (n = 4,885) were analysed to detect AF. Syncope (self-reported faints or blackouts) and falls in the past year, co-morbidities, health measures and medications were gathered through computer-aided personal interviews. Multivariable logistic regression was performed to study associations between AF, falls and syncope.
Results: mean age was 62 years (range: 50–91), 54% were female. Prevalence of AF was 3%, increasing to 8% in participants aged 75+. Of participants, 5% (n = 223) reported syncope and 20% (n = 972) reported falls. After adjustment for confounders, AF was significantly associated with faints and blackouts (odds ratio (OR) 2.0 [95% confidence interval (CI) 1.0–3.9]). After stratification by age category, we found that this association was strongest and only significant in participants aged 50–64 years (OR 4.4 [1.5–12.6]). Stratified for age group, AF was significantly associated with falls in participants aged 65–74 years (OR 2.0 [1.0–4.1]).
Conclusions: adults aged 50+ with self-reported syncope and adults aged 65–74 years with falls are twice as likely to have AF at physical examination. These associations are independent of stroke, cardiovascular and psychotropic drugs and other confounders. Further longitudinal studies are needed to explore this association and potential causality further.

Keywords: *falls, syncope, atrial fibrillation, cardiac arrhythmia, ECG, older people*

Introduction

Falls in older people and their related injuries form a significant healthcare burden [1, 2]. Several risk factors for falls in older persons have been recognised, but controversy still remains regarding the importance of heart rhythm abnormalities as a modifiable risk factor for falls [3]. Given that there is emerging evidence of overlap between the symptoms of falls and syncope [3], fall prevention guidelines recommend cardiovascular evaluation as part of comprehensive falls assessment [3]. Despite this recommendation, cardiovascular risk factors for falls remain under evaluated in clinical practice [4].

Arrhythmias are an important cardiac cause of syncope as they impair haemodynamic function, resulting in a critical decrease in cardiac output and cerebral blood flow [5]. Atrial fibrillation (AF) is the most common cardiac arrhythmia in adults with its prevalence rising from 1 to 2% in the general population to nearly 5% in community dwellings aged 65+ [6, 7]. To date, AF has only been linked to recurrent syncope in a general population study [8]. An association between AF and non-accidental falls was reported in a sample of patients attending the emergency department (ED) following a fall [9]. As yet, no studies have investigated the association between AF and falls on a general population level.

If AF is indeed associated with falls and syncope, this would provide new evidence for a potentially treatable risk factor for falls and syncope. In this study, we investigated whether AF was more common in community-dwelling older adults with a history of a fall, faint or blackout in the past year.

Methods

Study design

The Irish Longitudinal Study on Ageing (TILDA) is a nationally representative prospective cohort study comprising community dwellings aged 50+, resident in the Republic of Ireland. The current cross-sectional study was based on the first wave of data, collected between 2009 and 2011. Further details of the study are published elsewhere [10]. Data were collected by a personal interview, a self-completion questionnaire and a physical health assessment conducted in a health centre. Ethical approval was obtained with the Trinity College Dublin Research Ethics Committee; all experimental procedures adhered to the Declaration of Helsinki. All participants provided signed informed consent prior to participating.

Falls and syncope

Participants were asked how often they had a fall, faint or blackout in the past year. Falls were defined as one or more falls in the past year. Syncope was defined as one or more faints or blackouts.

Co-variate information

The following co-variates were taken from the home interview or self-completion questionnaire: age, gender, highest level of education, smoking, alcohol consumption and body mass index (BMI, kg/m^2). Depressive symptoms were defined as a score of ≥16 on the Centre for Epidemiological Studies Depression-scale [11]. Disability was defined as any disability from the lists of (instrumental) activities of daily living (iADL/ADL) [12]. For cognitive function, the Mini-Mental State Examination (MMSE) was used. Other co-morbidities included lung disease, angina, myocardial infarction, heart failure, diabetes mellitus, stroke, transient ischaemic attack and cardiac arrhythmias.

The following co-variates were gathered during the health assessment. Corrected visual acuity (VA) was measured in both eyes using a logMAR chart [13]. Blood pressure was measured from two recordings, using a sphygmomanometer on the upper arm in the seated position. Gait speed was measured using a computerised walkway (GAITRite©, CIR Systems Inc., New York, NY, USA). Medication use was recorded during the home interview and confirmed by cross-checking of medication labels; Anatomical Therapeutic Classification (ATC) codes were recorded [14]. Medication categories included were psychotropic drugs ('N05*','N06*') and cardiovascular medications: Cardiac therapy ('C01*'), antihypertensives ('C02*'), diuretics ('C03*'), peripheral vasodilators ('C04*'), beta blockers ('C07*'), calcium channel blockers ('C08*'), agents acting on the renin-angiotensin system ('C09*'), alpha-adrenoreceptor antagonist urologicals ('G04CA') and beta-blocker anti-glaucoma preparations ('S01ED').

Evaluation of AF

Ten-minute surface electrocardiograms (ECG) were conducted during the health assessment (Medilog Darwin®, Schiller, Baar, Switzerland) [7]. Two clinicians screened ECGs for AF independently, according to ESC guidelines [6]. In case of inter-rater disagreement, a cardiologist made final judgement.

Statistical analysis

Prevalence calculations were weighted with respect to age, sex and education to the Quarterly National Household Survey (2010) to ensure that data were nationally representative and further weighted by health status and sociodemographic factors to account for those who did not attend a health assessment. Baseline differences between groups were tested using an independent *t*-test for continuous variables and χ^2 tests for dichotomous variables. Mann–Whitney *U* test was used for continuous variables with non-normal distribution.

Multivariable logistic regression models were used to assess the association between AF and falls, and AF and syncope. The bivariate model included AF only. Model 1 included age, gender and education. In model 2, other potential confounders were added. Variables that changed the point estimate of the age, gender and education-adjusted model with AF and falls or syncope by >5% were added to the multivariable model, together with important risk factors

for falls and syncope [3]. Co-variates that were tested for potential confounding were any ADL disability, BMI, gait speed, depressive symptoms, VA, MMSE score, stroke, use of psychotropic drugs and use of cardiovascular drugs. To account for the potential role of AF-related cardiovascular conditions as confounders, an additional model was tested that included hypertension, congestive heart failure, heart attack and heart murmur.

Ordered logistic regression was used to investigate a dose response in the associations between AF and number of falls and syncope (categorized as none, one or ≥2 events). Odds ratios were interpreted as the odds of observing a response in higher falls or syncope risk categories, compared with lower risk categories. Test of parallel lines was used to assess the assumption of proportional odds. The same co-variates as for logistic regression analyses were used in the multivariable models. A *P*-value of <0.05 was used as the threshold for statistical significance. Statistical analyses were performed using IBM SPSS Statistics (Version 18.0, IBM Corp. Released 2010. Armonk, NY, USA).

Results

In total, 8,175 participants aged 50+ were recruited to the study. Of these, 5,036 underwent a health assessment; 4,890 (97%) underwent ECG recording. Information on falls was available in 4,888 participants and on syncope (self-reported faints or blackouts) in 4,886 participants. Mean age was 61.9 years (SD 8.4) and 54% ($n = 2,647$) were female. Of participants, 20.3% ($n = 972$) reported one or more falls and 4.9% ($n = 223$) reported one or more faints or blackouts.

Prevalence of AF was 3.0% ($n = 118$), increasing from 1.0% in participants aged 50–64 years to 4.1% in those aged 65–74 years, to 7.8% in those aged 75+. All ECGs with AF showed AF during the complete recording. Of participants with AF, 29.7% had experienced a fall versus 19.6% of non-AF participants ($P = 0.007$). Of participants with AF, 10.3% had experienced syncope, compared with 4.4% of non-AF participants ($P = 0.003$).

Table 1 shows baseline characteristics. Fallers and those with syncope were older, reported more depressive symptoms, disability, cardiovascular conditions and diabetes than those without events. They had slower gait speed and used more psychotropic drugs. Participants with syncope were somewhat younger than participants with falls. In addition, participants with syncope were more often smokers, reported more lung disease, hypertension and use of cardiovascular medication.

Table 2 shows the occurrence of AF in study participants with and without falls or syncope. AF was more prevalent in participants with syncope compared with participants without syncope (5.4 versus 2.3%, $P = 0.003$). AF was also more prevalent in fallers than in non-fallers (3.6 versus 2.1%, $P = 0.006$). Stratified for age category, prevalence of AF was significantly higher in those with falls aged 65–74 years and in those with syncope aged 50–64 years.

Table 3 shows odds ratios of AF according to a positive falls or syncope history in the past year. The following variables were entered into the multivariable model: age, gender, gait speed, depressive symptoms, medical history of stroke, VA, MMSE score, use of psychotropic drugs and use of cardiovascular drugs. After adjustment for these confounders, AF was significantly associated with syncope (odds ratio (OR) 2.0 [95% confidence interval (CI) 1.0–3.9]). After stratification by age category, we found that this association was strongest and only significant in participants between aged 50 and 64 years (OR 4.4 [1.5–12.6]). Bivariately, AF was associated with falls in the past year (OR 1.7 [1.1–2.5]), but not after adjustment for confounders. Stratified for age group, AF was associated with falls in participants aged 65–74 years (OR 2.0 [1.0–4.1]).

Addition of self-reported heart failure, myocardial infarction and heart murmur to the final model resulted in similar ORs for the association between AF and both falls and syncope, but for AF the association was not statistically significant. For syncope, the association remained significant in the stratified model for participants aged 50–64 years, but not in the model with all age categories.

After adjustment in for confounders, ordered logistic regression revealed a dose response in the associations between AF and increasing number of syncopal events (OR 2.0 [1.0–3.9], $P = 0.039$). Test of parallel lines confirmed that the proportional odds assumption was met. The OR for AF with respect to increasing number of falls was significant in the bivariate model (OR 1.7 [1.1–2.5]) but lost statistical significance in the multivariable model.

Discussion

In a large cohort of community dwellings aged 50 and older, objectively diagnosed AF was associated with syncope (self-reported faints or blackouts), independent of stroke, cardiovascular drugs and other confounders. AF was also associated with one or more falls in the past year in those aged 65–74 years.

To the best of our knowledge, this study is the first to report the association between AF and falls in the general population. However, AF has been associated with non-accidental falls in an ED setting [9]. Several studies on syncope in acute care settings have recognized arrhythmias as a cause of syncope [5], and a previous study has linked cardiac arrhythmia to syncope on a general population level [15]. Within the same cohort, AF specifically was reported as a risk factor for recurrent syncope [8]. The Framingham heart study reported no association between AF and syncope.

Amnesia for loss of consciousness is common in syncope [16], and fall events are often unwitnessed [17]. Older persons may therefore report syncope as falls. Potentially, this explains why AF was associated with faints and blackouts in the younger age group (50–64 years) and with falls in the older age group (65–74 years). The proportion of participants aged 75+ was only 10% of the cohort, which may explain the lack of association between AF and falls in that group. Baseline

Table 1. Clinical characteristics of patients with and without syncope (self-reported faints or blackouts) or falls in the past year

	No syncope *n* = 4,663	Syncope *n* = 223	No fall *n* = 3,916	Fall *n* = 972
Sociodemographic variables				
Age, mean	61.9 (±8.4)	62.8 (±9.3)	61.6 (±8.3)	63.2 (±8.7)***
Gender, female	54.2% (2,529)	52.2% (117)	53.9% (2,111)	55.1% (536)
Education, primary or none is highest	21.6% (1,007)	24.7% (55)	21.3% (835)	23.4% (227)
Syncope in the past year	–	–	3.7% (145)	8.0% (78)***
Fall in the past year	19.2% (893)	35.0% (78)***	–	–
Self-reported health				
Past or current smoker	54.0% (2,517)	61.9% (138)*	53.7% (2,101)	57.1% (555)
Alcohol units consumed weekly	6.0 (±9.2)	6.6 (±17.9)	6.0 (±9.1)	6.4 (±11.9)
ADL disability (any)	6.4% (297)	13.5% (30)***	5.7% (224)	10.6% (103)***
Lung disease	3.3% (155)	7.2% (16)**	3.5% (139)	3.3% (32)
≥1 cardiovascular conditions	12.9% (603)	22.4% (50)***	12.8% (501)	15.7% (153)*
Hypertension	33.2% (1,547)	43.0% (96)**	33.5% (1,310)	34.3% (333)
Angina	4.3% (202)	8.5% (19)**	4.4% (173)	5.0% (49)
Myocardial infarction	3.9% (184)	7.2% (16)*	4.3% (169)	3.2% (31)
Heart failure	0.8% (39)	1.3% (3)	0.7% (29)	1.3% (13)
Diabetes	6.3% (294)	9.9% (22)*	5.8% (229)	8.8% (86)**
Stroke	1.1% (53)	3.6% (8)**	1.0% (41)	2.1% (20)*
Heart murmur	4.8% (224)	8.1% (18)*	4.5% (176)	6.8% (66)**
Abnormal heart rhythm	6.9% (323)	13.0% (29)**	6.7% (261)	9.5% (92)**
Objective health measures				
Atrial fibrillation	2.3% (105)	5.4% (12)**	2.1% (83)	3.6% (35)**
Systolic blood pressure (mmHg)	134.6 (±19.4)	134.9 (±19.1)	134.6 (±19.4)	134.4 (±19.5)
Diastolic blood pressure (mmHg)	82.3 (±11.1)	82.8 (±11.3)	82.4 (±11.0)	81.9 (±11.5)
Body mass index (kg/m^2)	27.7 (±30.5)	28.0 (±5.2)	27.5 (±33.2)	28.7 (±4.9)
Visual acuity (logMAR)	0.06 (±0.18)	0.08 (±0.20)	0.06 (±0.19)	0.07 (±0.18)
Gait speed (m/s)	1.36 (±0.20)	1.29 (±0.23)***	1.36 (±0.20)	1.32 (±0.21)***
Depressive symptoms (CES-D)	10.4% (480)	20.6% (45)***	10.1% (392)	14.0% (134)**
MMSE (out of 30)	28.6 (±1.9)	28.4 (±1.9)	28.6 (±1.9)	28.5 (±1.7)
Medication use				
No. of reported medications	2.3 (±2.5)	3.5 (±3.1)***	2.3 (±2.5)	2.8 (±2.7)***
Psychotropic medication use	9.3% (434)	19.0% (42)***	8.8% (342)	13.8% (133)***
Cardiovascular medication use	34.4% (1,599)	43.4% (96)**	34.4% (1,340)	36.8% (355)

Data are expressed as either *n* (percentage, %) or mean (standard deviation, ±).
CES-D, Centre for Epidemiological Studies Depression scale; MMSE, Mini-Mental State Examination.
*$P < 0.05$.
**$P < 0.01$.
***$P < 0.001$.

Table 2. AF in patients with and without syncope (self-reported faints or blackouts) or falls in the past year

	AF % (*n*)		
	No syncope *n* = 4,663	Any syncope *n* = 223	*P*
Overall, *n* = 4,886	2.3% (105)	5.4% (12)	**0.003**
50–64 years, *n* = 3,139	0.8% (25)	3.8% (5)	**0.001**
65–74 years, *n* = 1,300	3.5% (43)	6.2% (4)	0.261
>75 years, *n* = 447	8.8% (37)	11.5% (3)	0.634
	No fall *n* = 3,916	Any fall *n* = 972	
Overall, *n* = 4,888	2.1% (83)	3.6% (35)	**0.007**
50–64 years, *n* = 3,141	0.9% (24)	1.2% (7)	0.536
65–74 years, *n* = 1,300	3.0% (31)	5.7% (16)	**0.036**
>75 years, *n* = 447	8.4% (28)	10.4% (12)	0.517

Bold values indicate significant differences ($P \leq 0.05$).

characteristics in the present study also show that participants with syncope and falls share similar clinical characteristics, providing further evidence that these conditions indeed overlap.

Although the design of the current study limits us to demonstrate a causal relationship between AF, falls and syncope, several potential pathways can provide an underlying rationale for our findings. Paroxysmal AF is considered the most common type of AF to cause syncope, as the onset of AF can induce haemodynamic changes resulting in syncope [5]. As AF was defined using 10-min ECGs, we were unable to establish whether the AF detected was paroxysmal or persistent type [6]. Due to the brief time period of recordings however, it is likely that the majority of AF cases represented subjects with a persistent-type AF. However, as paroxysmal AF in the course of time usually progresses into persistent forms of AF [6], potentially the mechanisms responsible for the association are similar.

Table 3. Association between AF and syncope (self-reported faints or blackouts) or falls in the past year through multivariate logistic regression analysis

	Bivariate OR (95% CI)	Model 1 OR (95% CI)	Model 2 OR (95% CI)
Any syncope[a]	**2.4 (1.3–4.5)****	**2.3 (1.2–4.4)***	**2.0 (1.0–3.9)***
50–64 years	**4.7 (1.8–12.6)****	**5.0 (1.9–13.9)****	**4.4 (1.5–12.6)****
65–74 years	1.5 (0.5–5.1)	1.6 (0.5–5.5)	1.4 (0.4–4.9)
>75 years	1.5 (0.4–5.5)	1.8 (0.5–6.5)	2.0 (0.5–8.2)
Any fall[a]	**1.7 (1.1–2.5)***	1.5 (0.96–2.3)	1.4 (0.9–2.2)
50–64 years	1.3 (0.6–3.1)	1.2 (0.5–2.8)	1.3 (0.5–3.0)
65–74 years	1.8 (0.96–3.5)	**2.0 (1.0–4.0)***	**2.0 (1.0–4.1)***
>75 years	1.2 (0.6–2.5)	1.3 (0.6–2.7)	1.1 (0.5–2.4)

Model 1: Adjusted for age, gender, education.
Model 2: Model 1 + gait speed, depressive symptoms, visual acuity, MMSE score, use of psychotropic drugs, use of cardiovascular drugs and medical history of stroke.
95% CI, 95% confidence interval; OR, odds ratio.
Bold values indicate significant differences ($P \leq 0.05$).
[a]Syncope: $n = 4{,}693$; falls: $n = 4{,}696$, 4.0% missing values.
*$P \leq 0.05$.
**$P < 0.01$.

AF can lead to decreased cardiac output because of increased and/or irregular ventricular rate, and a reduction in the atrial contribution to ventricular filling [18, 19]. Furthermore, vagal stimulation has potential to elicit (paroxysmal) AF [20, 21], and the presence of atrial ectopy is associated with orthostatic hypotension [22]. Orthostatic hypotension and vasovagal syncope are both important causes of falls and syncope on older persons [3], and this evidence highlights the potential role of AF in the causal chain between neurocardiovascular instability and syncope.

Cognitive impairment and depression, both important risk factors for falls [3], are associated with AF [23, 24], potentially explained through the association between AF, cerebral hypoperfusion and white matter lesions [25]. Furthermore, AF is associated with slower gait speed [26], which has been reported as a predictor for falls [27]. However, adjustment for these potential confounders in our analysis did not weaken associations, thus strengthening the potential for an independent relationship between AF and syncope and falls. As AF is often concomitant with other cardiovascular conditions, potentially AF merely acts as a marker for these cardiovascular conditions [5, 6]. Adjustment for cardiovascular conditions resulted in loss of significance of the reported associations. However, ORs remained unchanged, indicating that loss of significance was likely due to lack of power.

The current study has some limitations. As the design of the study was cross-sectional, we cannot draw conclusions regarding potential causality, as further longitudinal studies are needed to explore this. Diagnosis of AF was based on ECGs obtained during the health assessment, whereas falls or blackouts may have occurred at any time in the preceding year. Therefore, we are unable to conclude that subjects had AF during their event. A number of paroxysmal AF cases were likely missed, potentially leading to an underestimation of the associations. Furthermore, ECG recording was only performed in participants who attended the health assessment. It is known that participants who did not attend the health assessment represent an older and frailer group [28]. As these participants are prone to both falls and AF, this might have led to an underestimation of the associations in the oldest age category. As recall of falls in the last year is less sensitive than collecting falls data prospectively [29], falls may be under-reported in this sample. However, as the mean age of participants was 62 years and cognitive test scores were high, it is unlikely that poor recall of fall or syncope events accounted for the majority of this sample.

If future studies could demonstrate a causal relationship between AF and falls and syncope, this would have potential to contribute to practice guidelines for falls and syncope. AF is the most common cardiac arrhythmia in older adults, and several treatment options exist [6]. Some studies have shown an improvement of exercise capacity and ejection fraction in AF patients after cardioversion [19, 30]. Potentially, optimization of haemodynamic function in AF through adequate rate or rhythm control could lead to a reduction in falls and syncope. This would require further study through randomized controlled trials. Furthermore, as over 30% of subjects with AF are unaware of their diagnosis, and those at high risk of stroke often receive inadequate treatment [7], detection of AF in community dwellings could also add to the prevention of stroke and other AF-related events.

In summary, the results of our study show that AF was cross-sectionally associated with faints and blackouts in community-dwelling older adults aged 50+ and with falls in those aged 65–74 years. As AF may act as a risk indicator for falls and syncope, early recognition of AF in older adults is warranted in subjects presenting with these events. However, further longitudinal studies are needed to explore a potential causal relationship between AF and falls and syncope.

Key points

- Older adults with syncope often present with falls.
- With increasing age, syncope is more often of cardiac origin.
- AF is the most common cardiac arrhythmia.
- Little is known about the association between AF and falls and syncope.
- AF is associated with falls and syncope in community-dwelling older adults.

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Conflicts of interest

None declared.

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