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# The correlation of specific medication groups and falls risk in elderly. A medication logbook survey

**Maria Pyrgeli[1], Eleni Agapiou[2], Efstratios-Stylianos Pyrgelis[3], Dimitrios Manaras[4], Yannis Dionyssiotis[5], Ismene Dontas[6]**

*[1]ELEPAP, Athens, Greece; [2]Department of Physical and Rehabilitation Medicine, "Asklepieion Voulas" General Hospital, Athens Greece; [3] 1st Department of Neurology, School of Medicine, National and Kapodistrian University of Athens, 'Eginition' Hospital, Athens, Greece; [4] Health Center of Salamina, Greece; [5]Physical Medicine & Rehabilitation Department, European Interbalkan Medical Center, Thessaloniki, Greece; [6]Laboratory for Research of the Musculoskeletal System, School of Medicine, National and Kapodistrian University of Athens, KAT Hospital, Athens, Greece*



**Abstract**

Falls among elderly are a common and major public health problem. Even though most falls do not lead to injury, they threaten the independence of older people causing functional decline in activities of daily living (ADLs) with substantial socioeconomic consequences. According to current literature several risk factors have been identified. Falls rarely have a single cause and the majority of them are due to a complex interaction of the age-related changes, the underlying medical condition and the medications. Some medications due to their side effects are usually called fall-risk-increasing drugs (FRIDs). We conducted a retrospective, multicentre, observational chart review study of elderly aged over 60, which aims to reveal any correlation between specific groups of medications given for the most common diseases, and falls in elderly. The sample consists of 827 participants. The data were collected by using a medication logbook which includes information about sex, age, residency, underlying diseases and the corresponding medications, incidents of fall during the last 2 years and possible fracture as a consequence of the fall.

**Keywords:** Falls, Fall-related drugs, Elderly, Questionnaire

## Introduction

A fall is defined as an event which results in a person coming to rest inadvertently on the ground or floor or other lower level and this not as a consequence of violent blow, loss of consciousness, sudden onset of paralysis or an epileptic seizure[1]. Falls are very common in community-dwelling older adults; approximately one third of such individuals report falls at least once in the course of a year[2]. About 28-35% of people aged 65 years and over fall each year, whereas the rate of falls in those over 70 years of age increases to 32-42%[3]. Although most falls do not cause injury, 20-30% of falls among adults aged 65 years or older cause moderate to severe injuries, including fractures with hip fracture to be the commonest, soft tissue injuries, and head injuries[4]. Falls are a major public health problem that has substantial economic and quality of life consequences for the individual and for the society[5]. In 2011 fall-related injuries in older adults resulted in more than 689,000 hospitalizations. The Centers for Disease Control and Prevention (CDC) estimated that direct medical costs of injuries from falls among adults aged 65 years or older totaled $30 billion in 2010[6].

Few falls are caused by a single risk factor and the majority of falls are due to the associations of chronic and acute risk factors that one person may have in a particular environment[7]. The high risk of fall in elderly may be in part due to physical, sensory and cognitive changes associated

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***Corresponding author:*** *Maria Pyrgeli, Scientific Director of ELEPAP, 16, Kononos str, 11634 Athens, Greece*

***E-mail:*** *mariapyrdoc@yahoo.gr*

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with ageing but certainly the underlying medical conditions, such as neurological or cardiac diseases, and the medications play an important role[8].

Although there is a clear correlation between falls and taking a large number of drugs, some drugs are considered to be more dangerous in causing falls. This occurs mainly due to their side effects; such as sedation, dizziness, postural disturbances, altered gait and balance, or impaired cognition and these drugs are usually called fall-risk-increasing drugs (FRIDs)[9]. Numerous studies have evaluated the association of medication use with the risk of falling in elderly patients[10-12]. In addition, compared with younger patients, patients aged 65 years or older are at a four-fold higher risk for side effects[13]. Moreover, prescribing of medicines is further complicated by pharmacokinetic and pharmacodynamic changes of the ageing body[14].

The present study aimed to revel if there is any correlation between some groups of medications and falls in people over 60 years old. Concretely we examined if there is significant higher risk of fall in groups who take medication for the most common diseases and whether is there a link between polypharmacy and falls in elderly. The objective of this study was to reveal (assess) any correlation between specific groups of medications given for the most common diseases, and falls in elderly.

## Methods

### *Patients and settings*

This is a retrospective, multicentre, observational chart review of elderly aged over 60, which aims to assess any correlation between medications and falls in elderly. The inclusion criteria were age, over 60 years old, and the willingness to participate. Each subject was informed about this study and consented individually to participate. The sample consists of 827 participants, both males and females. The sample covered both urban and rural areas, in the region of Athens, the capital city of Greece, Lamia, a quiet large city, and Chios Island. The participants were selected randomly and were enrolled in this study from January of 2013 till June of 2014. The medical facilities from where the specimen came were Outpatient Departments of Public Hospitals, Medical Rehabilitation Centers, Primary Health Care Centers and Retirement Home Settings/Retirement Facilities.

### *Data collection*

The data were collected with the usage of a medication logbook, one logbook per participant. This logbook constitutes a standardized data collection sheet which was prepared for this study. For each subject information sex, age, residency, underlying diseases and the corresponding medications, incidents of fall during the last 2 years and possible fracture as a consequence of the fall were registered. A fall was defined as any unexpected event in which the subject comes to rest on the ground, floor, or lower level. The Medication Logbooks were completed by physicians/(ordinary clinical staff) who worked in the facilities from where the study population/sample came. The main information source the researchers used was patients' interviews.

### *Definition of variables / Data analysis*

The study included 827 participants. Females represented 80.4% of the sample while the mean age of the participants was 71.02 years old. The Medication Logbooks were completed by physicians who worked to facilities from which the sample came. The physicians collected data from individual medication administration records and throughout interviews. The following information were collected from each subject: age, gender, residency, list of medical conditions (such as hypertension, stroke, anxiety, malignancy, osteoporosis), list of medication, one or more fall incidents during the last 2 years, if there was any fracture due to the fall and where the fracture was. The various diseases enrolled in wider groups depending on the system affected. For example hypertension, hyperlipidemia and coronary heart disease were all included in the group of cardiovascular diseases. The participants were mainly categorized to:

A. Those taking medications for
- cardiovascular diseases,
- neuropsychiatric diseases,
- diseases after cerebrovascular incidents (mainly strokes),
- endocrinology diseases (separately those for thyroid and parathyroid problems),
- osteoporosis,
- ophthalmologic diseases,
- hematologic diseases,
- rheumatologic diseases and
- malignancies.

B. Those who presented fall the last 2 years,
- Those who presented fracture due to fall, and
- To some smaller groups depending on the location of the fracture.

Each subject could be categorized to more than one category.

We compromise to our further analysis and study only four groups of medication, "under cardiovascular treatment", "under neuropsychiatric treatment", "under ophthalmological treatment" and "under antiosteoporotic treatment". Two were the main reasons that led researchers to this screening, a) the vast majority of elderly were under these groups of treatment whereas the other groups represented less than 1% of the sample, and b) some of these medications had been associated with greater risk of fall according to the current literature.

We compared these groups and their possible association with falls. Specifically we compared those who followed one kind of treatment and presented fall with those followed the same treatment and presented no fall. During the study further categorizations were came off in order to reveal or reject any possible correlation. The most important of these

secondary classifications were formed according gender (one group of males and other of females), age (one group between 60-70 yrs and other 70+ yrs) and combination of two (under two kind of treatment) and of three kind of treatment (under three kind of treatment), the last defined as "polypharmacy".

## Statistical analysis

Primary outcome measures were incidence of falls in the categories "under cardiovascular treatment", "under neuropsychiatric treatment", "under antiosteoporotic treatment" and under 2 and 3 kind of treatment. The category "under ophthalmological treatment" was not included in the analysis due to the small number of objects in correlation with the other categories, whereas other categories were formed. Data were expressed as mean ± standard deviation (S.D.) for continuous variable (age) and as percentages for categorical data. The Kolmogorov-Smirnov test was utilized for normality analysis of the parameters.

We determined the association between all *binary qualitative variables* and Fall status (no-yes) using the Chi-square test or Fisher's exact test , whereas the Student t-test was used to examine if the quantitative variables differed in patients without and patients with Falls.

Any variable whose univariate test p-value <0.25 was considered as a candidate for inclusion in the multivariable analysis[15]. These variables were subjected to logistic regression analysis; establishing presence of Fall as the outcome variable and odds ratio's (OR) and their 95% confidence intervals (95% CI) are presented. The Wald forward elimination method was used to arrive at the final model. Goodness of fit was evaluated using the Hosmer-Lemeshow statistic[16]. This statistical methodology was followed in previous studies[15,16]. All tests are two-sided, a p-value of <0.05 was used to denote statistical significance. All analyses were carried out using the statistical package SPSS version 16.00 (Statistical Package for the Social Sciences, SPSS Inc., Chicago, Ill., USA).

## Results

All demographic and clinical characteristics are presented in Table 1. Although, the majority of the participants of this study were women (80.4 vs. 19.6%), results from a smaller size sample of men of similar age were also presented. Bivariate analysis showed that females had a 2.22-times higher risk [95% CI (1.36-3.62); p=0.002] of falling, compared with males and patients using antiosteoporotic treatment had 92% higher risk [95%CI (1.31-2.83); p=0.001] of fall, compared with subjects without antiosteoporotic treatment. (Table 2) Factors associated with Fall (Table 3) were: female gender, associated with increased likelihood of Fall [(OR 1.92, 95% CI 1.15-3.19), antiosteoporotic treatment had 69% higher risk of Fall [95%CI (1.14-2.51); p=0.009], compared with those without receiving antiosteoporotic treatment. We found

| Characteristic | No (%) |
|---|---|
| **Gender** [Female / Male (n, %)] | 665(80.4%) / 162 (19.6%) |
| **Age** (y), (mean, range) | 71.02 (60 - 95) |
| **Cardiovascular therapy** | |
| No | 343 (41.5 %) |
| Yes | 484 (58.5%) |
| **Neuropsychiatric therapy** | |
| No | 627 (75.8%) |
| Yes | 200 (24.2%) |
| **Antiosteoporotic therapy** | |
| No | 674 (81.5%) |
| Yes | 153 (18.5%) |
| **Ophthalmological therapy** | |
| No | 786 (95.0%) |
| Yes | 41 (5.0%) |
| **Fracture** | |
| No | 625 (75.6%) |
| Yes | 202 (24.4%) |
| **Fracture region** | |
| Hip | 22 (2.7%) |
| Spinal cord | 15 (1,8%) |
| Upper Limb | 102 (12,3%) |
| Ankle | 67 (8,1%) |
| Other region | 17 (2.1%) |

**Table 1.** Patients' demographic and clinical characteristics.

homogeneity of the odds ratio of Fall for all treatments between males and females. Female population receiving cardiovascular and antiosteoporotic therapy had 38% and 64% higher risk [95%CI (0.96-1.98); p=0.085 and 95% CI (1.10-2.45); p=0.018] of Fall, vs. female population without receiving the above treatments, respectively. (Table 4) Odds ratios of Fall for all treatments among age groups was also homogenous. Participants with age more than 70 years and receiving cardiovascular and antiosteoporotic therapy had 2.7-times higher likelihood and 85% higher risk [95%CI (0.72-4.69); p=0.028, 95%CI (1.54-4.61); p=0.001] of Fall, in comparison with participants with age more than 70 years without receiving the above treatments, respectively (Table 5). Subjects who received cardiovascular and antiosteoporotic therapy as monotherapy had 2.6-times higher likelihood and 64% higher risk of fall [95%CI (1.08-2.69); p=0.023 and 95%CI (1.30-5.13); p=0.007], compared with patients without receiving any therapy, respectively. Additionally, participants who received combination of cardiovascular and antiosteoporotic therapy had 2 times higher likelihood of fall [95%CI (1.05-3.84);

| | No Fall (n=641) | Fall (n=186) | $OR_{bivariate}$ (95%CI) | p-value |
|---|---|---|---|---|
| **Age** (y), (mean±SD) | 71.15±7.79 | 70.58±7.12 | 0.99(0.97-1.01) | 0.573 |
| **Gender** | | | | **0.002** |
| male | 141(87.0%) | 21(13.0%) | 1 | |
| female | 500(75.2%) | 165(24.8%) | 2.22(1.36-3.62) | |
| **Cardiovascular therapy** | | | | 0.177 |
| No | 274(80.0%) | 69(20.0%) | 1 | |
| Yes | 367(75.8%) | 117(24.2%) | 1.27(0.91-1.77) | |
| **Ophthalmological therapy** | | | | 0.564 |
| No | 611(77.7%) | 175(22.3%) | 1 | |
| Yes | 30(73.2%) | 11(26.8%) | 1.28(0.63-2.61) | |
| **Neuropsychiatric therapy** | | | | 0.245 |
| No | 490(78.1%) | 137(21.9%) | 1 | |
| Yes | 151(75.5%) | 49(24.5%) | 1.16(0.80-1.68) | |
| **Antiosteoporotic therapy** | | | | **0.001** |
| No | 538(79.8%) | 136(20.2%) | 1 | |
| Yes | 103(67.3%) | 50(32.7%) | 1.92(1.31-2.83) | |

**Table 2.** Association of qualitative and quantitative variables with Falls status.

| | Reference category | $OR_{multifactorial}$ 95%CI | p-value |
|---|---|---|---|
| **Age** | --- | 0.99(0.97-1.01) | 0.393 |
| **Gender** | male | 1.92(1.15-3.19) | **0.012** |
| **Cardiovascular therapy** | no | 1.30(0.91-1.86) | 0.147 |
| **Neuropsychiatric therapy** | no | 1.06(0.72-1.57) | 0.765 |
| **Ophthalmological therapy** | no | 1.20(0.58-2.47) | 0.616 |
| **Antiosteoporotic therapy** | no | 1.69(1.14-2.51) | **0.009** |

**Table 3.** Multifactorial analysis of qualitative and quantitative variables with presence of Fall.

p=0.036], compared with patients without receiving any therapy. Finally, those who received combination of cardiovascular, antiosteoporotic and neuropsychological therapy had 3.1 times higher likelihood of fall [95%CI (1.38-7.06); p=0.006], compared those without receiving any therapy (Table 6 ).

## Discussion

This study presents data on FRIDs in older subjects participated in a retrospective, multicenter, observational chart review which included outpatients, inpatients who underwent rehabilitation, and subjects in Retirement Facilities.

As expected we have demonstrated falls were related with increasing age in both men and women. Compared to men, women had a 2.2 fold increased odds ratio to falls. The results could be explained by the presence of low muscle strength in females which are more likely than males to experience a fall-related injury[17,18]. However, there was homogeneity of the odds ratio of fall for all treatments with FRIDs between males and females.

There are studies suggesting that falls should be recognized as adverse drug reactions (ADRs) in the case of drugs. Older people in particular are at increased risk of developing falls. The extent and the exact number of falls due to polypharmacy are not possible to be measured unless we recognize officially falls as possible ADRs[19]. Back in 1999 Leipzig et al. published a meta-analysis showing association between falls and the use of psychotropic, cardiological and analgesic drugs in elderly subjects[20,21]. Ten years later another metaanalysis

| | | No Fall (n=641) | Fall (n=186) | $OR_{bivariate}$ (95%CI) | p-value | p-value homogeneity |
|---|---|---|---|---|---|---|
| **Cardiovascular therapy** | | | | | | |
| male | No | 54(85.7%) | 9(14.3%) | 1 | 0.811 | 0.316 |
| | Yes | 87(87.9%) | 12(12.1%) | 0.83(0.33-2.10) | | |
| female | No | 220(78.6%) | 60(21.4%) | 1 | **0.085** | |
| | Yes | 280(72.7%) | 105(27.3%) | 1.38(0.96-1.98) | | |
| **Ophthalmological therapy** | | | | | | |
| male | No | 136(86.6%) | 21(13.4%) | 1 | 0.621 | 0.313 |
| | Yes | 5(100.0%) | 0(0.0%) | ---- | | |
| female | No | 475(75.5%) | 154(24.5%) | 1 | 0.429 | |
| | Yes | 25(69.4%) | 11(30.6%) | 1.09(0.87-1.36) | | |
| **Neuropsychiatric therapy** | | | | | | |
| male | No | 120(87.0%) | 18(13.0%) | 1 | 0.622 | 0.836 |
| | Yes | 21(87.5%) | 3(12.5%) | 0.95(0.26-3.52) | | |
| female | No | 370(75.7%) | 119(24.3%) | 1 | 0.352 | |
| | Yes | 130(73.9%) | 46(26.1%) | 1.10(0.74-1.63) | | |
| **Antiosteoporotic therapy** | | | | | | |
| male | No | 138(87.9%) | 19(12.1%) | 1 | 0.126 | 0.244 |
| | Yes | 3(60.0%) | 2(40.0%) | 4.84(0.76-30.87) | | |
| female | No | 400(77.4%) | 117(22.6%) | 1 | **0.018** | |
| | Yes | 100(67.6%) | 48(32.4%) | 1.64(1.10-2.45) | | |

**Table 4.** Association of qualitative and quantitative variables with Falls status adjusted for gender.

presented a significant association between falls and the use of sedatives and hypnotics, antidepressants and benzodiazepines[22].

Generally, it is difficult to compare data related to drugs because studies investigated different drug classifications. In this study subjects who had fallen were prescribed a higher number of continuous-use of drugs compared to subjects with no reported falls. Participants who received cardiovascular and antiosteoporotic therapy as monotherapy and those received combination of cardiovascular and antiosteoporotic therapy had 2.6-times and 2 times higher risk of fall, respectively, compared with subjects without therapy. Finally, the patients who received combination of cardiovascular, antiosteoporotic and neuropsychological therapy had 3.1 times higher likelihood of fall compared with subjects without therapy. A possible explanation for this increased result could be synergistic effect of neuropsychiatric and cardiovascular drugs in fall. Neuropsychiatric drugs have a parallel muscle-relaxing effect and it is already shown that benzodiazepines are associated with increased risk of hip fractures in the elderly[23] while cardiovascular drugs, such as the commonly prescribed diuretic furosemide, can cause or worsen orthostatic hypotension and lead to Falls.

The result of increased percentage of falls in women taken antiosteoporotic drugs is difficult to be explained. We are not aware of any study investigating the effect of antiosteoporotic drugs on the risk of falls. Moreover, the results of fall related fractures in 24.4% of the population (12.3% in the upper limb, 2.7% at the hip and 1.8% at the spine etc.) suggested that more than half of fractures were injury related and not osteoporotic. However, this result needs to be approached with caution and requires further investigation. The number of spine fractures could be higher because the study only recorded answers in questionnaires and some morphological vertebral fractures may remained without diagnosis.

The strengths of this study are the large numbers of subjects (women) studied. Moreover, this was an 'open access' service and subjects were not pre-selected on grounds about increased fracture risk. This suggests that the results may be applicable to women of this age. Female sex and polypharmacy were associated with falls. In our study, female sex was associated with a trend of higher number of cardiovascular and antiosteoporotic drugs and this might explain the association with severe falls.

| | | No Fall ( n=641) | Fall ( n=186) | $OR_{bivariate}$ (95%CI) | p-value | p-value homogeneity |
|---|---|---|---|---|---|---|
| **Cardiovascular therapy** | | | 50(22.9%) | | | |
| 60-70 | No | 168(77.1%) | 44(23.0%) | 1 | 0.981 | 0.097 |
| | Yes | 147(77.0%) | 19(15.2%) | 1.00(0.63-1.60) | | |
| 70+ | No | 106(84.8%) | 73(24.9%) | 1 | **0.028** | |
| | Yes | 220(75.1%) | | 1.85(1.06-3.22) | | |
| **Ophthalmological therapy** | | | | | | |
| 60-70 | No | 299(76.9%) | 90(23.1%) | 1 | 0.745 | 0.283 |
| | Yes | 16(80.0%) | 4(20.0%) | 0.83(0.27-2.55) | | |
| 70+ | No | 312(78.6%) | 85(21.4%) | 1 | 0.149 | |
| | Yes | 14(66.7%) | 7(33.3%) | 1.84(0.72-4.69) | | |
| **Neuropsychiatric therapy** | | | | | | |
| 60-70 | No | 261(78.9%) | 70(21.1%) | 1 | 0.069 | 0.100 |
| | Yes | 54(69.2%) | 24(30.8%) | 1.66(0.96-2.87) | | |
| 70+ | No | 229(77.4%) | 67(22.6%) | 1 | 0.631 | |
| | Yes | 97 (79.5%) | 25(20.5%) | 0.88(0.53-1.48) | | |
| **Antiosteoporotic therapy** | | | | | | |
| 60-70 | No | 256(78.3%) | | 1 | 0.223 | 0.106 |
| | Yes | 59(72.0%) | | 1.41(0.81-2.43) | | |
| 70+ | No | 282(81.3%) | | 1 | **0.001** | |
| | Yes | 44(62.0%) | | 2.66(1.54-4.61) | | |

**Table 5.** Association of qualitative and quantitative variables with Falls status adjusted for age.

| | Reference category | ORmultivariable 95%CI | p-value |
|---|---|---|---|
| Age | --- | 0.99(0.97-1.01) | 0.409 |
| Gender | male | 2.00(1.20-3.35) | **0.008** |
| Antiosteoporotic therapy ( n=48) | | 2,58(1,30-5,13) | **0.007** |
| Neuropsychiatric therapy ( n=44) | No therapy | 1,76(0,81-3,80) | 0.151 |
| Cardiovascular therapy ( n=272) | ( n=242) | 1.70(1,08-2.69) | **0.023** |
| Neuropsychiatric + Antiosteoporotic therapy (n=9) | | 1.42(0,28-7,11) | 0.673 |
| Cardiovascular + Antiosteoporotic therapy (n=65) | | 2,00(1,05-3,84) | **0.036** |
| Cardiovascular + Neuropsychiatric therapy (n=116) | | 1.37(0,76-2,46) | 0.297 |
| All the 3 medications ( n=31) | | 3,12 (1,38-7,06) | **0,006** |

**Table 6.** Multivariable analysis of qualitative and quantitative variables with presence of Falls (logistic regression).

The study had some limitations. Some of our subjects were residents of Retirement Home Settings/Retirement Facilities and may had multimorbidities and use of a high number of drugs, and might therefore be more prone to fall. This may have caused some bias. A major limitation of the study is the lack of a comprehensive geriatric assessment, its cross-sectional and retrospective design.

## Conclusions

Interventions to prevent falls in elderly patients need to shift from reducing the total number of drugs to withdrawing certain medications which cause fall. We need to emphasize in the importance of regular revision of drug treatment in elderly primary care subjects. Not only polypharmacy but specific drug categories lead to Falls. Moreover, to prevent

**Falls we need to use a fall risk assessment tool including FRIDs in order to categorize elders into low and high risk of falling subjects.**

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