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# Falls in RAC-OST-POL Study: the results from 10-year prospective longitudinal observation

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## Abstract

**Introduction:** The aim of the study was presentation of the data on falls in a cohort of postmenopausal women in a 10-year prospective longitudinal observation.

**Material and methods:** 640 postmenopausal women at baseline age above 55 years were included. The cohort was randomly selected from the population of the whole Racibórz district. Data on falls and fracture incidence were gathered yearly.

**Results:** 256 (40%) women had no falls, and in 384 (60%) subjects at least one fall was noted. The number of women with 1, 2, and 3 or more falls were 115, 62, and 207, respectively. The total number of falls was 1988. Mean baseline age in those who noted falls was  $65.7 \pm 7.02$  years, and it was significantly higher than in the rest of the patients ( $64.1 \pm 6.75$ ;  $p < 0.01$ ). During follow-up 190 osteoporotic fractures were noted in 129 patients. Falls were proven to have a strong, significant relationship with fracture (chi-square test = 80.5;  $p < 0.0001$ ). Among potential clinical factors only diabetes type 1 (chi-square test = 5.80;  $p < 0.05$ ) and depression (chi-square test = 3.82;  $p < 0.05$ ) influenced falls incidence. The risk of falls was increased in cases of greater numbers of clinical risk factors (chi-square test = 28.4 df = 5;  $p < 0.0001$ ).

**Conclusions:** In long-term follow-up in postmenopausal women, falls were frequently observed, and their occurrence increased the fracture rate. Diabetes type 1 and depression increase the fall rate, which suggests the necessity of implementation of some preventive procedures.

**Key words:** clinical risk factors; falls; fracture; women

## Introduction

Falls are an important factor that increases the incidence of fractures. Falls may cause several serious medical consequences such as soft tissue injuries, pain, problems with functional status, reduction in quality of life, and increased mortality. Falls prevalence concerns 28–35% subjects aged over 65 years and up to 42% in subjects over 75 years of age [1]. In baseline analysis performed in women from the RAC-OST-POL study, falls occurred in 33.8% of subjects studied [2]. The most important consequence of falls are fractures [3]. Serious injuries occur in 10–15% of falls, resulting in fractures at different skeletal sites in 5% and in hip fractures in 1–2% [4]. Involutional osteoporosis is one of the most common diseases in elderly populations. Typical osteoporotic fracture, e.g. caused by minimal trauma, usually after a fall from standing height is the most serious consequence of osteoporosis. Hip and spine fractures

are especially deleterious to health status. There are 2 main risk factors for fracture: low bone mineral density (BMD) and falls. With ageing the role of low BMD decreases and more frequent falls contribute to an increased number of fractures. Further, falls may affect BMD due to immobilisation from self-restriction of activities, because after the first fall 30% of subjects develop a fear of falling [5]. The described circumstances on the frequency of falls and their consequences indicate clearly that activities able to diminish the number of falls should be one of the most important aims in the management of elderly populations.

The aim of current paper is the presentation of falls incidence in 10-year follow-up regarding several medical aspects gathered in a population-based, epidemiological cohort from the RAC-OST-POL study. The results of this study regarding the role of functional status and falls were presented earlier in several manuscripts [2, 6–10].



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## Material and methods

The study group was created by the cohort of the RAC-OST-POL Study recruited in the year 2010. The population was randomly selected from women above 55 years of age of the whole Racibórz district in the South of Poland. At baseline the total number of randomly selected women was 625. Baseline epidemiological data were presented earlier [2]. However, besides randomly selected women invited by letters sent by regular mail, additionally 353 women who came 'as volunteers' were included in the study. To present data in a larger cohort we added these women to the previously described randomly recruited group. We checked whether baseline prevalence of falls was dependent on the method of recruitment (random or not random subjects). As was shown by chi-square test, falls occurrence did not differ among them (33.8% in the random cohort and 33.1% in the non-random cohort,  $p = 0.84$ ).

Therefore, further studies were based on analyses performed in the whole cohort of 978 women [8, 9]. In a questionnaire, described earlier in detail [2], several data were gathered including prior falls, which occurred within the 12 months preceding the day of review. The event of a fall was defined and described to the responders as an accident starting in standing position with sudden loss of balance resulting in going down onto the ground or towards the ground without any intention to do so. Accidents that happened on horizontal surfaces or on stairs were considered.

Afterwards, all subjects were asked annually using phone interviews about new (only low-trauma) fractures and new falls that occurred in the meantime. Finally, in a 10-year follow-up, 640 patients at the mean age of  $75.04 \pm 6.95$  years remained under observation. The total drop-out was then 34.5%, while some subjects were lost to follow-up due to the following reasons: loss of contact in 25.6%, death 7.5%, refusal to cooperate 1%, and lack of baseline DXA scans in 0.4%.

All interviews were performed by one experienced investigator (WP).

The study was approved by the Ethics Committee of Medical University of Silesia (KNW/0022/KB1/132/10). At baseline in 2010 all participants gave their written informed consent.

### Statistics

All calculations were done using the Microsoft Office Excel application and Statistica software (StatSoft Inc., Tulsa, OK; www.statsoft.com) on a PC computer. Descriptive statistics of quantitative values are presented as mean values and standard deviations (SDs). The normality of distribution of analysed data was verified by the Shapiro-Wilk test. The t-test for independent samples was performed for the comparison of continuous parameters between subgroups. The presentation of qualitative features was done by providing the number of subjects and the percentage value in defined subgroups. The comparisons of frequency of qualitative features between subgroups were performed by the chi-square test. In order to achieve age adjustment when necessary, ANCOVA analysis with age as a covariate was additionally performed. Correlation analyses were performed by Spearman correlation test. All  $p$  values  $< 0.05$  were considered statistically significant.

## Results

Mean baseline age, weight, height, and BMI were  $65.0 \pm 6.9$  years,  $74.5 \pm 14.0$  kg,  $156.6 \pm 6.6$  cm, and  $30.6 \pm 5.4$  kg/m<sup>2</sup>, respectively.

At baseline data collection in year 2010 in 433 (67.7%) no falls were reported, and in 207 (32.3%) at least one fall was noted (during 12 months before the interview). During the 10-year prospective observation 256 (40%) women had no falls, and in 384 (60%) at least one fall

was observed. The number of women with 1, 2, or 3 or more 'follow-up' falls were 115, 62, and 207, respectively. Over the period of observation, a total of 1988 falls was observed. The highest 10-year cumulative number of falls in one person was 31. The mean age in those who noted falls was  $65.7 \pm 7.02$  years, and it was significantly higher than in the rest of the patients ( $64.1 \pm 6.75$ ;  $p < 0.01$ ). Mean height, weight, and BMI did not differ (data not shown).

We have proven that the falls incidence during follow-up was significantly dependent on falls reported at baseline: 76% of women declaring falls at baseline also had falls during the follow-up period *vs.* 52% in the baseline non-fallers subgroup (chi-square test 32.0;  $p < 0.0001$ ).

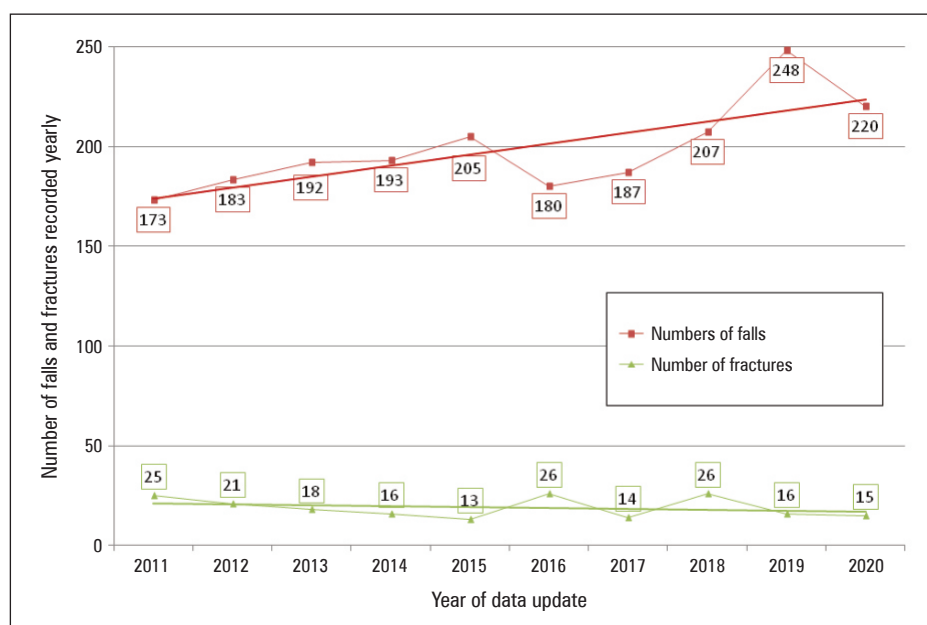
During follow-up osteoporotic fractures were noted in 129 patients. Among 384 women with falls, fractures occurred in 122 subjects, and in 256 women without falls only 7 experienced fractures. Falls was proven to have a strong, significant relationship with fractures (chi-square test = 80.5;  $p < 0.0001$ ).

We verified whether the place of living (the city of Racibórz or the surrounding rural area), kind of job, level of education, and marital status affected falls incidence, and we found that those factors did not play a significant role (data not shown). Also, the baseline hip BMD value did not differ between fallers and non-fallers (data not shown).

We also analysed whether the presence of some clinical factors influenced the fall rate. These findings were based on data gathered at baseline interview. This analysis was age-adjusted, and the following factors were checked: smoking ( $n = 68$ ), bronchial asthma ( $n = 48$ ), rheumatoid arthritis ( $n = 38$ ), diabetes type 1 ( $n = 17$ ), diabetes type 2 ( $n = 80$ ), use of glucocorticosteroids ( $n = 33$ ), colitis ulcerosa ( $n = 28$ ), and depression ( $n = 132$ ). Among them only diabetes type 1 and depression influenced the fall rate. Among 132 patients with depression, 89 falls were noted (chi-square test = 3.82;  $p = 0.05$ ). In 17 patients with diabetes type 1, only 2 did not fall (chi-square test = 5.80;  $p < 0.05$ ).

The risk of falls was increased in cases of higher cumulative number of clinical risk factors (previous fractures, previous falls, smoking, use of glucocorticosteroids, rheumatoid arthritis, alcohol intake, depression; identified reasons for secondary osteoporosis were taken into consideration) (chi-square test = 28.4;  $p < 0.0001$ ). Also, Spearman correlation analysis revealed a significant relationship between number of risk factors and fall rate ( $r = 0.23$ ,  $p < 0.0001$ ).

The impact of co-morbidities on the occurrence of falls and fractures during the follow-up period was also analysed. The following chronic diseases were taken into account: rheumatoid arthritis, diabetes



**Figure 1.** The yearly number of falls and fractures observed in the study cohort during 10-year follow-up

type 1 and type 2, hypothyroidism, chronic kidney disease, inflammatory bowel disease, bronchial asthma, liver cirrhosis, Alzheimer's disease, and depression. In the analysed group, 367 women did not have any of the above-mentioned diseases, 186 subjects had one of the above-mentioned diseases, 64 had 2 diseases, 23 declared 3 diseases, and one person was diagnosed with 4 diseases. The occurrence of falls during the follow-up period was not dependent on the number of co-morbidities (chi-square test = 7.24;  $p = 0.12$ ). Similarly, there was no relationship between the number of co-morbidities and the occurrence of fractures (chi-square test = 5.43;  $p = 0.25$ ).

We assumed that in every consecutive year of observation the number of falls and fractures might increase (due to increasing age of observed subjects). Such a trend was observed for falls, whereas the yearly average number of fractures was stable. Those trends are presented in [Figure 1](#).

## Discussion

The most significant finding of the current longitudinal study is the observation that the fall rate increased the fracture rate in long-term follow-up. The observation that diabetes type 1 and depression increased the fall rate is also important for practitioners. This indicates the role of some preventive steps to diminish the fall and fracture rates. There are several potential factors increasing the fall rate in patients with diabetes and depression. Diabetes complications including peripheral neuropathy, retinopathy

and skeletal muscle weakness may increase the fall rate. The most important way to avoid frequent falls and subsequent fractures is efficient diabetes therapy verified by well-known laboratory parameters, especially glycated haemoglobin.

Depression was unexpectedly common in the studied population. Depression may have an impact on general human health. Subjects with this disease present diminished physical activity, which leads to skeletal muscle weakness and atrophy, and low sun exposure, which may aggravate muscle dysfunction. One important management step is regular outside physical activity. For both diseases, diabetes and depression, adequate dietary consumption of calcium (usually 1000–1200 mg daily) and proteins (1 g per 1 kg of body weight) are also very important. In diabetic patients with unrestricted outside activity, vitamin D should be administered in the autumn/winter season. In patients with depression who would rather stay at home, vitamin D supplementation should be recommended all year long.

Additionally, one should note that the design of the current study allowed us to gather reliable data. Long-term observation of a population-based epidemiological cohort provides such data. It is interesting to compare the current results with those reported in the same population at baseline [8]. In analysis of baseline data, we noted that in women from the city of Racibórz falls were less frequent than in women from rural areas. Among underlying diseases at baseline, diabetes type 1 and depression influenced the fall rate, and this observation is confirmed in current longitu-

dinal observation. However, previous analysis had proven also significant roles of renal disease, rheumatoid arthritis, and bronchial asthma, which were not shown in follow-up analysis. For both analyses a strong relationship between fractures and falls was shown.

We believe that the comparison of baseline [8] and longitudinal prospective data suggests that the more reliable data come from long-term follow-up.

We have also proven that an increased number of clinical risk factors increased the fall rate. This observation is important for daily practice with patients.

Some studies published so far have presented longitudinal observations [11–15]. Only one study presented the results of a 10-year follow-up [15], while others concerned shorter observations - from 4 months to 3 years. In a study by Balogun et al. [15] the observed fall rate was 64%, which is very close to our result of 60%. The incidence of fractures was lower than in our study (17% vs. 20%), which may be related to the lower average age.

As we have already mentioned, the most important conclusions from studies on the frequency of falls should point to potential preventive actions that can reduce the frequency of falls. Some studies present such data [16–18].

In a long-term, 20-year observation of recreational gymnastics, Uusi-Rasi et al. [16] demonstrated the potential to reduce the risk of traumatic falls in old age. The authors compared the incidence of fall-related injuries in a group of 103 recreational gymnasts, comparing them to 84 sedentary controls, and found that regular physical activity resulted in an approximately 30% reduction in the incidence of injuries. A fall prevention model was established in 647 nursing home patients over a 9-month follow-up period [17]. It can also be expected that vitamin D use may improve functional status and fall rates. This problem has been demonstrated by other authors [18], but in the current study we did not take into account the role of vitamin D. We plan to conduct such an analysis in further studies.

Other studies with cross-sectional design [19–23] have reported outcomes regarding falls. We believe that despite some interesting information resulting from these studies, the most valuable data are those based on long-term follow-up. Our own experiences described earlier support the statement about the priority given by longitudinal research.

Falls can always cause serious health problems and are especially dangerous for older people. Patient management recommendations include certain steps to reduce the incidence of falls [24]. Also, in the recent recommendations of a group of Polish authors, directions for improving muscle condition and reducing the risk of falls were proposed [25].

Our study has some limitations: we only studied women, and no data were collected on the exact date and place of falls (at home or outside). However, the study design, the collection of data in a population-representative epidemiological sample, and long-term follow-up allowed us to obtain reliable data on the incidence of falls.

Concluding, in long-term follow-up of postmenopausal women, falls were common, and their occurrence increased the incidence of fractures. Observations of the incidence of falls indicate the role of functional status as a factor increasing the fracture rate. Some preventive measures are particularly valuable in patients with type 1 diabetes and depression.

### Data availability statement

The data may be available on request.

### Ethics statement

The study was approved by the Ethics committee of Medical University of Silesia (KNW/0022/KB1/132/10). At baseline in 2010 all participants gave their written informed consent.

### Author contributions

W.P.: concept and design of the study, acquisition of data, analysis and interpretation of data, drafting of the manuscript, final approval of the submitted version (the first author); P.A.: analysis and interpretation of data, drafting of the manuscript, preparing graphical presentation, final approval of the submitted version; B.D.: analysis and interpretation of data, critical revision of the manuscript, final approval of the submitted version.

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### Conflict of interest

The authors declare they have no conflict of interest, which might include: grants funding the project; speaker honoraria from a company; consulting fees and stock options; other forms of gratification.

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