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The significance of height loss in postmenopausal women. The results from GO Study

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Abstract

background: The aim of the study was the assessment of clinical significance of height loss (HL) in female population.

Material: The study cohort was recruited from GO Study. Data from 1735 postmenopausal women aged over 55 years (mean age 68.15 ± 8.16 years) were analysed.

Methods: Data on clinical risk factors for osteoporosis and fractures were collected. Bone densitometry at hip was performed using a device Prodigy (GE, USA). Height was established using stadiometer and was compared with maximal height in early adulthood.

Results: The mean HL was 3.9 ± 3.2 cm. HL was significantly higher in women with fractures in comparison with those without fracture (4.9 ± 3.6 cm vs 3.4 ± 2.8 cm; $P < .0001$). HL increased with the number of fractures, and was 4.1 ± 3.2 cm, 5.3 ± 3.5 cm and 6.7 ± 4.1 cm in women with one, two and three or more fractures respectively. Women with spine fractures presented with HL higher in comparison with all the other subjects (6.3 ± 4.0 vs 3.6 ± 2.9 cm, $P < .0001$) and women with all non-spine fractures (6.3 ± 4.0 vs 4.0 ± 3.0 cm, $P < .0001$). In women with steroid use and falls, HL was significantly greater than in subjects without this factor. HL correlated significantly with age and BMI (positively) and current height (negatively). Mean T-score for FN BMD was −1.75 ± 0.9 and correlate significantly with HL ($r = -.21$, $P < .0001$). For the HL threshold above 4 cm, the fracture incidence was above 50%.

Conclusion: Height loss value is a simple and very informative measure describing fracture risk and functional status in postmenopausal women. HL exceeding 4 cm is related to fracture probability above 50%.

1 | INTRODUCTION

Involutional osteoporosis is an important medical issue in the elderly population. The most significant problem concerns fractures commonly being the consequence of low-trauma accidents, eg, falls from standing height. Osteoporosis is called 'silent epidemic' because of its long-term clinically asymptomatic course and the number of affected subjects. Therefore, one of the most important point is to recognise early symptoms of osteoporosis noticeable prior to the first osteoporotic fracture. Patients screened for osteoporosis should undergo careful examination in order to gather data on risk factors for osteoporosis and fractures. One of the most important measures is height assessment. A simple measurement of height provides a significant information of current health status, and height is identified as a factor related to fracture risk.[1-3] In many studies, height loss (HL) increased fracture risk, especially with regard to hip fracture.[4-12]

HL is a frequent manifestation among the elderly and it is easy to estimate its value in clinical setting. Such easily available parameter should be applied wider in daily practice and it may be helpful in patients' assessment and early detection of bone disturbances.

The aim of the study was the assessment of the clinical importance of HL with regard to prior osteoporotic fracture in a group of postmenopausal women from GO Study.

2 | MATERIAL

The presented analyses were performed in 1735 women aged over 55 years selected from database gathered in one outpatient osteoporotic clinic in South of Poland, named 'Gliwice Osteoporosis Study' (GO Study). The study with the acronym 'Go Study' concerns data collected in the osteoporotic outpatient clinic of the city of Gliwice over more than two decades. The overall aim of the GO Study was to present the results of bone health in a female cohort that may be of interest and help to practitioners. A huge amount of details have been gathered in the patient database that may affect bone health. The current study is the first one based on the analysis of data from this database.

Mean age, height, weight and BMI were 68.15 ± 8.14 years, 157.14 ± 6.29 cm, 69.31 ± 12.98 kg and 28.08 ± 5.06 kg/m^2 respectively. In the study group, 1069 women had no fractures (61.6%) and 666 (38.4%) reported at least one fracture. Altogether, 1153 osteoporotic fractures were reported: 372 women (21.5% of the study cohort) had one fracture, 167 (9.6%) had two fractures and 127 (7.3%) noted three or more fractures.

The number of women with fractures at spine, hip, forearm, arm, ribs, clavicula, shin, foot and pelvis was, respectively, 257, 38, 323, 39, 30, 11, 117, 52 and 9. The number of women with all non-spine fractures was 409. All fractures included was osteoporotic nature, eg, were the consequence of minimal trauma commonly the fall from standing height.

Following clinical risk factors were noted: hip fracture in parents—18, steroid use—115, rheumatoid arthritis—26, smoking—211, secondary reasons of osteoporosis—93 and falls during last 12 months in 211 subjects.

3 | METHODS

Data on clinical risk factors for osteoporosis and fractures were collected from all the patients. Bone densitometry (DXA) at femoral neck (FN) was performed using a device Prodigy (Lunar, GE, USA). All measurements were performed by one experienced operator. Based on repeated measurements, the precision (CV%) of DXA measurements at FN was established at 1.6%. Height was established using wall stadiometer before bone densitometry and it was compared with the self-reported maximal height in early adulthood. In order to establish the precision of height measurement, a duplicate measurements were performed in 22 women. A local Ethics Committee gave the consent for the study.

What's known

- Height loss is a simple, easily accessible parameter that is related to the bone health status.
- Although it has not been incorporated into any of the widely used fracture risk calculators, assessing this parameter may be helpful in identifying people with osteoporosis.

What's new

- Height loss is significantly higher in women with previous fractures in comparison with those without fracture and this observation is not limited to vertebral fractures.
- Height loss increases with the number of fractures.
- Steroid use and reported falls are related to greater height loss.
- Height loss exceeding 4 cm is related to fracture probability above 50%.
- Height loss value is a simple and very informative measure describing fracture risk and functional status in postmenopausal women.

3.1 | Statistics

Statistical analysis was performed using Statistica software (StatSoft, Tulsa, OK, USA). Descriptive statistics for continuous variables were presented as mean values and standard deviations. The normality of data distribution was checked by the Shapiro-Wilk test. For comparative analysis, the Student's *t* test for independent samples or the Mann-Whitney *U* test was used (for data with and without a normal distribution, respectively). Analysis of variance (ANOVA) and post hoc verification with the least significant difference test (LSD) were performed when comparisons between more than two subgroups were necessary. Correlation analysis was performed using Spearman's correlation tests. Comparisons of the prevalence frequency of qualitative features between subgroups were performed using the χ^2 test. The significance of the results of all statistical analyses was assumed at $P < .05$.

4 | RESULTS

A precision of height measurement expressed as coefficient of variation (CV%) was 0.18%. HL was noted in the majority of subjects: 1536 (88.5%), and only in 199 women (11.5%) height did not change. Maximal HL was 21 cm, and the mean HL in the whole study group was 3.95 ± 3.24 cm. Data on HL in the study group stratified into subgroups according to HL thresholds are presented in Table 1. HL was significantly higher in women with fractures in comparison with those without fracture (4.9 ± 3.6 cm vs 3.4 ± 2.8 cm; $P < .0001$). HL increased with the number of fractures. The average values of

HL in women with one, two and three or more fractures in comparison with women without fractures are presented in Figure 1. It was shown in ANOVA analysis that all the differences between subgroups presented in the figure were statistically significant.

Women with spine fractures presented with HL higher in comparison with all the other subjects (6.3 ± 4.0 vs 3.6 ± 2.9 cm, $P < .0001$) and women with all non-spine fractures (6.3 ± 4.0 vs 4.0 ± 3.0 cm, $P < .0001$). Weaker but also significant difference was revealed in comparison of women with hip fracture with all the other subjects (5.0 ± 3.7 vs 3.9 ± 3.2 cm, $P < .05$). HL differed also between women with non-spine fractures and subjects without fractures (4.0 ± 3.0 vs 3.4 ± 2.8, $P < .001$).

We also performed the HL comparisons regarding the presence of clinical risk factors other than previous fractures. These data are shown in Table 2. Prior steroid use and falls within last year were identified as factors connected with significantly higher HL value. Interestingly, smoking women had smaller HL than non-smoking. This unexpected phenomenon should be probably explained by the difference in age between smokers and non-smokers (mean age in smokers was 64.1 ± 7.26 years vs 68.7 ± 8.13 years in non-smokers; $P < .0001$).

TABLE 1 HL in the study group divided according to HL value categories

The value of HL	Number of subjects	Per cent of study group
0 cm	199	11.5
1-2 cm	498	28.7
3-4 cm	432	24.9
5-6 cm	297	17.1
7-8 cm	150	8.6
9-10 cm	102	5.9
>10 cm	57	3.3

The results of correlation analysis between HL and age and body size are presented in Table 3. HL correlated significantly with age and BMI (positively) and current height (negatively). HL did not correlate with body weight and maximal height.

Mean T-score for FN BMD was −1.75 ± 0.9 and correlated significantly with HL ($r = -.21$, $P < .0001$).

The fracture prevalence was compared between the subgroups defined according to different HL threshold values. The results of those comparisons are presented in Table 4. For the HL threshold above 4 cm, the fracture prevalence was above 50%.

5 | DISCUSSION

We believe that the most important finding from the current study is the premise that the measurement of current height in order to establish HL should be included in the assessment of patients in daily practice. Several of the results presented confirm this general statement. Increasing HL in parallel with the increasing number of

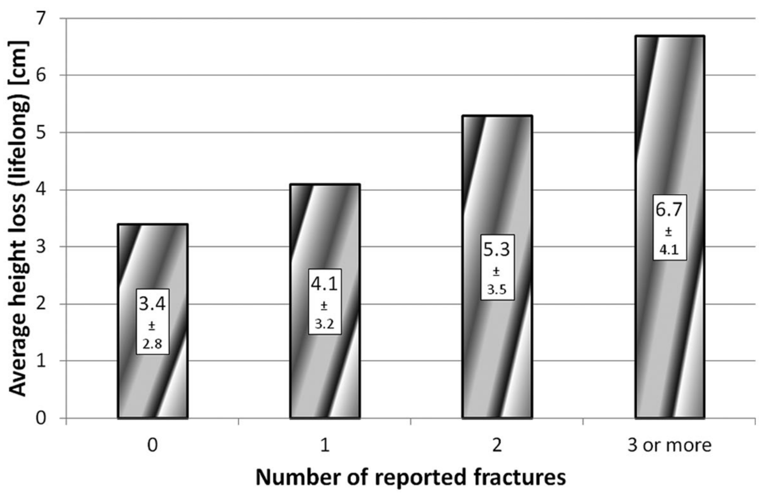

FIGURE 1 Average height loss (mean ± SD) in subgroups stratified according to the number of reported fractures. Comparisons between all presented groups provide statistically significant differences with *P* value < .001 (no fractures vs one fracture and two fractures vs three or more fractures) or <.0001 (all the other possible comparisons); least significant difference (LSD) test

TABLE 2 The comparison of HL with respect to the presence of clinical risk factors

Clinical risk factor	HL in women with the factor present [cm]	HL in women without the factor [cm]	*P*
Steroid use (n = 115)	4.57 ± 4.08	3.91 ± 3.16	<.05
Parental hip fracture (n = 88)	3.58 ± 2,81	3.97 ± 3.26	NS
Smoking (n = 211)	3.20 ± 2.93	4.06 ± 3.27	<.001
Rheumatoid arthritis (n = 26)	4.77 ± 3.6	3.94 ± 3.23	NS
Secondary osteoporosis (n = 93)	3.98 ± 3.04	3.95 ± 3.25	NS
Falls in last year (n = 211)	4.77 ± 1.3	3.72 ± 3.54	<.0001

fractures supports the role of height measurement in daily practice. It can be expected that in subjects with spine fractures HL will be significantly greater than in people without fractures. This was confirmed by our results. However, a similar relationship was also observed for all other fracture sites, indicating that HL is an important clinical symptom in individuals with osteoporosis.

In our opinion, very important data may be derived from the analysis of fracture prevalence in subgroups defined according to different HL thresholds (see Table 4). It can be noticed that for the HL threshold of 4 cm, the prevalence of fractures in the subgroup above the threshold reaches approximately 50% and of course it remains above 50% for any higher threshold. In turn, the highest value of χ^2 statistics achieved for a threshold HL value of 6 cm indicates the highest statistical strength of the difference between fracture rates in subgroups below and above this threshold. Those observations can be summarised with the statement that the HL in the range between 4 and 6 cm indicate the border value above which the probability of osteoporotic fracture increases significantly. This information is consistent with the results published by other authors who indicated similar HL as a significant risk factor for the occurrence of fractures.[4,6,7,9-11] Only one study suggested that HL lower than 3 cm may be indicative for high fracture risk.[8]

An important proof of the role of spinal deformity was demonstrated in a review article published some years ago.[12] One should remember that spinal deformity is a sign not only of the presence of vertebral fractures but expresses also the process of generalised bone loss. In patients with spinal deformity altered biomechanical and global spinal imbalance impairs physical functioning, general health and quality of life. Therefore, the results of current study as well as data presented by other authors[4-12] clearly indicate that the measurement of current height and its comparison with prior measurements are essential in osteoporotic subjects. However, the results obtained in longitudinal studies[4-8] cannot be directly compared with current results. In three others studies,[9-11] the role of HL was studied without prospective observation, which allows to perform direct comparisons with our results. Kamimura at al. noted that HL equal or greater than 4 cm increased fracture risk by 2.3 times (9). This observation is similar to our results showing that the threshold of 4 cm of HL may be considered as a significant indicator of fracture probability. Also other authors noted that cut-off for HL of 4 cm increases the spine fracture prevalence [?]. Similar observation was provided by one more study.[11] Additionally, irrespective of differences between prospective studies[4-8] and retrospective analysis performed in current study, some other interesting observations were noted by other authors. Leslie et al have found that 3 cm of HL doubled the risk of subsequent fracture.[8] Mikula et al[7] stated that the loss of 4 cm had 95% specificity for spine fractures prediction. Hannan et al[6] observed that 5 cm of height loss significantly increased hip fracture risk and Hiller et al[5] described that HL by 5 cm was associated with 50% increase in hip and non-spine fractures. Interestingly, these thresholds being generally around 4 cm were similar to our threshold obtained in retrospective analysis. An interesting observation was provided by prospective study by Moayyeri et al.[4] They noted that annual height loss of 1 cm was comparable with having a past history of fracture and equivalent to being approximately 14 years older in chronological age in terms of the magnitude of relationship with fracture risk.

In current study, we have also analysed the relationship between HL and the presence of clinical risk factors. As expected HL was higher in prior steroid users, which may be attributed to recognised or silent spine fractures. Interestingly, smoking women had smaller

TABLE 3 The results of correlation analysis of HL with age and body size

Correlated variables	Coefficients of correlation	*P* value
HL versus age	.48	<.0001
HL versus current height	−.43	<.0001
HL versus maximal height	.03	NS
HL versus weight	.01	NS
HL versus BMI	.21	<.0001

TABLE 4 The comparisons of fracture prevalence in subjects with 'lower' and 'higher' HL value performed for different HL thresholds

HL threshold	Fracture prevalence in subgroup with HL equal or below the HL threshold	Fracture prevalence in subgroup with HL above the HL threshold	χ^2 statistics value	*P* value
1 cm	24.5%	42.2%	38.8	<.0001
2 cm	29.2%	44.5%	41.3	<.0001
3 cm	30.4%	47.2%	51.3	<.0001
4 cm	32.2%	49.7%	51.2	<.0001
5 cm	33.3%	53.8%	57.6	<.0001
6 cm	34.1%	57.9%	60.7	<.0001
7 cm	34.8%	60.4%	57.1	<.0001
8 cm	36.1%	61.0%	37.9	<.0001
9 cm	36.4%	63.5%	36.2	<.0001
10 cm	37.4%	66.7%	19.9	<.0001

HL than non-smoking. This a bit unexpected phenomenon, may be possibly explained by the difference in mean age between smokers and non-smokers, but this finding needs further exploration. An important information is provided by the analysis of HL with regard to falls. Women with prior falls had significantly greater HL in comparison with those without falls (Table 2). We postulate that this finding has a significant clinical importance. HL might be treated as an indicator of physical impairment leading to falls and subsequent fractures.

Our study has several limitations. HL was established as a difference between precisely measured height and self-reported height in the past. Therefore, one may consider that HL in some subjects might be not precise. We did not perform a longitudinal observation, which could give more reliable information. The study cohort was not a sample representative for general population. The study was performed only in women. Only clinically recognised vertebral fractures were included and some fractures of the spine might have been omitted. Thus, it is impossible to establish if the relationship between HL and falls rate is determined stronger by vertebral fractures or by spine deformities.

However, the sample size of the group and wide range of different clinical data allowed to present important findings for practitioners with regard to the role of height measurement.

Concluding, height loss is an important clinical phenomenon in postmenopausal women being an indicator of fracture risk and functional status. HL exceeding 4 cm probably corresponds to fracture probability above 50%.

DISCLOSURE

Wojciech Pluskiewicz, Piotr Adamczyk and Bogna Drozdzowska declare that they have no conflict of interest related to this manuscript.

AUTHORS' CONTRIBUTIONS

W. Pluskiewicz—study design, data collection, conception of the article, data interpretation, writing the first draft of the article, revision and approval of the final version of the article. P. Adamczyk—study design, statistical analysis of collected data, conception of results' presentation, data interpretation, writing some parts of the article, revision and approval of the final version of the article. B. Drozdzowska—study design, conception of the article, data interpretation, revision and approval of the final version of the article.

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