The role of employment status in the musculoskeletal characterization of a cohort of women over fifty: a comparative study

Federica Russo [1], Marco Paoletta [2], Sara Liguori [1], Michele Tardugno [1], Mariangela Airoma [1], Giovanni Iolascon [1], Antimo Moretti [1], Francesco Paolo Fabrazzo [1]

[1] Department of Medical and Surgical Specialties and Dentistry, University of Campania "Luigi Vanvitelli", Naples, Italy, [2] Department of Mental and Physical Health and Preventive Medicine, University of Campania "Luigi Vanvitelli", Naples, Italy

ABSTRACT

Purpose: Occupational activity plays a critical role in both the development and the prevention of fragility fractures, which are a major clinical concern in older adults as they profoundly affect quality of life and mortality. The present study therefore aimed to assess the impact of occupational activity on muscle strength, physical performance, and fracture risk among active workers, sedentary workers, and unemployed women.

Methods: Female patients with osteoporosis and at least one documented fragility fracture were enrolled. Inclusion criteria included a bone mineral density (BMD) T-score below –2.5 standard deviations and ongoing pharmacological treatment for osteoporosis. Patients with severe comorbidities were excluded. A comprehensive multidimensional assessment was conducted, including age, body mass index, smoking status, alcohol consumption, sun exposure, physical activity (assessed using the International Physical Activity Questionnaire), and physical performance (assessed using the Short Physical Performance Battery). Muscle strength was evaluated using handgrip dynamometry (handgrip strength), BMD by dual-energy X-ray absorptiometry, and fracture risk using the FRAX algorithm. Participants were categorized as employed or unemployed, and employed individuals were further classified as visual display terminal workers or physically active (PA) workers. Between-group differences in physical performance, physical activity, muscle strength, and fracture risk were analyzed.

Results: The study cohort included 100 women with a mean age of 66.9 ± 8.6 years. Of these, 63% were employed, and 87% had sustained fragility fractures, most commonly involving the vertebrae. The PA workers exhibited a 50.38% lower fracture risk compared with the unemployed participants ($p < 0.001$). The employed women demonstrated significantly higher physical performance and muscle strength than the unemployed women, with the PA subgroup showing the highest outcomes across all functional and strength measures, as well as the lowest fracture risk.

Conclusions: Occupational activity, particularly if physically demanding, may act as a protective factor against fragility fractures. However, differences between sedentary workers and unemployed women were not statistically significant. Further studies are warranted to clarify the relationship between sedentary work and fracture risk.

KEYWORDS

Fragility fractures, bone mineral density, osteoporosis, employment status, muscle strength.

Introduction

Fragility fractures are a major clinical concern, particularly among older adults, as they substantially affect both quality of life and mortality [1]. According to the World Health Organization, these fractures may occur spontaneously or following a minimal trauma, caused by mechanical forces that would not normally result in injury [2]. Thus, these fractures typically arise from low-energy trauma, such as a fall from standing height or a minor impact.

Research shows that falls are the leading cause of non-vertebral fractures and that vertebral fragility fractures often remain undiagnosed [3].

Despite regional variations in fracture risk, the global incidence of fragility fractures is projected to increase across all populations due to the progressive aging of society [4].

In Italy, osteoporosis affects 23.1% of women and 7.0% of men over the age of 50, and the incidence of major osteoporotic fractures (MOFs) is expected to rise by 22.4% between 2017 and 2030 [5]. The lifetime risk of MOFs in Italian women (34%) exceeds the EU6 average (31%), whereas the corresponding risk in men is lower (16% vs. 18%) [6]. These differences are

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Contact
Michele Tardugno; michele.tardugno@studenti.unicampania.it
Department of Medical and Surgical Specialties and Dentistry, University of Campania "Luigi Vanvitelli", Naples, Italy

likely explained by body mass index (BMI), calcium intake, sunlight exposure, and socioeconomic status, rather than bone mineral density (BMD) alone.

Among the various factors influencing the occurrence and prevention of fragility fractures, occupational activity may play a significant role, acting either as a protective or a risk factor depending on the nature of the work performed and the individual's overall musculoskeletal health status [7,8]. Sedentary behavior may increase the risk of fragility fractures through effects such as reduced BMD, metabolic alterations promoting faster bone loss, and diminished muscle strength and balance leading to increased risk of falls. Regular physical activity can mitigate these effects, contributing to improved skeletal health [7].

The aim of the present study was to investigate the relationship between occupational activity and bone health, focusing in particular on the role of employment in preventing fragility fractures. Specifically, we examined the effects of work on muscle strength, physical performance, and fracture risk in active employed women, sedentary employed women, and unemployed women.

Methods

We conducted an observational retrospective study of patients referred to our unit—Physical Medicine and Rehabilitation, University of Campania "Luigi Vanvitelli"—from October 2020 to April 2023 with osteoporosis diagnosed according to the WHO criteria and no severe comorbidities.

The evaluation protocol included the following parameters: (1) age; (2) BMI; (3) smoking status and alcohol consumption; (4) level of sun exposure; (5) level of physical activity evaluated using the International Physical Activity Questionnaire (IPAQ); (6) work history (current employment, characteristics of the work environment, history of accidents at work, work pace, number of shifts/week, and any night shifts); (7) current drug therapy; (8) previous anti-osteoporotic therapy; and (9) calcium and/or vitamin D intake.

Muscle strength was evaluated by measuring isometric hand grip strength (HGS) using a hand-held Jamar dynamometer. We considered the maximum value (in kg) from three consecutive measurements of the dominant hand (with a 1-min interval after each measurement) [9]. Spine pain severity and its impact on activities of daily living were evaluated using the spine pain index (SPI).

Physical performance was assessed using the Short Physical Performance Battery (SPPB), which included walking speed, chair stand ability, and balance, and additionally by recording 4-m gait speed (4MGS) [10]. Dual-energy X-ray absorptiometry (DXA) was used to measure BMD and to obtain the Trabecular Bone Score (TBS) [11]. Fracture risk was calculated using the FRAX algorithm, FRAX corrected for BMD, and FRAX corrected for TBS [12].

Functional evaluation entailed measuring kinematic parameters during both the Timed Up and Go (TUG) test and the TUG Dual Task test—the latter consisting of TUG combined with a verbal task—using an inertial sensor (G-WALK®, BTS) placed on the skin of the lumbar region at L5 level [9].

Balance was assessed on the ProKin 252 MF® platform with the following tests: (a) bipodal stabilometry on a static platform (Romberg test), (b) stability limits on a static platform, and (c) two-legged balance on a dynamic platform.

The definition of "physically active (PA) worker" was based on the Italian National Institute of Health's PASSI (Progressi delle Aziende Sanitarie per la Salute in Italia) surveillance system [13], according to which a person is considered "physically active" if they: a) perform heavy work that requires significant physical effort (e.g., laborer, construction worker, farmer); b) adhere to physical activity guidelines, performing ≥30 minutes of moderate activity on ≥5 days a week and/or ≥20 minutes of vigorous activity on ≥3 days a week. Conversely, a sedentary person, by definition, does not perform heavy work and does not engage in moderate or vigorous physical activity during their free time.

We divided our cohort into two groups: employed and unemployed, the former classified as either visual display terminal (VDT) workers, or PA workers, in line with the above PASSI surveillance system definition. Between-group differences in physical performance, activity, muscle strength, and fracture risk were analyzed.

Statistical analysis was carried out using Statistical Package for the Social Sciences 25 (SPSS 25; IBM Corp., Armonk, NY, USA) software. Data for continuous variables were expressed as means ± standard deviations or as the median (interquartile range). Categorical data were reported in terms of counts (absolute numbers and percentages). Normality was checked using the Shapiro-Wilk test. The Chi-square test was used for comparing categorical variables. The Mann–Whitney U test was used to compare continuous variables. We considered a significance threshold of $p < 0.05$.

Results

We enrolled 100 female patients with a mean age of 66.9±8.6 years, of whom 63 were current or former workers, and 37 had never worked. Eighty-seven patients had previously experienced fragility fractures caused by simple falls: in detail, vertebral fractures were reported by 57 women, wrist fractures by 23, hip fractures by 14, and humeral fractures by 13, while a pelvic fracture was reported by one patient (Table I).

According to BMI analysis, two patients were underweight (BMI <18.5 kg/m^2), 62 were of normal weight (18.5 < BMI < 24.99 kg/m^2), 31 were overweight (BMI 25–29.99 kg/m^2), and five were obese (BMI >30 kg/m^2). Muscle strength assessment using the HGS test showed that 19/100 women had a deficit (HGS <16 kg), while 34 exhibited a deficiency in muscle performance (SPPB <8). The IPAQ results revealed low levels of physical activity in three women, moderate levels in 34, and high levels in 32.

Comparison between employed *vs.* unemployed subjects

Between-groups comparison of IPAQ scores showed a mean value of 1710±1910 in the employed individuals (n=63) versus 1614±1630 in the unemployed patients (n=37), corre-

sponding to a 5.95% higher physical activity level in the employed group. Additionally, the employed subjects had a higher mean SPPB score (8.71±2.85) than the unemployed subjects (7.61±3.0), corresponding to a 14.5% difference (p<0.05). Similarly, the employed individuals had a higher mean HGS score (21.79±6.09 kg) than the unemployed ones (19.13 ±5.92 kg), representing a difference of 13.9% (p<0.05).

The employed individuals had a lower mean risk of major osteoporotic fractures within ten years (17.37±10.01%) than the unemployed ones (24.18±15.91%). This difference corresponded to a 28.17% reduction in the risk of these osteoporotic fractures (p<0.01); they also had a lower mean risk of hip fractures (7.25±9.24%) than the unemployed group (13.30±14.51%), corresponding to a 45.49% risk reduction (p<0.01) (Table II).

Comparison between PA workers *vs.* unemployed subjects

Further analysis categorized the working women into sedentary (VDT) workers (n=49) and PA workers (n=14), the latter engaged in physically demanding roles such as caregiving, healthcare, and warehouse work. This classification into subgroups revealed additional differences in physical performance and FRAX-calculated fracture risk.

The PA workers exhibited significantly better physical capacity and lower fracture risk than the unemployed individuals. Indeed, the PA workers had a mean SPPB score of 9.85±2.03 compared with 7.61±3.0 in the unemployed individuals, corresponding to a 29.44% higher score (p<0.005). The IPAQ results showed a mean of 2362±2497 Metabolic Equivalent of Task (METs) recorded in the PA workers, higher than the 1614±1630 recorded in the unemployed individuals (46.37% difference). Similarly, HGS was found to be greater in the PA workers (25.21±5.95 kg) than in the unemployed individuals (19.13±5.92 kg), with a 31.78% difference (p<0.005).

The FRAX-calculated risk of major osteoporotic fractures was 11.99±5.89% in the PA workers compared with 24.18±15.91% in the unemployed individuals, corresponding to a 50.38% difference (p<0.001). Similarly, hip fracture risk in the PA workers was 6.98±7.24%, significantly lower than the 13.30±14.51% recorded in the unemployed individuals (47.52% difference, p<0.001) (Figure 1). These findings highlight the role of occupational physical activity in reducing fracture risk and enhancing musculoskeletal health.

Table I Sociodemographic and clinical characteristics of women with osteoporosis (n=100).

VARIABLE	
Age (mean±SD) (years)	66.9±8.6
Body mass index (mean±SD) (kg/m^2)	23.61±5.2
Cigarette smokers (n)	29
Alcohol drinkers (n)	5
Sun exposure (>30 min/day) (n)	18
Previous anti-osteoporotic therapy (n)	54
Vitamin D supplementation	88
History of fragility fractures: total number* - vertebral - wrist - hip - humeral - pelvic *Some patients may have had more than one fracture*	87 57 23 14 13 1
IPAQ (total METs) (mean±SD)	1731±1658
SPPB (total score) (mean±SD)	8.21±2.91
HGS (kg) (mean±SD)	21.16±6.16
FRAX-major risk (%) (mean±SD)	22.14±14.33
FRAX-hip risk (%) (mean±sd)	11.11±12.88

Legenda: **IPAQ** = International Physical Activity Questionnaire; **METs** = Metabolic Equivalent of Task; **SPPB** = Short Physical Performance Battery; **HGS** = handgrip strength; **FRAX-major risk** = ten-year risk of a major osteoporotic fracture; **FRAX-hip risk** = ten-year risk of a hip osteoporotic fracture.

Comparison between PA workers vs. VDT workers

The PA workers showed significantly better physical capacity and lower major fracture risk than the VDT workers.

The PA workers had a mean of SPPB score of 9.85±2.03 versus the VDT workers' 8.31±2.89, a difference of 18.5% (p<0.03). On the IPAQ, the PA workers recorded 2362±2497 METs and the VDT workers 1495±1464 METs, a 58.0% difference. On HGS assessment, the PA workers were found to have a mean grip strength of 25.21±5.95 kg compared with the 20.60±4.93 kg recorded by VDT workers, corresponding to a

Table II Comparison of physical activity (IPAQ), physical performance (SPPB), muscle strength (HGS), and FRAX-calculated risk (major and hip) between employed and unemployed women.

VARIABLE	EMPLOYED (n=63)	UNEMPLOYED (n=37)	% DIFFERENCE	p VALUE
IPAQ (total METs) (mean±SD)	1710±1910	1614±1630	+5.95 %	>0.05
SPPB (total score) (mean±SD)	8.71±2.85	7.61±3.0	+14.5 %	<0.05
HGS (kg) (mean±SD)	21.79±6.09	19.13±5.92	+13.9 %	<0.05
FRAX-major risk (%) (mean±SD)	17.37±10.01	24.18±15.91	-28.17 %	<0.01
FRAX-major risk (%) (mean±SD)	7.25±9.24	13.30±14.51	-45.49 %	<0.01

Legenda: **IPAQ** = International Physical Activity Questionnaire; **METs** = Metabolic Equivalent of Task; **SPPB** = Short Physical Performance Battery; **HGS** = handgrip strength; **FRAX-major risk** = ten-year risk of a major osteoporotic fracture; **FRAX-hip risk**= ten-year risk of a hip osteoporotic fracture.

22.4% difference ($p<0.01$).

Finally, the FRAX-estimated risk of major osteoporotic fractures was 11.99±6.12 % in the PA workers versus 20.67±14.36% in the VDT workers, corresponding to a 42.0% difference ($p<0.004$). Hip fracture risk was 6.98±10.85% in the PA workers versus 9.56±11.44% in the VDT workers, representing a 27.0% difference (Figure 2). These findings suggest that physically demanding jobs enhance musculoskeletal function and reduce fragility-related fracture risk.

Comparison of VDT workers *vs.* unemployed subjects

The VDT workers, due to their predominantly sedentary lifestyle and occupational habits, exhibited levels of physical performance and fracture risk similar to those of unemployed individuals.

The VDT workers recorded a mean SPPB score of 8.36±2.95 versus 7.61±3.0 in the unemployed individuals, corresponding to a 9.86% difference. On the IPAQ, the VDT workers recorded a mean of 1520±1398 METs, slightly lower than the 1614±1630 recorded by the unemployed individuals (5.82% difference). On HGS assessment, the VDT workers showed a mean grip strength of 20.73±5.96 kg, higher than the 19.13±5.92 kg shown by the unemployed individuals (8.37% difference).

The FRAX-calculated risk of major osteoporotic fractures in the VDT workers was 18.87±9.56% versus 24.18±15.91% in the unemployed individuals, corresponding to a 21.96% difference. Similarly, hip fracture risk among the VDT workers was 7.32±9.83%, lower than the 13.30±14.51% observed in the unemployed individuals (44.96% difference) (Table III). No statistically significant differences were observed in any of these comparisons.

These results underscore the negative impact of both a sedentary lifestyle and inactive work on physical performance and bone health.

Discussion

Osteoporosis is a well-recognized systemic skeletal disorder characterized by reduced bone strength and an increased

Figure 1 Comparison between PA workers and unemployed women in terms of physical activity (IPAQ), physical performance (SPPB), muscle strength (HGS) and FRAX-calculated risk (major and hip). (**IPAQ**=International Physical Activity Questionnaire; **METs**=Metabolic Equivalent of Task; **SPPBS**=Short Physical Performance Battery; **HGS**=handgrip strength; **FRAX-major**=ten-year risk of a major osteoporotic fracture; **FRAX-hip**=risk at ten years of a hip osteoporotic fracture).

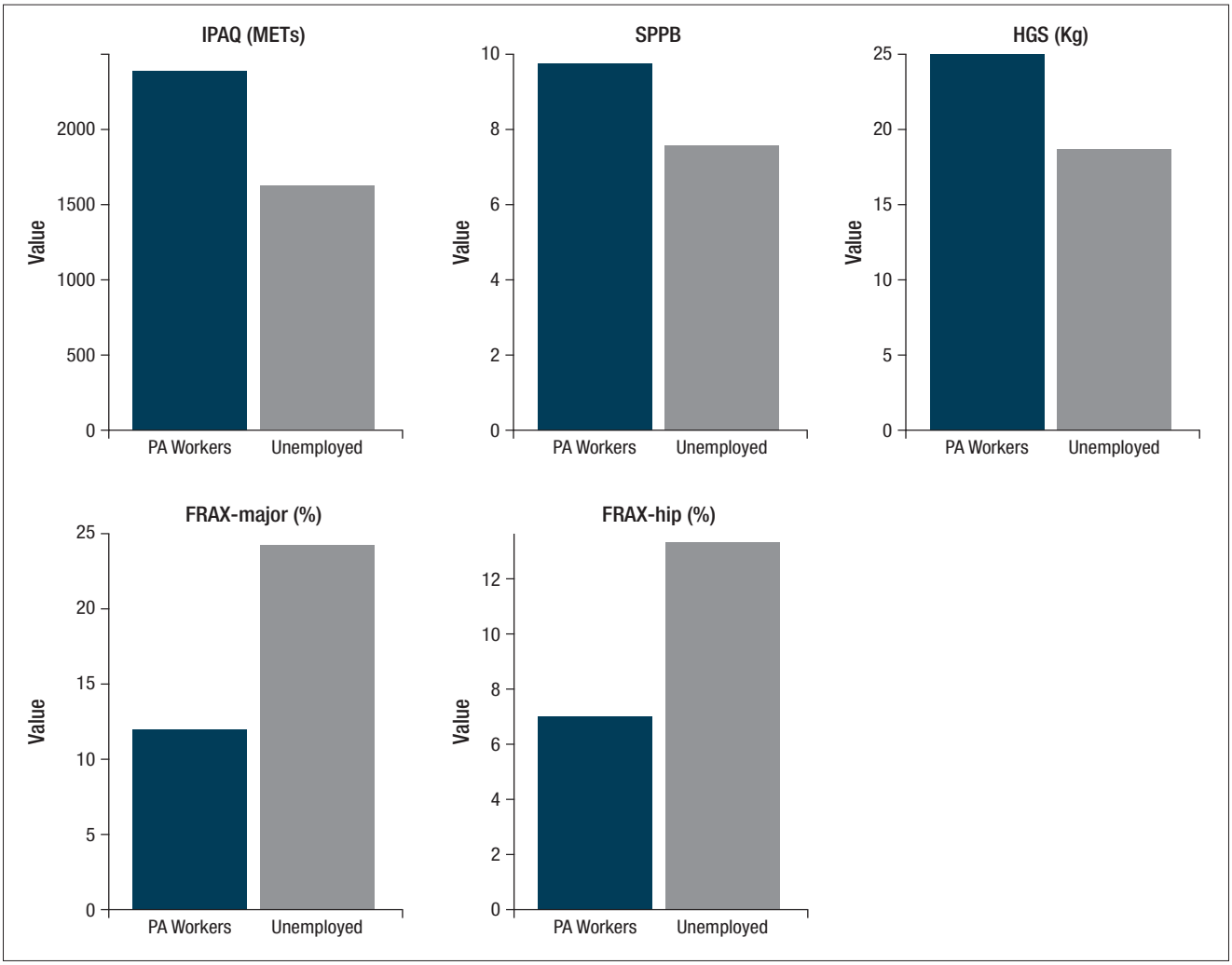
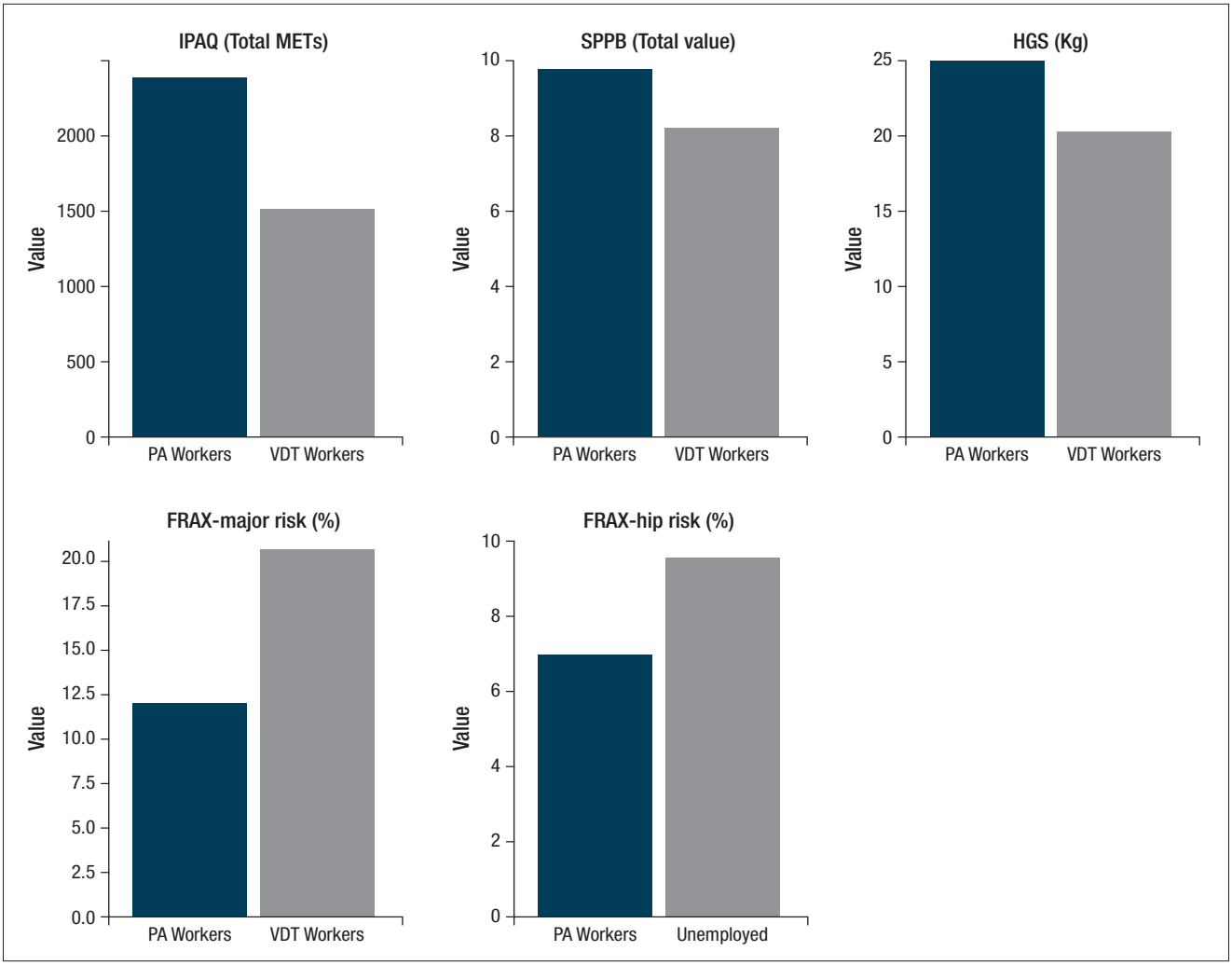


Figure 2 Comparison between PA and female VDT workers in terms of physical activity (IPAQ), physical performance (SPPB), muscle strength (HGS) and FRAX-calculated risk (major and hip). (**IPAQ**=International Physical Activity Questionnaire; **METs**=Metabolic Equivalent of Task; **SPPBS**=Short Physical Performance Battery; **HGS**=handgrip strength; **FRAX-major**=ten-year risk of a major osteoporotic fracture; **FRAX-hip**=ten-year risk of a hip osteoporotic fracture).



risk of fragility fractures, which can significantly compromise an individual's independence and quality of life. Multiple factors influence the development and prevention of these fractures, including lifestyle choices and occupational activity, which may exert complex and multifactorial effects.

Occupations involving substantial physical demands—such as manual or construction work—may promote musculoskeletal health through frequent engagement in weight-bearing activities, lifting, and movement. These activities and actions stimulate bone formation and enhance bone BMD, muscle strength, and postural stability, thereby lowering the risk of fragility fractures. Conversely, predominantly sedentary occupations, such as those requiring prolonged computer or desk work, may contribute to decreased musculoskeletal integrity and an increased risk of fracture. Reduced daily physical activity in sedentary workers can lead to sarcopenia, impaired balance, and increased susceptibility to falls. Despite this theoretical framework, dedicated studies assessing the relationship between occupational activity patterns and fragility fracture risk across different working populations remain limited in the scientific literature.

In this context, the present study investigated the association between occupational activity and bone health, paying particular attention to the role of employment in mitigating fracture risk. Our findings indicate that employment—especially in occupations involving regular physical activity—may serve as a protective factor against fragility fractures. The study cohort consisted exclusively of women diagnosed with osteoporosis and a documented history of at least one fragility fracture, and thus enabled focused analysis within a clinically relevant population.

The results demonstrated marked differences between the examined subgroups. The PA workers exhibited a significantly lower fracture risk compared with the other groups (50.38% lower than in unemployed participants). This underscores the importance of maintaining an active lifestyle, even within the context of occupational duties, as a strategy to prevent fragility fractures. Conversely, the sedentary VDT workers showed a higher fracture risk than the PA workers—approximately 50% higher—although still lower than the risk observed in unemployed individuals.

The unemployed participants showed the highest fracture

Table II Comparison of physical activity (IPAQ), physical performance (SPPB), muscle strength (HGS), and FRAX-calculated risk (major and hip) between female VDT workers and unemployed women.

VARIABLE	VDT WORKERS (*n*=49)	UNEMPLOYED (*n*=37)	% DIFFERENCE	*p* VALUE
IPAQ (total METs) (mean±SD)	1520±1398	1614±1630	+5.82 %	>0.05
SPPB (total score) (mean±SD)	8.36±2.95	7.61±3.0	+9.86 %	>0.05
HGS (kg) (mean±SD)	20.73±5.96	19.13±5.92	+8.37 %	>0.05
FRAX-major risk (%) (mean±SD)	18.87±9.56	24.18±15.91	-21.96 %	>0.05
FRAX-hip risk (%) (mean±SD)	7.32±9.83	13.30±14.51	-44.96 %	>0.05

Legenda: **IPAQ** =International Physical Activity Questionnaire; **METs**= Metabolic Equivalent of Task; **SPPB**= Short Physical Performance Battery; **HGS**= handgrip strength; **FRAX-major risk**= ten-year risk of a major osteoporotic fracture; **FRAX-hip risk**= ten-year risk of a hip osteoporotic fracture

risk, approximately 39.2% higher than that of the employed women. These findings highlight the potential protective role of work, not only for social and economic well-being but also for maintaining musculoskeletal health and functional independence.

Although clear differences emerged between the groups, no statistically significant difference in fracture risk was found between unemployed individuals and sedentary workers. This finding is particularly intriguing, as it highlights physiological and functional similarities between these two distinct populations. Both groups exhibited comparable levels of physical activity, physical performance, and fracture risk, suggesting that occupational sedentary behavior may pose health challenges similar to those associated with unemployment.

This observation raises important questions regarding the broader impact of physical inactivity on musculoskeletal health and overall well-being. It underscores the potential need for targeted interventions aimed at increasing physical activity levels and reducing fracture risk among both sedentary workers and unemployed individuals. Understanding the mechanisms underlying these parallels could provide valuable insights for clinicians and policymakers seeking to develop effective strategies to promote physical health and prevent injury, irrespective of employment status. However, further research is warranted to clarify these associations.

To our knowledge, this is the first study to directly examine the relationship between employment status and fragility fracture risk. Previous research has primarily focused on established risk factors such as advanced age, comorbidities, medication use, and lifestyle factors as the principal determinants of fracture susceptibility.

In conclusion, physical activity—whether occupational or leisure-related—appears to play a crucial role in reducing the risk of fragility fractures. The present findings suggest that maintaining regular movement during work may represent an important, yet underrecognized, component of fracture prevention strategies in individuals at risk of osteoporosis [14,15].

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