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Plantar sensation, plantar pressure, and postural stability alterations and effects of visual status in older adults

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ABSTRACT

Purpose: Ageing leads to plantar sensation and pressure alterations and poor postural control. The aim of this study was to compare the plantar sensation and static plantar pressure distribution between young and older adults. A secondary aim was to investigate the effect of ageing and visual status on postural stability.

Materials and methods: Forty older subjects and 43 young adult individuals participated in the study. Plantar light touch sensation was evaluated using Semmes–Weinstein monofilaments. Static plantar pressure and postural stability were assessed with the WinTrack® Pedobarography device.

Results: Plantar sensation thresholds of the older individuals were higher compared to the young in all plantar regions ($p < 0.001$). The plantar contact area was greater in older individuals ($p < 0.001$). Maximum plantar pressure of midfoot was higher and maximum plantar pressure of the rearfoot and whole foot was less in older individuals during quiet stance ($p < 0.05$). The main effects of group and visual condition were significant for mean latero-lateral and antero-posterior sway speed with large effect sizes ($p < 0.05$).

Conclusions: The sensation of all plantar regions reduced, the rearfoot plantar pressure decreased, and the midfoot plantar pressure increased in older individuals compared to young. Postural stability was reduced in the older individuals, and their postural control was more affected by the eliminated visual information compared to the young. Increased plantar contact area and midfoot plantar pressure may be related to decreased MLA height in older individuals. Older individuals may need visual information more to maintain postural control because of reduced plantar sensation.

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KEYWORDS
Ageing; older; plantar sensation; plantar pressure; postural stability

Introduction

Ageing leads to neuromuscular and cognitive problems along with the locomotor system alterations, thus gait and balance disturbances may arise (Hortobágyi et al. 2015; Guadagnin et al. 2016). Impairments in gait and balance and decreased muscle strength are serious risk factors for falling in older adults (Ishigaki et al. 2014; Caetano et al. 2018; Ancum et al. 2018). Besides, ageing leads to altered foot posture, reduced foot muscle strength, and joint flexibility, and decreased plantar sensation (Perry 2006; Mickle et al. 2009; Spink et al. 2011; Menz 2015). These problems arising in the structure and function of the foot, which provides mechanical support and sensory information in weight-bearing activities, may cause balance and mobility impairments (Menz et al. 2005).

Somatosensorial disorders are common in advanced ages. It has been reported that plantar sensory loss due to somatosensory disorder may cause balance and gait disturbances and an increased risk of falling (Cruz-Almeida et al. 2014). The reduction of plantar light touch sensation in the first metatarsophalangeal joint was revealed to have adverse effects on balance and function in older adults (Menz et al. 2005). Moreover, impairment of the plantar two-point discrimination sensation of the first toe was found to be associated with the risk of falls (Melzer et al. 2004).

The static pedobarographic analysis provides information on the plantar load distribution during standing. The data obtained from this analysis are used for purposes such as revealing the causes and effects of foot-related pathologies, designing external supports, and planning treatments (Menz 2015). The mean static plantar pressure of midfoot was found to be higher in older individuals compared to young (Machado et al. 2016). Plantar pressure is thought to be affected by plantar sensory alterations. The acutely reduced plantar sensation was suggested to cause a decrease in plantar pressure of the first toe and heel in healthy individuals (Eils et al. 2004). On the other hand, it has been reported that the decrease in plantar sensation results in an increase in the forefoot loading on walking in individuals with diabetic neuropathy (Melai et al. 2013). In older individuals, the reduced plantar sensation of the first toe and midfoot was revealed to be associated with increased static plantar pressure in those regions (Zhang and Li 2013).

Poor postural control is associated with loss of mobility, physical inactivity, and risk of falls in older adults (Laughton et al. 2003; Kanekar and Aruin 2014). As age progresses,

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the ability to maintain balance is impaired because of the reduction of sensory and motor capability and orientation skills required for postural stability. Age-related proprioceptive and vestibular impairments increase the need for visual inputs (Kanekar and Aruin 2014).

There are studies investigating plantar sensation, plantar pressure, and postural stability in older adults (Melzer et al. 2004; Zhang and Li 2013; Machado et al. 2016). However, differences in regional plantar sensation and pressure distribution between young and older individuals along with the relationship among plantar sensation, plantar pressure, and postural stability continue to be discussed. The primary aim of this study was to compare the regional plantar light touch sensation and static plantar pressure distribution between young and older adults. A secondary aim was to investigate the effect of ageing and visual status on postural stability. Our first hypothesis was older individuals had reduced plantar sensation, altered plantar pressure distribution, and decreased postural stability compared to young; and the second was the altered visual status caused more deterioration of postural stability in older adults.

Materials and methods

Subjects

This was a cross-sectional study conducted in a local older care and rehabilitation centre. 40 older subjects age above 65 years and 43 young adult individuals aged between 18 and 45 years participated in the study. Subjects who could walk independently in the community without lower limb orthosis or walking aid were included in the study. Exclusion criteria were cognitive impairment (Standardized Mini Mental Test Score below 24 points), history of lower extremity injuries within the previous 6 months, any diagnosis of diseases affecting the neurological or vestibular system, uncontrolled metabolic or cardiovascular disorders, severe visual impairment, and severe osteoporosis with a risk of compression fracture.

This study was approved by the local Ethics Committee of Hacettepe University (protocol no: GO 16/589 - 11). All participants were informed about the study, and an 'informed consent form' was signed by each participant.

Outcome measurements

Demographic data of all individuals were recorded. The dominant feet of the participants were determined. In the literature, the dominant lower limb was defined as the side where mobilization is carried out in the weight-bearing activities. The dominant feet of the participants were determined by questioning which foot they used to kick a ball (Sadeghi et al. 2000). Plantar light touch sensation was evaluated using Semmes–Weinstein monofilaments. Static plantar pressure and postural stability were assessed with the WinTrack® Pedobarography device. All 40 older individuals participated in the whole evaluation procedure; seven of 43 young subjects did not participate in the plantar sensation assessment. All the assessments were performed by the same researcher at the research laboratory. Statistical analyses were conducted by another researcher.

Plantar light touch sensation was evaluated in nine regions, including the heel (H), the medial midfoot (MM) and lateral midfoot (LM), the 1st, 3rd, and 5th metatarsal head (MT1, MT3, and MT5, respectively), and the 1st, 3rd and 5th toe (T1, T3, and T5 respectively). Measurements were performed on both feet using SemmesWeinstein® type 6 different monofilaments (gauges of 2.83, 3.61, 4.31, 4.56, 5.07, and 6.65 which apply 0.07, 0.4, 2, 4, 10, and 300 g of force respectively) of equal length and different diameters that apply standard pressure to the skin. While the participant was lying in a supine position with closed eyes, the examiner applied enough pressure to bend the monofilament for 1 s. The order of the different plantar regions tested was randomized in each subject. Three trials were conducted for each monofilament in all regions. The descending forced choice method was used. The participants were asked to indicate whether and where they felt the touch. The minimum gauge detected correctly was recorded (Perry 2006; Snyder et al. 2016). Plantar sensation values of rearfoot, midfoot, and forefoot were calculated. The regional plantar sensation was calculated as the mean of the T1, T3, T5, M1, M3, and M5 for forefoot, and the mean of MM and LL for midfoot. The plantar sensation of rearfoot was accepted as the sensation value measured in the heel.

Static plantar pressure and postural stability assessments were conducted using the Win-Track (Medicapteurs)® pedobarography platform and software. The platform, which measures 1610 mm × 652 mm × 30 mm, had 12,288 sensors (size of 7.8 × 7.8 mm) embedded in the active area of 1500 × 500 mm. Static plantar pressure analyses were performed while the participant was in a barefoot standing position on the force platform of the device. Participants were asked to keep their arms relaxed beside the trunk and looking forward. Maximum pressure, mean pressure, and contact area of each foot; percentage of pressure for each quarter consisting of the fore and rear halves of each foot; and a maximum pressure of forefoot, midfoot, and rearfoot were measured by static pedobarographic assessment. Postural stability assessment was conducted while the participants were in bipedal standing posture with 5 cm between the heels and 30 degrees of foot angle on the platform (Machado et al. 2017). Measurements were carried out in two different situations, with open and closed eyes. The centre of mass (CoM) sway was recorded for 30 s during each measurement. The sway area of CoM along with mean latero-lateral and antero-posterior sway speed and deviation amount was measured by postural stability assessment.

Statistical analysis

Statistical analysis was performed using the Statistical Package for Social Science (SPSS), version 16 (SPSS Inc., Chicago, IL, USA). The significance level was set at $p < 0.05$. Normality tests (visual and analytical) were performed to determine whether the numerical data were normally distributed. Demographic features and static plantar pressure results of the young and older individuals were compared using the Independent-samples *t*-test. One-way repeated-measures ANOVA was used to compare plantar pressure of rear, mid, and forefoot regions for both groups. A Chi-square test was used to compare the plantar sensation data and sex ratio between the groups. Mean plantar sensation values of the rear, mid and forefoot regions were compared using Kruskal–Wallis test. Bonferroni correction was used in pairwise comparisons of parameters with a significant difference in multiple comparisons. The effect of age on the change in postural stability parameters by open and closed eyes conditions was investigated using mixed between-within ANOVA.

Results

This study was completed with 40 older and 43 young participants. Plantar sensation and static pedobarographic parameters were similar in dominant and non-dominant feet of both groups ($p > 0.05$). Data for the dominant foot were used for subsequent analyses. Demographic characteristics of the participants were presented in Table 1. Intergroup analysis indicated no significant differences in height and gender ($p > 0.05$). Weight and body mass index were higher in older individuals compared to young ($p < 0.001$).

Table 2 presents the comparison of the plantar light touch sensation thresholds between the groups. Plantar sensation thresholds of the older individuals were higher in all the evaluated regions ($p < 0.001$).

The mean regional plantar sensation values of the forefoot, midfoot, and rearfoot were respectively 3.60 ± 0.33, 3.56 ± 0.43, and 4.07 ± 0.40 in the young group and 4.78 ± 0.72, 4.67 ± 0.77, and 5.71 ± 0.93 in the older group. In both groups, there were significant differences among the three regions in terms of plantar sensation ($p < 0.001$). Pairwise comparisons indicated that plantar light touch sensation of the rearfoot reduced compared to the fore and midfoot ($p < 0.001$). There was no significant difference between fore and midfoot in terms of plantar light touch sensation ($p > 0.05$).

Comparison of the static pedobarographic parameters indicated that plantar contact area was greater in older individuals compared to young ($p < 0.001$). Maximum plantar pressure of midfoot was higher and maximum plantar pressure of the rearfoot and whole foot was less in older individuals ($p < 0.05$). There were no significant differences in terms of pressure percentage of the fore and rearfoot regions and maximum plantar pressure of the forefoot between the groups ($p > 0.05$) (Table 3).

Table 1. Demographic characteristics.

	OG $n = 40$	YG $n = 43$	p
Age (mean ± SD)	75.55 ± 6.49	27.48 ± 7.53	<0.001*
Height (m) (mean ± SD)	1.64 ± 0.88	1.68 ± 0.08	0.094
Weight (kg) (mean ± SD)	75.70 ± 12.88	64.70 ± 13.76	<0.001*
BMI (kg/m^2) (mean ± SD)	28.01 ± 4.38	22.91 ± 3.65	<0.001*
Gender (F/M)	21/19	30/14	0.142

*$p < 0.001$; OG: older group; YG: young group; SD: standard deviation; BMI: body mass index; F: female; M: male.

There were significant differences among the three regions in terms of static plantar pressure of both groups ($p < 0.001$). Pairwise comparisons indicated that the highest maximum pressure values were in the rearfoot, the lowest maximum pressure values were in the midfoot ($p < 0.001$).

A comparison of postural stability parameters between groups within different visual conditions was presented in Table 4. The main effects of group and visual condition were significant for mean latero-lateral and antero-posterior sway speed with large effect sizes ($p < 0.05$). There were significant

Table 2. Comparison of plantar light touch sensation between older and young participants.

Plantar region	Monofilament threshold (level)	OG $n = 40$ n (%)	YG $n = 36$ n (%)	p
T1	2.83	1 (2.5)	9 (25)	<0.001*
	3.61	2 (5)	19 (52.8)	
	4.31	21 (52.5)	8 (22.2)	
	4.56	3 (7.5)	0	
	5.07	8 (20)	0	
	6.65	5 (12.5)	0	
T3	2.83	0	10 (27.8)	<0.001*
	3.61	6 (15)	20 (55.6)	
	4.31	18 (45)	6 (16.7)	
	4.56	4 (10)	0	
	5.07	7 (17.5)	0	
	6.65	5 (12.5)	0	
T5	2.83	0	8 (22.2)	<0.001*
	3.61	7 (17.5)	21 (58.3)	
	4.31	16 (40)	7 (19.4)	
	4.56	4 (10)	0	
	5.07	10 (25)	0	
	6.65	3 (7.5)	0	
MT1	2.83	0	8 (22.2)	<0.001*
	3.61	0	21 (58.3)	
	4.31	21 (52.5)	7 (19.4)	
	4.56	8 (20)	0	
	5.07	5 (12.5)	0	
	6.65	6 (15)	0	
MT3	2.83	0	5 (13.9)	<0.001*
	3.61	1 (2.5)	24 (66.7)	
	4.31	17 (42.5)	7 (19.4)	
	4.56	6 (15)	0	
	5.07	6 (15)	0	
	6.65	10 (25)	0	
MT5	2.83	1 (2.5)	1 (2.8)	<0.001*
	3.61	1 (2.5)	28 (77.8)	
	4.31	14 (35)	7 (19.4)	
	4.56	7 (17.5)	0	
	5.07	10 (25)	0	
	6.65	7 (17.5)	0	
MM	2.83	0	11 (30.6)	<0.001*
	3.61	3 (7.5)	20 (55.6)	
	4.31	26 (65)	5 (13.9)	
	4.56	3 (7.5)	0	
	5.07	4 (10)	0	
	6.65	4 (10)	0	
LM	2.83	0	5 (13.9)	<0.001*
	3.61	1 (2.5)	23 (63.9)	
	4.31	24 (60)	8 (22.2)	
	4.56	5 (12.5)	0	
	5.07	4 (10)	0	
	6.65	6 (15)	0	
H	2.83	0	0	<0.001*
	3.61	0	14 (38.9)	
	4.31	3 (7.5)	19 (52.8)	
	4.56	4 (10)	2 (5.6)	
	5.07	14 (35)	1 (2.8)	
	6.65	19 (47.5)	0	

*$p < 0.001$; OG: older group; YG: young group; T1: 1st toe; T3: 3rd toe; T5: 5th toe; M1: 1st metatarsal head, M3: 3rd metatarsal head; M5: 5th metatarsal head; MM: medial midfoot; LM: lateral midfoot; H: heel.

Table 3. Comparison of static pedobarographic parameters between older and young participants.

	OG $n = 40$ (mean ± SD)	YG $n = 43$ (mean ± SD)	Effect size	p
Contact area (cm^2)	116.77 ± 19.80	96.69 ± 21.30	0.196	<0.001**
Pressure percentage (%)				
Fore region	22.82 ± 4.80	22.72 ± 4.69	0.000	0.921
Rear region	27.00 ± 4.61	28.02 ± 5.23	0.011	0.349
Mean pressure (g/cm^2)	330.62 ± 41.89	337.27 ± 5.61	0.007	0.437
Maximum pressure (g/cm^2)				
Whole	599.32 ± 76.79	637.00 ± 61.80	0.070	0.016*
Forefoot	543.67 ± 78.16	561.00 ± 89.59	0.011	0.352
Midfoot	372.75 ± 135.98	281.97 ± 186.67	0.074	0.013*
Rearfoot	585.37 ± 87.25	623.79 ± 73.14	0.055	0.032*

*$p < 0.05$; **$p < 0.001$; OG: older group; YG: young group; SD: standard deviation.

Table 4. Comparison of postural stability parameters between groups (YG and OG) within different visual conditions (open eyes and closed eyes).

	OG $n = 40$ (mean ± SD)	YG $n = 43$ (Mean ± SD)	ES[a]	p[a]	ES[b]	P[b]	ES[c]	P[c]
CoM area (mm^2)								
OE	55.08 ± 42.02	65.09 ± 94.15	0.034	0.106	0.049	0.050	0.059	0.031*
CE	141.18 ± 244.34	59.29 ± 71.74						
Mean l-l speed (mm/s)								
OE	2.51 ± 1.30	1.75 ± 0.68	0.170	<0.001**	0.115	0.002*	0.060	0.029*
CE	3.52 ± 2.63	1.95 ± 0.91						
Mean a-p speed (mm/s)								
OE	2.55 ± 1.06	2.10 ± 0.64	0.117	0.002*	0.110	0.003*	0.069	0.019*
CE	4.00 ± 3.51	2.25 ± 1.39						
Mean l-l deviation (mm)								
OE	1.51 ± 0.79	1.44 ± 0.78	0.020	0.209	0.040	0.077	0.022	0.197
CE	1.86 ± 1.05	1.50 ± 0.95						
Mean a-p deviation (mm)								
OE	1.87 ± 0.90	1.79 ± 1.23	0.041	0.072	0.039	0.081	0.040	0.077
CE	2.46 ± 1.62	1.74 ± 1.23						

*$p < 0.05$; **$p < 0.001$; OG: older group; YG: young group; SD: standard deviation; ES: effect size; OE: open eyes; CE: closed eyes.
[a]Main effect for group; [b]main effect for visual condition; [c]interaction between visual condition and group.

interaction effects for CoM sway area and mean latero-lateral and antero-posterior sway speed and the effect sizes were moderate ($p < 0.05$). There were no group, visual condition, and interaction effects for mean latero-lateral and antero-posterior sway deviation ($p > 0.05$).

Discussion

This study was conducted to reveal plantar light touch sensation, static plantar pressure distribution, and postural stability differences between young and older adults. The results indicated that plantar sensation, maximum rearfoot plantar pressure, and postural stability reduced, contact area and maximum midfoot plantar pressure increased in older individuals. Besides, the adverse effect of eliminating visual input on postural stability was higher in older individuals than young. However, the older and young individuals exhibited similar pressure percentages in the rear and fore halves of the foot.

The light touch sensation of whole plantar regions was found to be reduced in older adults. Plantar sensation decreases due to somatosensory disorders with ageing. It was reported that deterioration of feedback from plantar tactile mechanoreceptors would adversely affect balance and gait and might be a risk factor for falls (Menz et al. 2005; Peters et al. 2016). There are several studies indicating that the plantar sensation of older individuals decreased compared to the young, similar to our results (Perry 2006; Franco et al. 2015; Machado et al. 2016; Peters et al. 2016) Moreover, the current study revealed that plantar light touch sensation was less in rearfoot compared to fore and midfoot in both groups. Machado et al. (2016) revealed that while there was no difference among the fore, mid, and rearfoot of the young individuals in terms of plantar light touch sensation, the plantar light touch sensation of the fore and rearfoot decreased compared to the midfoot in the older adults. In that study, it was reported that the plantar light touch sensation of the rearfoot was less than that of the forefoot, but the difference was not statistically significant (Machado et al. 2016). Similarly, our results in older individuals indicated that the least sensitive plantar region was in rearfoot, and although it was not statistically significant, the plantar sensation was less in the forefoot than in the midfoot. Zhang and Li (2013) reported that in the older individuals with peripheral neuropathy, the most sensitive plantar region was midfoot, and this region was followed by the fifth metatarsal, the heel, the first metatarsal the first toe respectively. Strzalkowski et al. (2015) reported that in healthy young individuals, plantar light touch sensation was less in rearfoot and forefoot compared to midfoot and less in rearfoot compared to the forefoot. In the same study, it was indicated that plantar skin thickness and stiffness were positively correlated with plantar sensation (Strzalkowski et al. 2015). Based on this, it can be suggested that the differences in the stiffness and thickness of the plantar skin led to regional differences in the plantar sensation. Alterations in the skin tissue due to ageing lead to an increment in stiffness and thickness of the plantar skin (Menz 2015). Therefore, this alteration in plantar skin may be one of the important causes of reduced plantar sensation of older individuals.

The results of the static pedobarographic evaluation in our study indicated that the plantar contact area of older individuals was greater than the young. Ageing leads to a gradual reduction of the medial longitudinal arch (MLA) height. The contact area of the midfoot is thought to increase due to reduced MLA height in older individuals (Menz 2015). Our results revealed that the maximum plantar pressure of the whole foot and rearfoot decreased and the maximum plantar pressure of the midfoot increased in older individuals compared to the young. Besides the maximum pressure of forefoot and mean pressure values were similar in both groups. These results suggest that the loading of the midfoot increased due to the low of the MLA in older individuals. Machado et al. (2016) revealed that older adults had increased midfoot and forefoot plantar pressure. Reduced MLA height was excluded in their study, so they argued that loading towards the mid and forefoot may be due to reduced plantar sensation primarily seen in the rearfoot (Machado et al. 2016). Our similar results indicated that plantar loading was transferred from the least sensitive rearfoot region to the most sensitive midfoot region. To the current results, while the body weight was higher in the older group the maximum pressure of the whole foot was less compared to young. This finding indicates that older individuals transfer the maximum pressure of the rearfoot, in which region the load should be the most during standing, to the midfoot. Moreover, the current study exhibited that, there was no difference between young and older individuals in terms of pressure percentages of the fore and rear plantar halves. So older individuals did not have an asymmetry in fore and rear plantar load distribution compared to the young.

A regional comparison of static maximum plantar pressure indicated that the plantar pressure was highest in the rearfoot and lowest in the midfoot in both groups. So, the current study, in which the plantar light touch sensation was the lowest in the rearfoot and highest in the midfoot, revealed that the loading increased in the regions with reduced plantar sensation. Zhang and Li (2013) indicated that the decrease in plantar sensation of the first toe and midfoot increases static plantar pressures in the first toe and heel respectively. On the other hand, a previous study revealed that plantar loading was transferred from insensitive regions to more sensitive regions (Nurse and Nigg 2001). Ultimately, there is a consensus in the literature that plantar sensory alteration affects plantar pressure distribution. Our study indicated that older individuals had less sensation in each plantar region than young people, but plantar pressure decreased in the rearfoot and increased in the midfoot. On the other hand, regional comparisons revealed that plantar pressure is higher in regions with lower sensation. It is known that plantar skin has more thickness and stiffness in regions with higher plantar pressure (Menz 2015). Therefore, the effect of the increased plantar skin thickness and stiffness due to high plantar pressure on the plantar sensation should be emphasized besides the effect of plantar sensory changes on the plantar pressure distribution.

The present study revealed that postural sway speed was higher in older individuals compared to the young. Postural stability is known to be impaired with ageing. One of the resources of impaired postural stability is decreased somatosensory function in older individuals (Ueda and Carpes 2013; Kanekar and Aruin 2014). Several studies exhibited that decreased plantar sensation was associated with poor postural control in older adults (Peters et al. 2016; Machado et al. 2017; Andreato et al. 2020). Our study also indicated that eliminating visual information affected older individuals more than young in terms of static postural stability. Vision is one of the important sensory parameters to maintain balance (Aartolahti et al. 2013). Proprioceptive and vestibular losses due to ageing cause more need for visual inputs to maintain balance (Kanekar and Aruin 2014). Machado et al. (2017) reported that the postural sway of both young and older individuals did not change when measured with open and closed eyes. Billot et al. (2015) revealed that the postural sway of healthy young individuals whose plantar sensitivity was impaired with the plantar cold application was similar in the eyes open and closed conditions. However, it has been indicated that visual impairment adversely affects balance in older individuals and is an important risk factor for falls (Lord and Dayhew 2001). Our results revealed that although there was no change in postural sway when vision was eliminated in young individuals, postural control was impaired in the absence of visual information in older individuals. This result indicates that older individuals more need visual information to maintain postural control, suggesting that their other sensory systems are usually impaired.

The current study has some limitations. Factors that may affect plantar sensation and pressure such as foot posture and plantar skin characteristics were not evaluated. This was not a regression study with large sample size, so we interpreted the results of a cross-sectional study.

Our study revealed that in older individuals, plantar light touch sensation reduced, the rearfoot plantar pressure decreased, and the midfoot plantar pressure increased compared to young. Increased static plantar contact area and midfoot plantar pressure suggested that MLA height decreased in older individuals. The reduction of rearfoot plantar pressure in the older individuals indicated that they transferred the load from the rearfoot to the midfoot, and this alteration was thought to be due to more sensitive plantar midfoot or reduced MLA height. The regional comparison of plantar sensation and pressure exhibited that the static plantar pressure was higher in regions with reduced plantar sensation. Postural stability was reduced in the older individuals, and their postural control was more affected by the eliminated visual information compared to the young, which may be related to the reduced plantar sensation.

Ethical approval

This study was approved by the local Ethics Committee of Hacettepe University (protocol no: GO 16/589 - 11).

Consent to participate

All participants were informed about the study, and an 'informed consent form' was signed by each participant.

Author contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Banu Unver and Nilgun Bek. The first draft of the manuscript was written by Banu Unver and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Data availability statement

The data of this study is not publicly available but can be obtained from the corresponding author upon request.

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