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Correlation Between Toe Grip Strength and Physical Performance in Elderly with Pronated Foot: A Pilot Study

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ABSTRACT

Background: Age-related loss of muscle strength and balance often leads to reduced mobility and greater fall risk in older adults. Toe grip strength (TGS) is a key contributor to stability and gait, while foot posture—particularly pronation—can influence lower-limb mechanics. The combined effect of these factors on physical performance in the elderly remains underexplored.
Aim: To examine the relationship between toe grip strength, foot posture index (FPI), and functional mobility using the Short Physical Performance Battery (SPPB) in older adults with pronated feet.
Methods: A cross-sectional pilot study was carried out among 12 community-dwelling older adults (≥60 years) with pronated foot posture (FPI ≥ 6). TGS was assessed using a pinch gauge dynamometer, foot posture with the Foot Posture Index (FPI-6), and physical performance with the SPPB (balance, gait speed, chair stand). Correlations were analyzed with Karl Pearson's coefficient, significance set at $p < 0.05$.
Results: Mean TGS was 2.66 ± 1.28 kg, mean FPI 7.33 ± 1.43, and mean SPPB 3.75 ± 1.54. TGS showed a significant positive correlation with SPPB ($r = 0.663$, $p = 0.019$). In contrast, FPI showed weak, non-significant negative correlations with both TGS ($r = –0.279$, $p = 0.38$) and SPPB ($r = –0.122$, $p = 0.705$).
Conclusion: Toe grip strength was positively associated with functional mobility in elderly individuals with pronated feet, while foot posture alone showed no significant influence. Strengthening toe flexors may be a valuable approach to enhance mobility and reduce fall risk in older adults. Larger, longitudinal studies are required to confirm these preliminary observations.

Keywords: Toe grip strength, foot posture index (FPI), pronated feet.

BACKGROUND

The global rise in the elderly population has increased attention toward musculoskeletal health and mobility challenges in later life. Ageing is often accompanied by muscle weakness, joint stiffness, and reduced proprioceptive feedback, which together contribute to impaired balance, slower walking, and a decline in daily functional capacity. One key but frequently overlooked

factor in maintaining mobility is toe grip strength (TGS), which depends on the coordinated activity of both intrinsic and extrinsic muscles of the foot. These muscles provide stability, assist in walking mechanics, and play an essential role in preventing falls[1,2].

Research indicates that reduced toe grip strength is linked with compromised balance, slower gait speed, and a higher risk of falls among older adults. Since the toes provide both sensory input and mechanical push during the late stance phase of gait, their strength is closely tied to overall lower-limb performance. Hence, TGS can be considered a practical measure of functional mobility and physical capacity in the ageing population[3].

In addition to muscle strength, foot structure has a major influence on stability and walking efficiency. Among various foot types, pronated posture—characterized by a flattened medial arch and inward rolling of the rearfoot—has been associated with altered load transfer, diminished shock absorption, and less effective propulsion during walking. These mechanical changes may limit the effectiveness of toe flexor muscles, further reducing functional capacity in elderly individuals[4].

Although both TGS and foot posture independently affect balance and gait, very few studies have investigated how they interact and influence physical performance. Moreover, limited attention has been given to older adults with pronated feet, who may be particularly vulnerable to mobility problems due to the combined effect of muscular weakness and structural changes.

The present pilot study therefore aimed to examine the association between toe grip strength, foot posture index (FPI), and functional mobility measured through the Short Physical Performance Battery (SPPB) in elderly adults with pronated feet. Clarifying these relationships may help clinicians design targeted interventions to maintain or improve independence in this population.

MATERIALS AND METHODS

Study Design and Setting:

This was a cross-sectional pilot study conducted to investigate the relationship between toe grip strength (TGS), foot posture index (FPI), and physical performance using the Short Physical Performance Battery (SPPB) in elderly individuals with pronated foot posture.

Participants:

A total of 12 elderly volunteers were recruited using convenience sampling.

Inclusion criteria

Age ≥ 60 years

Presence of pronated foot posture as identified by Foot Posture Index (FPI ≥ 6)

Ability to walk independently without assistive devices

Exclusion criteria

History of lower limb surgery or fracture in the past 6 months

Neurological conditions affecting gait or balance (e.g., Parkinson's disease, stroke)

Severe visual or vestibular impairments

Use of orthotic devices during testing

All participants provided informed consent prior to data collection.

RESULT

The statistical analysis was done using SPSS 23.0. Categorical variables were expressed using frequency and percentage. Numerical variables were presented using mean and standard deviation. Correlation was done using Karl Pearson correlation. A p value <0.05 was considered statistically significant.

Table 1: Age distribution of participants

		Frequency	Percent
AGE	<70 year	9	75.0
	>=70 years	3	25.0
	Total	12	100.0

The age distribution showed 75.0% of the participants being younger than 70 years and the remaining 25.0% aged 70years or older. The total number of participants was 12.

Figure 1: Age distribution of participants

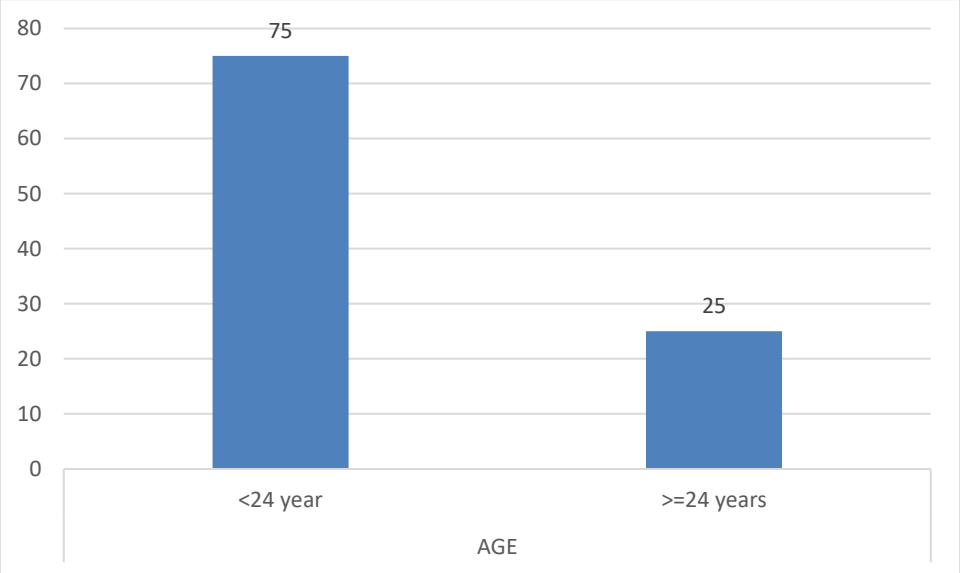


Table 2: Gender distribution of participants

		Frequency	Percent
GENDER	Female	6	50 %
	Male	6	50 %
	Total	12	100.0 %

The gender distribution was equal, with 50.0% of the participants being female and 50.0% male, out of a total of 12 participants.

Figure 2: Gender distribution of participants

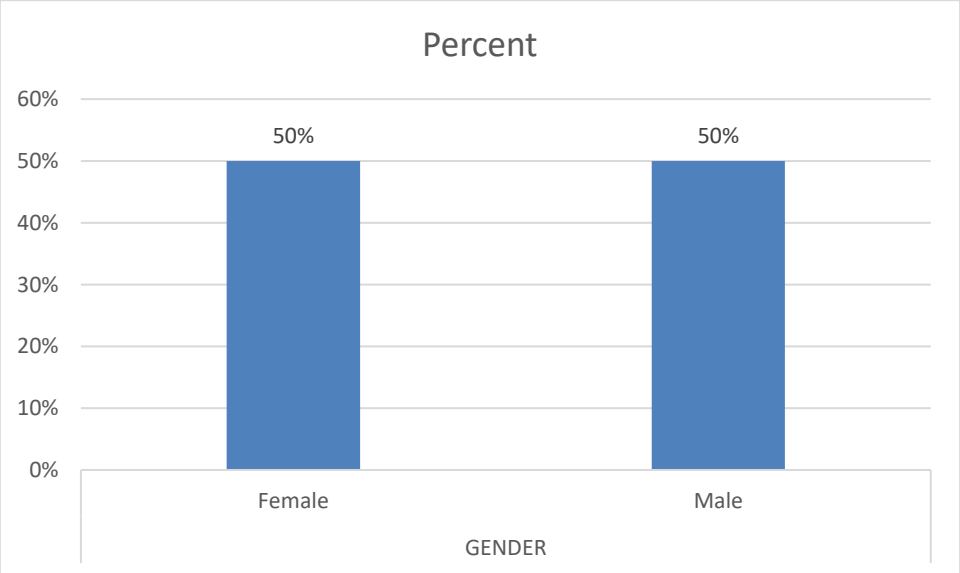


Table 3: Mean representation of toe gip strength (TGS)

	N	Minimum	Maximum	Mean	Std. Deviation
TGS	12	1	5	2.66	1.28

The toe grip strength (TGS) of the participants ranged from 1 to 5, with a mean TGS being 2.66 ± 1.28 kg.

Figure 3: Mean representation of Toe grip strength (TGS)

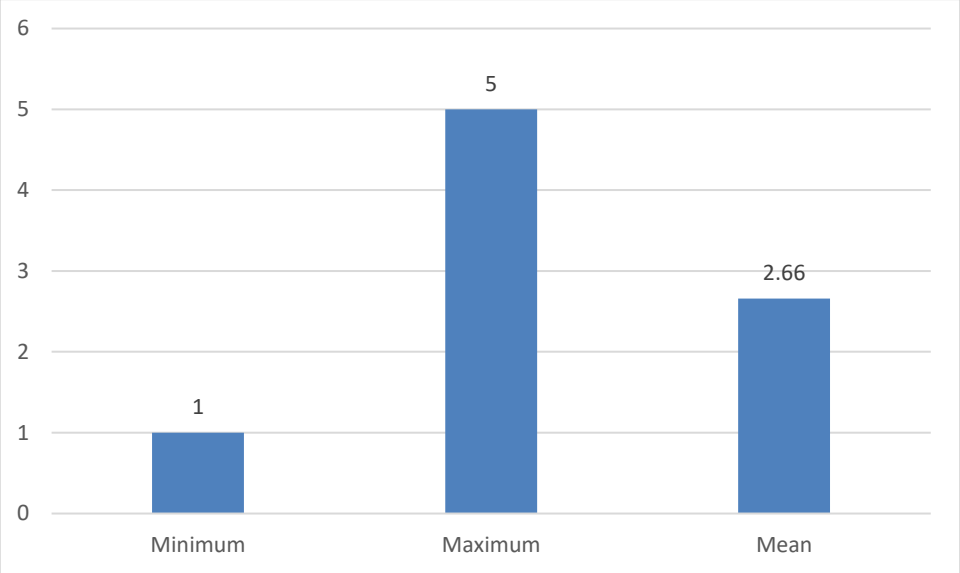


Table 4: Mean representation of Foot posture index FPI

	N	Minimum	Maximum	Mean	Std. Deviation
FPI	12	6	10	7.33	1.43

The Foot posture index of the participants ranged from 6 to 10, with a mean 7.33 ± 1.43.

Figure 4: Mean representation of foot posture index (FPI)

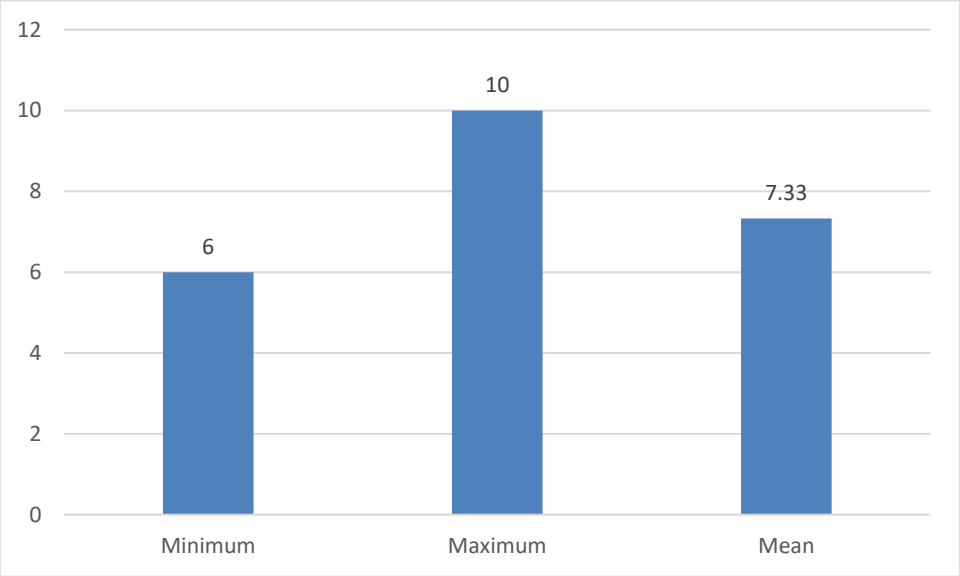


Table 5: Mean representation of Short physical performance battery

	N	Minimum	Maximum	Mean	Std. Deviation
SPPB	12	2	7	3.75	1.54

The Short physical performance battery of the participants ranged from 2 to 7, with a mean 3.75 ± 1.54.

Figure 5: Mean representation of Short physical performance battery

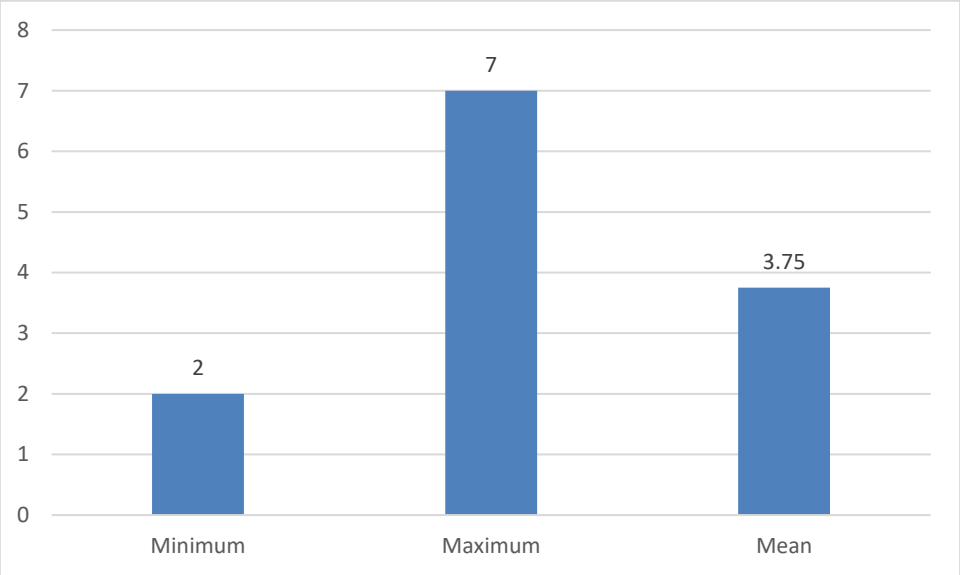


Table 6: Showing correlation between TGS and FPI

TGS		FPI
	r value	-0.279
	p value	0.38
	N	12

The correlation between toe grip strength and foot posture index shows a weak negative correlation (r=-0.279) however the p value (0.38) shows that this correlation is not statistically significant.

Figure 6: Showing correlation between TGS and FPI

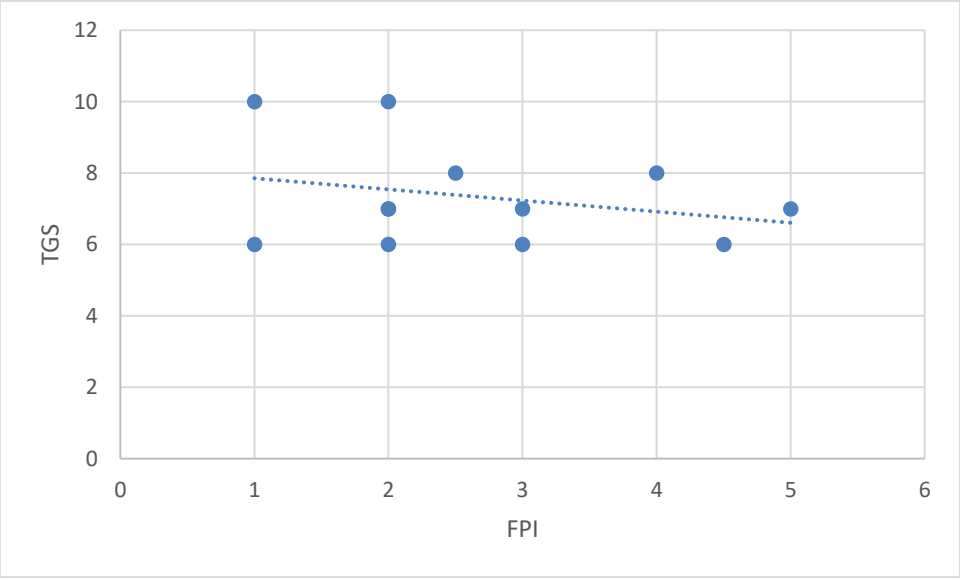


Table 7: Showing correlation between SPPB and FPI

SPPB		**FPI**
	r value	-0.122
	p value	0.705
	N	12

The correlation between SPPB and FPI shows a very weak negative correlation (r=-0.122). the p value (0.705) indicates that the correlation is not statistically significant.

Figure 7: Showing correlation between SPPB and FPI

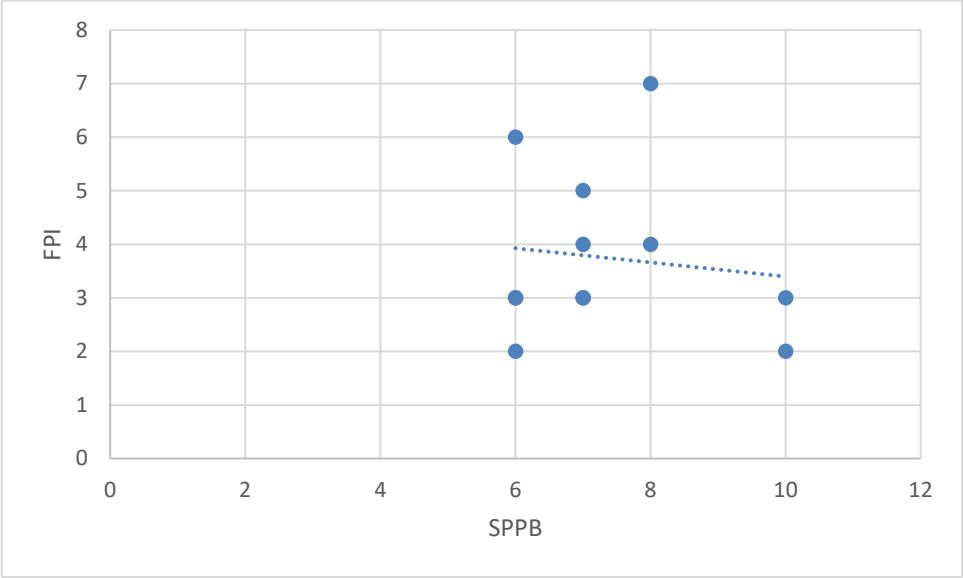
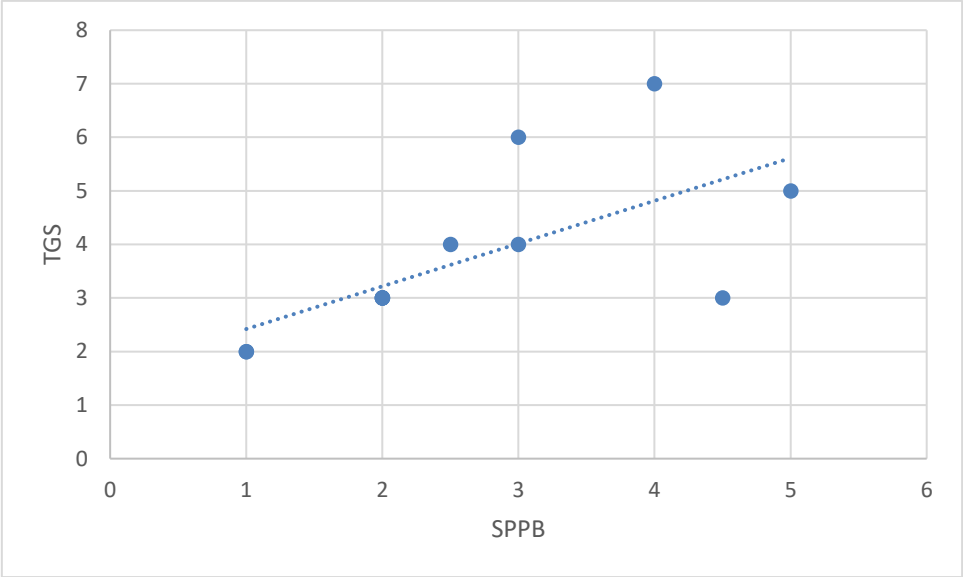


Table 8: Showing correlation between TGS and SPPB

TGS		SPPB
	r value	0.663
	p value	0.019
	N	12

The correlation between toe grip strength and physical performance shows a strong positive correlation (r=0.663). the p-value (0.019) indicates that this correlation is statistically significant as p value is <0.05.

Figure 8: Showing correlation between TGS and SPPB



DISCUSSION

This pilot study explored how toe grip strength (TGS), foot posture index (FPI), and functional capacity (SPPB) relate to each other in older adults with pronated feet. The analysis revealed a statistically significant positive correlation between TGS and SPPB (r = 0.663, p = 0.019), suggesting that individuals with stronger toe flexor muscles demonstrated better lower-limb function and mobility. This finding reinforces the idea that intrinsic foot muscle strength plays a central role in balance and walking ability, particularly in elderly individuals with altered foot alignment.

From a biomechanical perspective, toe grip strength reflects the functionality of muscles such as the flexor hallucis brevis, flexor

digitorum brevis, and the deeper long toe flexors. These muscles assist in stabilizing the arch, providing propulsion during push-off, and correcting posture while walking. In pronated feet, where the medial arch collapses and the foot rolls inward, these muscles may operate less efficiently. Strengthening them could therefore help offset the negative effects of pronation and enhance dynamic stability.

Interestingly, the study did not find significant associations between FPI and either TGS ($r = –0.279$, $p = 0.38$) or SPPB ($r = –0.122$, $p = 0.705$). Although weak negative trends were noted, the lack of statistical significance indicates that static foot posture may not be a strong determinant of functional performance in older adults. This could be due to the limitations of FPI, which captures static alignment but does not reflect dynamic adaptations during movement. It is also possible that older adults develop compensatory neuromuscular strategies that help maintain function despite structural deviations.

Our results align with previous work by Misu et al. (2014), who reported that toe flexor strength was a predictor of walking speed and balance in older adults. Similarly, Uritani et al. (2014) observed that reduced TGS was related to poorer balance, recommending toe strengthening exercises for fall prevention. The present findings extend this evidence to individuals with pronated feet, showing that muscle strength retains its importance even when structural abnormalities are present.

The absence of significant correlations involving FPI may also reflect the small sample size ($n = 12$), which reduces statistical power, and the narrow range of pronation among participants (FPI 6–10), limiting variability. Larger studies with greater diversity in foot posture and dynamic gait analysis are needed to clarify these relationships more fully.

From a clinical standpoint, the findings emphasize the importance of including toe flexor strengthening in geriatric physiotherapy. Exercises such as towel curls, marble pickups, and resistance-based toe training may help improve balance, walking speed, and reduce the risk of falls. Even in cases where pronated posture is present, functional improvements are possible through targeted strengthening, highlighting its value in rehabilitation programs.

Additionally, these results support preventive strategies in community settings, where identifying individuals with weak toe grip strength may allow for early intervention before significant mobility decline occurs. A combined approach involving physiotherapists, podiatrists, and geriatricians could further enhance management by integrating both muscle training and orthotic support when required.

CONCLUSION

This pilot study highlights a clear positive association between toe grip strength and functional mobility in elderly individuals with pronated foot posture. Although foot posture itself did not show a meaningful link with either muscle strength or physical performance, the findings suggest that intrinsic foot muscle strength plays a crucial role in maintaining independence and preventing mobility decline.

From a practical perspective, incorporating toe flexor strengthening exercises into geriatric rehabilitation and fitness programs may help improve walking performance, stability, and fall resistance—even when structural alterations such as pronation are present.

Future research with larger samples, control groups, and longitudinal follow-up is needed to confirm these findings and clarify the underlying biomechanical and neuromuscular pathways. Such evidence could guide more targeted physiotherapy strategies for promoting mobility and reducing fall risk in the ageing population. Additionally, even though there is no significant correlation between toe grip strength and foot posture, more studies with

increased sample size can be carried out to determine the effect.

Declaration By Authors

Ethical Approval: Approved
Source of Funding: None
Conflict of Interest: The authors declare no conflict of interest.

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