KINESITHERAPEUTIC EXERCISES FOR HALLUX VALGUS: A STATIC AND DYNAMIC FOOT ANALYSIS

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ABSTRACT
Introduction: The primary goal of conservative treatment for hallux valgus is to alleviate symptoms without surgically correcting the underlying anatomical deformity. Common non-surgical approaches include shoe modifications, orthotic devices, analgesics, non-steroidal anti-inflammatory drugs (NSAIDs), and therapeutic exercise programs. Surgical intervention is considered when conservative measures fail to provide relief. The aim of this study was to evaluate the effect of a specific kinesitherapeutic exercise program on the static characteristics of the foot in individuals diagnosed with hallux valgus. Methods: A total of 32 participants diagnosed with bilateral hallux valgus deformity were enrolled in the study (30 women and 2 men; mean age 40.3 ± 15.3 years). Participants were divided into two groups. Those in the experimental group (n = 20) performed a 30-day home-based kinesitherapy program consisting of exercises using an elastic resistance band and a small proprioceptive massage ball. Static foot characteristics were assessed using the Podoscope MultiREHA system. Parameters evaluated pre- and post-intervention included the Alpha angle, Beta angle, Gamma angle, visual deformity grade, KY index, and Wejsflog index. Results: A statistically significant reduction in the Alpha angle was observed in the experimental group, decreasing by 1.6° (from 13.20 ± 7.76° to 11.60 ± 7.87°, p = .024), whereas the control group exhibited only a minimal, non-significant change of 0.13° (from 12.28 ± 7.91° to 12.15 ± 7.96°, p = .964). Furthermore, a significant improvement was found in the KY index within the experimental group, which decreased by 0.03 ± 0.04 (from 0.39 ± 0.06 to 0.36 ± 0.07, p = .001), indicating an enhancement in the longitudinal arch of the foot. However, between-group comparisons of changes in the Alpha angle and KY index did not reach statistical significance. Conclusion: A short exercise program consisting of five targeted exercises using an elastic resistance band and a small massage ball, performed daily, may reduce the hallux valgus angle and improve parameters related to flatfoot, which is often associated with this deformity.

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INTRODUCTION

Hallux valgus (HV), commonly known as a bunion, is one of the most prevalent and progressive forefoot deformities. It is characterized by a lateral deviation of the hallux at the metatarsophalangeal joint, accompanied by medial deviation of the first metatarsal bone, and is diagnosed when the hallux valgus angle exceeds 15 degrees (Mortka & Lisiński, 2015). The bunion, or medial projection created by the lateral displacement and pronation of the hallux, represents only one component of this three-dimensional deformity. Hallux valgus can cause significant discomfort and alter joint kinematics (Khan & Patil, 2024).

Hallux valgus is relatively common. A systematic review by Nix et al. (2010) reported that the deformity affects approximately 23% of adults aged 18–65 years, 36% of adults over 65 years, and around 30% of adult females. Although the precise etiology remains unclear, hallux valgus is now recognized as a multifactorial condition. Predisposing intrinsic and extrinsic factors include the use of high-heeled or narrow shoes, excessive weight-bearing, genetic predisposition, age, sex, abnormal metatarsal morphology, forefoot varus or pes planovalgus (either flexible or rigid), gastrocnemius equinus, abnormal foot mechanics, ligamentous laxity, and joint hypermobility (Kuhn & Alvi, 2023; Mortka & Lisiński, 2015).

The severity of hallux valgus varies from mild, asymptomatic deviations to significant deformities. Commonly reported symptoms include pain in the hallux area, metatarsalgia, skin irritation, overloading of soft tissues in the foot, increased calf muscle tension, and pain extending to the knee, hip, or spine (Żłobiński et al., 2021). Subluxation of the first metatarsophalangeal joint and the formation of an osseous prominence often lead to altered plantar loading, impaired gait patterns, reduced balance, a higher risk of falls, and decreased health-related quality of life (Menz et al., 2023; Nix et al., 2013; Shima et al., 2021; Sacli et al., 2023; Rosemberg et al., 2023; Castellani et al., 2025).

Treatment for hallux valgus includes both surgical and non-surgical interventions. Although many cases ultimately require surgery, non-surgical approaches remain of significant clinical interest. The primary aim of conservative management is to relieve symptoms rather than correct the underlying structural deformity. Common non-surgical interventions include the use of analgesics and non-steroidal anti-inflammatory drugs (NSAIDs), shoe modifications, orthotic devices, manual therapy, kinesiotaping, and therapeutic exercises (Menz et al., 2023; Hurn et al., 2016, 2022). In clinical practice, these interventions are frequently combined in a multifaceted approach (Hurn et al., 2016; Hurn et al., 2022; Abdalbary, 2018; Bayar et al., 2011; Żłobiński et al., 2021; Jankowicz-Szymańska et al., 2025).

This study aims to evaluate the effect of a specific kinesitherapy exercise program on the static characteristics of the foot in individuals diagnosed with hallux valgus.

METHODOLOGY

A total of 38 participants diagnosed with hallux valgus (HV) were initially recruited for the study. Of these, 32 participants (30 women and 2 men; mean age, 43.1 ± 13.9 years) completed the follow-up assessment after participating in a 30-day kinesitherapeutic program developed specifically for this study. Participants were divided into two groups. The experimental group comprised 20 participants (18 women and 2 men; mean age = 43.1 ± 13.9 years old) who performed daily exercises for 30 consecutive days.

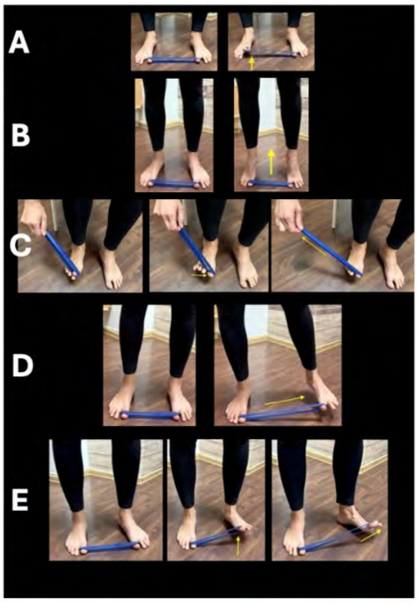

Figure 1. *Sequence of elastic band exercises for correction of hallux valgus: (A) Lifting of the hallux from the corrected position; (B) Rising on toes; (C) Dynamic isometric abduction; (D) Lateral "kick" movement; (E) Heel pivot with elastic band. Yellow arrows indicate movement direction.*

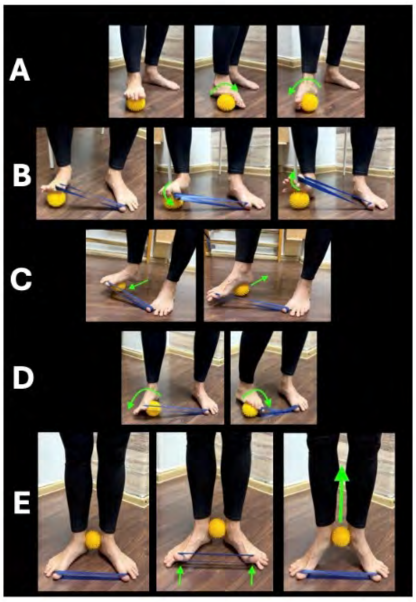

Figure 2. *Proprioceptive and massage ball exercises for correction of hallux valgus: (A) Rolling of the transverse arch; (B) Flexion–extension of the hallux; (C) Rolling of the longitudinal arch with elastic band correction; (D) Transverse arch rolling with elastic band correction; (E) Combined hallux lift and heel raise with a massage ball. Green arrows indicate movement direction.*

Two kinesitherapeutic exercise protocols were developed and applied to the experimental group, while the control group received no intervention.

1. *Elastic resistance program:* This program used a blue TheraBand loop (20.5 cm in length and 7.5 cm in width). For better attachment to the hallux, one-third of the band's width (≈ 2.5 cm) was used, corresponding to an approximate resistance of 0.85 kg at 100% elongation, as specified by the manufacturer. Exercises targeted both intrinsic and extrinsic foot muscles—particularly the abductor hallucis—to facilitate hallux correction during active movement (see Figure 1).
2. *Massage ball and proprioceptive program:* This program involved a small massage ball (8 cm in diameter) and the same blue TheraBand loop to maintain hallux correction during performance. Exercises consisted of controlled rolling of the ball from a corrected hallux position to provide proprioceptive stimulation aimed at enhancing the longitudinal and transverse arches of the foot (see Figure 2).
3. Each program comprised five exercises, performed in one set of ten repetitions. The programs alternated daily, with one protocol completed per day.

The control group consisted of 12 participants (all women; mean age, 43.0 ± 12.5 years), who received no intervention and continued their usual daily routines. Both feet of each participant were examined, resulting in 40 feet in the experimental group and 24 feet in the control group for statistical analysis. All participants provided written informed consent prior to inclusion in the study. All procedures adhered to the ethical principles of the Declaration of Helsinki (2013).

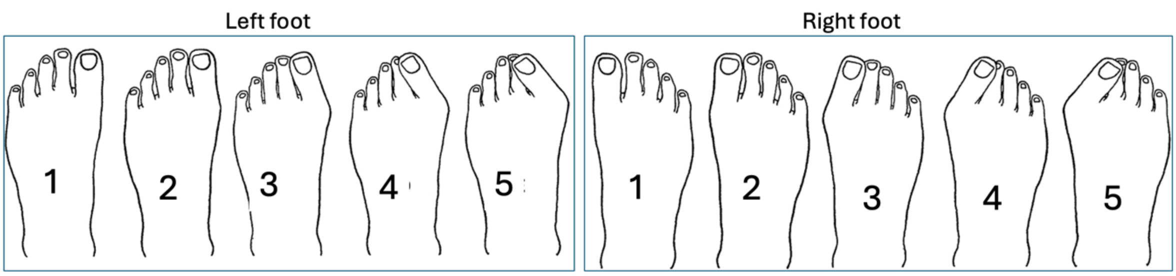

Figure 3. *Visual deformity score*

Assessment instruments included the Podoscope MultiREHA for static analysis and the DIERS Postura system for dynamic gait assessment. The parameters evaluated pre- and post-intervention included. Visual deformity score – a qualitative assessment of the degree of hallux valgus deformity based on visual inspection of the forefoot alignment. Reference values: Score 1 (no deformity) to Score 5 (severe deformity) (Figure 3). Foot length (mm) and foot width (mm) – linear anthropometric measurements used to detect potential dimensional changes of the foot after the exercise program. The *Alpha angle* (°) is between the medial tangent of the foot and the tangent from the point at the widest point of the forefoot to the edge of the big toe. The normal value is 0° to 9°. The *Beta angle* (°) is between the tangent line to the outer edge of the foot and the tangent from the point at the widest point of the forefoot to the edge of the fifth toe. The normal value is 0° to 9°. The *Gamma angle* (°) is between the straight tangents to the medial and lateral edges. The normal value for the Gamma heel angle is 15° - 18°. KY index – It defines the ratio of the length of the section running in the middle of the arch of the longitudinal arch (through the shaded part of the trace). Reference values: normal ≈ 0.25–0.45; values > 0.45 indicate flattening. Wejsflog index – calculated as the ratio of foot length to width, reflecting the proportional structure of the foot's arches. Reference values: 2.55–3.0 = normal; < 2.5 = flat foot tendency; > 3.0 = high arch. Quantitative variables were expressed as means ± standard deviations, while categorical variables were summarized as absolute and relative frequencies.

Within-group changes from baseline to post-intervention were assessed using the Wilcoxon signed-rank test. Between-group comparisons of change scores were performed using the Mann–Whitney *U* test, due to the non-parametric distribution of the data and unequal group sizes. Changes in the visual distortion assessment (an ordinal categorical variable) were analyzed using a shift table. Statistical significance was determined with Fisher's exact test and Pearson's chi-square test. A p-value $< .05$ was considered statistically significant.

RESULTS

A total of 32 participants completed the study. They were randomly assigned to two groups. The experimental group consisted of 20 participants (18 women and 2 men) with a mean age of 43.2 ± 14.8 years and a Body Mass Index (BMI) of 22.5 ± 4.0. Both feet were evaluated, resulting in a total of 40 analyzed feet. The control group included 12 participants, all female, with a mean age of 43.0 ± 12.5 years and a BMI of 22.8 ± 4.8, totaling 24 analyzed feet. No statistically significant differences were found between the two groups in the demographic parameters of age ($p = .583$), BMI ($p = .939$), weight ($p = .961$), and height ($p = .862$). All baseline parameters related to the hallux valgus deformity showed no statistically significant differences between groups (Table 1).

When assessing foot length, minimal changes were observed in both groups. In the control group, foot length increased by 1.25 ± 5.11 mm, while in the experimental group, the increase was 0.85 ± 3.56 mm. These differences were not statistically significant either within or between groups. The measurement method used in this study assessed foot length from the heel to the tip of the hallux, where even small positional variations could influence measurement outcomes. Foot width, a key parameter in hallux valgus, showed a slight reduction—an indicator of improvement—in both groups. In the control group, the reduction was 0.21 ± 3.50 mm (from 100.00 ± 8.16 mm to 99.79 ± 7.26 mm, $p = 1.000$), while in the experimental group, the decrease was 0.50 ± 8.99 mm (from 98.88 ± 5.39 mm to 98.38 ± 11.36 mm, p = 0.206). These changes were not statistically significant within or between groups. Regarding the KY index, which reflects the degree of flatfoot often associated with hallux valgus, a minimal change of 0.01 was observed in the control group (from 0.40 ± 0.06 to 0.39 ± 0.07, $p = .109$), which was not statistically significant. In contrast, a greater and statistically significant improvement was found in the experimental group, with a reduction of 0.03 ± 0.04 (from 0.39 ± 0.06 to 0.36 ± 0.07, $p = .001$). However, between-group comparison of KY index changes did not reach statistical significance ($p = .385$). In the Alpha angle, a greater improvement was observed in the experimental group, with a decrease of 1.6° (from 13.20 ± 7.76° to 11.60 ± 7.87°, $p = .024$), compared to a minor change of 0.13 ± 4.48° in the control group (from 12.28 ± 7.91° to 12.15 ± 7.96°, $p = .964$). Nevertheless, between-group differences were not statistically significant. Changes in the Beta angle were minimal in both groups and not statistically significant either within or between groups ($p = .618$). In the control group, the difference was 0.54 ± 4.11° (from 14.68 ± 5.73° to 15.21 ± 5.45°, p = 0.617), while in the experimental group, the change was 0.90 ± 3.18° (from 14.41 ± 4.86° to 15.31 ± 5.01°, $p = .134$).

Table 1. *Descriptive Characteristics of Participants*

Variable	Experimental Group (n = 20, 40 feet)	Control Group (n = 12, 24 feet)	Test (U)	p-value
Sex (n, %)	**18 female (90%), 2 male (10%)**	**12 female (100%), 0 male (0%)**	—	—
Age (years)	43.2 ± 14.8	43.0 ± 12.5	440.0	.583
Height (cm)	166.2 ± 7.9	166.3 ± 8.4	450.0	.682
Weight (kg)	62.0 ± 11.5	63.1 ± 15.1	476.0	.961
BMI (kg/m²)	22.5 ± 4.0	22.8 ± 4.8	486.0	.939
Score	1.63 ± 0.67	1.88 ± 0.61	583.5	.113
Foot length (mm)	247.2 ± 11.8	249.7 ± 12.6	504.5	.739
Foot width (mm)	98.9 ± 5.4	100.0 ± 8.2	524.0	.545
Alpha angle (°)	13.2 ± 7.8	12.3 ± 7.9	442.0	.603
Beta angle (°)	14.41 ± 4.86	14.68 ± 5.73	497.0	.819
Gamma angle (°)	15.06 ± 1.90	14.95 ± 2.23	400.0	.270
KY index	0.39 ± 0.06	0.40 ± 0.06	502.5	.760
Wejsflog index	2.50 ± 0.12	2.51 ± 0.14	506.5	.718

Notes. Values are presented as mean ± standard deviation (SD) unless otherwise specified. Mann–Whitney U test was used for between-group comparisons at baseline. No significant differences were observed between the experimental and control groups for any variable (p > .05).

Table 2. *Comparison of parameter change*

Parameter	Group	Initial *Mean ± SD*	Final *Mean ± SD*	Within-group p	Δ *Mean ± SD*	Between-group p
Length (mm)	Control	249.67 ± 12.56	250.92 ± 13.42	.172	−1.25 ± 5.11	.447
	Experimental	247.18 ± 11.76	248.03 ± 11.24	.169	−0.85 ± 3.56	
Width (mm)	Control	100.00 ± 8.16	99.79 ± 7.26	1.000	0.21 ± 3.50	.527
	Experimental	98.88 ± 5.39	98.38 ± 11.36	.206	0.50 ± 8.99	
KY index	Control	0.40 ± 0.06	0.39 ± 0.07	.109	0.01 ± 0.04	.385
	Experimental	0.39 ± 0.06	0.36 ± 0.07	< .001**	0.03 ± 0.04	
Alpha angle (°)	Control	12.28 ± 7.91	12.15 ± 7.96	.964	0.13 ± 4.48	.430
	Experimental	13.20 ± 7.76	11.60 ± 7.87	.024*	1.60 ± 2.64	
Beta angle (°)	Control	14.68 ± 5.73	15.21 ± 5.45	.617	−0.54 ± 4.11	.618
	Experimental	14.41 ± 4.86	15.31 ± 5.01	.134	−0.90 ± 3.18	
Gamma angle (°)	Control	14.95 ± 2.23	15.11 ± 2.57	.842	−0.16 ± 1.44	.593
	Experimental	15.06 ± 1.90	15.78 ± 2.43	.016*	−0.73 ± 1.68	
Wejsflog index	Control	2.51 ± 0.14	2.61 ± 0.40	.178	−0.10 ± 0.42	.235
	Experimental	2.50 ± 0.12	2.51 ± 0.14	.532	0.01 ± 0.06	
Score	Control	1.88 ± 0.61	1.83 ± 0.64	.766	0.04 ± 0.46	.704
	Experimental	1.63 ± 0.67	1.63 ± 0.63	1.000	0.00 ± 0.39	

Notes. Within-group p: Wilcoxon signed-rank test. Between-group p: Mann–Whitney U test on change (Δ = Initial - Final). p < .05 → statistically significant (*).p < .01 → highly significant (**)

For the Gamma angle, an increase was observed in the experimental group by 0.73 ± 1.68° (from 15.06 ± 1.90° to 15.78 ± 2.43°, p = .016), which was statistically significant, while the control group showed a smaller, non-significant increase of 0.16 ± 1.44° (from 14.95 ± 2.23° to 15.11 ± 2.57°, p = .842). Both groups remained within the normal reference range for the Gamma angle (15°–18°), and the between-group difference was not statistically significant (p = .593). The Wejsflog index in both groups was at the borderline between normal and flatfoot values. A slight deterioration was observed in the control group (−0.10 ± 0.42, from 2.51 ± 0.14 to 2.61 ± 0.40, p = .178), while the experimental group demonstrated a minimal and statistically non-significant change (0.01 ± 0.06, from 2.50 ± 0.12 to 2.50 ± 0.14, p = .532). The visual deformity score, evaluated by a physiotherapist, showed no major deviations or statistically significant changes within or between groups (p = .704). All results are presented in Table 2.

DISCUSSION

The literature review of non-surgical treatments for hallux valgus reveals a wide range of interventions, with many studies employing multifaceted therapeutic approaches. Despite numerous investigations, the overall level of certainty regarding the effectiveness of these methods remains low, and long-term outcomes are generally lacking. Several studies have examined the effects of exercise in patients with hallux valgus; however, methodological variability, differences in intervention combinations, and non-standardized outcome measures make it difficult to compare therapeutic effectiveness across studies.

The performance of a corrective exercise program using an elastic band and training focused on the m. abductor hallucis, combined with positioning the hallux in a corrected alignment that allows the flexor and extensor muscles to function without worsening the deformity, can contribute to a reduction in the hallux valgus angle. The observed improvement in the Alpha angle in our study is consistent with the findings of Oztarsu et al. (2023), who reported a decrease in the adduction angle measured with a goniometer in both exercise groups. It is important to note that participants supervised by a physiotherapist demonstrated greater improvement than those performing the exercises independently at home. Additionally, the exercise duration in their study was eight weeks, compared to 30 days in our protocol, which may have been insufficient to achieve optimal correction (Oztarsu & Oksuz, 2023). An exercise-based approach also demonstrated positive outcomes in comparison with other non-surgical methods, as shown in the study by Külünkoğlu et al. (2021), which compared three treatment strategies: electrotherapy, night splinting (worn for 8 hours daily), and exercise performed three to four times per day over a 30-day period. Radiographic evaluation confirmed improvement in the measured angles, whereas in our study, angular parameters were assessed clinically using a semi-automated Podoscope MultiREHA system. The best results in Külünkoğlu's study were achieved in the splint group (Külünkoğlu et al., 2021). In contrast, our program consisted of a single five-minute session per day, with two alternating protocols designed to increase participant engagement. While the shorter duration and frequency may represent a limitation, this schedule is practical and easily integrated into daily routines. Despite the minimal exercise volume, we observed a positive effect on the hallux valgus angle. The combination of kinesitherapeutic exercises and splint use was also investigated by Abdalbary (2018), who implemented a three-month therapeutic plan that reduced the radiographically measured hallux valgus angle by approximately 9°, with improvement maintained over one year. The study also reported enhanced hallux abduction strength, although a partial decrease was noted after one year of follow-up. The relatively short 30-day period in our study may limit the magnitude of angular correction, which we acknowledge as a methodological limitation.

Jankowicz-Szymańska et al. (2025) investigated the effects of exercise combined with kinesiotaping or mechanical correction over a 12-week period. Participants were divided into five groups: Group E performed exercises twice weekly under the supervision of a physiotherapist and independently on the remaining days. Group EKT combined exercises with kinesiotaping every four days. Group EMC performed exercises, along with nightly mechanical correction using an orthotic device, to maintain hallux abduction. Two control groups were also included: one with hallux valgus (CHV) and one without deformity, both without intervention. They found improvement in the Alpha angle across all exercise groups, with an average reduction of 2–3°, compared to our study's 1.6° improvement using a home-based program. The Wejsflog index in their participants was slightly lower than in our sample but improved after the program to near-normal levels, similar to the borderline values seen in our participants (Jankowicz-Szymańska et al., 2025). Bayar et al. (2011) investigated the hallux valgus angle using a toe goniometer in two groups of women: one performing exercises alone and the other combining exercises with rigid taping for eight weeks. Both groups showed significant within-group improvement in the HV angle, although between-group differences were not significant. Their protocol included two daily sessions, each lasting several minutes. Similar to our findings, the group that performed daily exercises achieved modest but measurable improvements, demonstrating that short, specific kinesitherapeutic programs can effectively correct mild to moderate flexible deformities when performed consistently (Bayar et al., 2011).

CONCLUSION

A short exercise program consisting of five exercises using an elastic resistance band and a small massage ball, performed daily, may reduce the hallux valgus angle and improve parameters associated with flatfoot, which often accompanies this deformity. This approach can be considered a suitable conservative treatment option for achieving minimal correction in mild to moderate cases of hallux valgus.

Limitations of the study

The study has several limitations. The sample size was relatively small. The intervention period was short (30 days). Long-term follow-up was not conducted. Exercise adherence and compliance were not objectively monitored or verified.

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