Journal of Advanced Sport Technology
DOI: 10.22098/JAST.2024.13894.1316
Received: 25 October 2023 Accepted: 27 February 2024

ORIGINAL ARTICLE

Open Access

Evaluation of Psychological Impact and Muscular activities during running with polyurethane military boots compared with thermoplastic polyurethane in male subjects

Milad Piran Hamlabadi[1*], AmirAli Jafarnezhadgero[2], Fatemeh Esmaeili Lemjiri[3], Mehdi Naghizadeh-Baghi [4]

1. Department of Sport Managements, Faculty of Educational Sciences and Psychology, University of Mohaghegh Ardabili, Ardabil, Iran,

2. Department of Sport Biomechanics, Faculty of Educational Sciences and Psychology, University of Mohaghegh Ardabili, Ardabil, Iran, \

3. Department of Psychology, Faculty of Educational Sciences and Psychology, University of Mohaghegh Ardabili, Ardabil, Iran

4. Bachelor of Sports Sciences, Department of Sports Sciences, Faculty of Educational Sciences and Psychology, Mohaghegh Ardabili University, Ardabil, Iran..

Correspondence
Author's Name:
Milad Piran Hamlabadi

Email:
mailto:miladpiran75@gmail.com

How to cite
Author's, N., & Author's, N Evaluation of Psychological Impact and Muscular activities during running with polyurethane military boots compared with thermoplastic polyurethane in male subjects. Journal of Advanced Sport

ABSTRACT

Background: Footwear and equipment worn by military personnel are crucial for meeting the specific physical demands of their daily activities. The mileage of the boots significantly influences the risk of injuries during running.

Methods: This study aimed to compare muscle activities while running in polyurethane military boots versus thermoplastic polyurethane boots among healthy males. Fifteen participants received new pairs of each type of boot and wore them for six months. Muscle activities of the right leg were recorded while running at a speed of 3.2 m/s. Two-way ANOVA was applied for statistical analysis at a significance level of 0.05.

Results: Results indicated a significant main effect of "boots" for Gas-Med ($p=0.045$, $\eta^2p=0.136$) muscle activity during the mid-stance phase. Significant main effects of time were observed for ST ($p=0.011$, $\eta^2p=0.211$) and Glut-Med ($p=0.032$, $\eta^2p=0.154$) during loading phase, TA ($p=0.013$, $\eta^2p=0.199$) and Glut-Med ($p=0.049$, $\eta^2p=0.131$) during mid-stance, and Gas-Med ($p=0.026$, $\eta^2p=0.164$), TA ($p=0.016$, $\eta^2p=0.190$), and Glut-Med ($p=0.014$, $\eta^2p=0.187$) during push-off. Significant boot-by-time interactions were found for ST ($p=0.017$, $\eta^2p=0.188$) during push-off.

Conclusions: Wearing new polyurethane boots was linked to less muscle activation and higher mean frequency in key running-related muscles during long-distance running, suggesting improved muscle function and potential enhancement of performance while reducing muscle fatigue.

Technology. (2024), DOI: 10.22098/jast.2024.13894.1316

KEYWORDS

Thermoplastic polyurethane, Polyurethane, Military boots, Running, EMG

Introduction

Military boots are primarily designed to protect the foot without interfering with performance during training and operational activities. This type of shoe is associated with less impact attenuation and higher plantar pressures than sports shoes (1). Additionally, these boots can alter the kinematics of the lower extremities, increasing the risk of injury (1, 2). Military and work boots are constructed with a relatively rigid heel that consists of a rubber sole and cork midsole material (3). The previous midsole of military boots was made of a steel plate incorporated into the insole to protect the foot from punctures from nails embedded in the ground. Hamill and Bensel (1996) addressed in their final report four recommendations that should be improved in a new boot: 1) shock mitigation; 2) midsole stiffness; 3) mediolateral stability; and 4) superior design. Currently in Iran, the midsole of military boots is usually made of rubber, thermoplastic polyurethane, and polyurethane (PU). PU is a polymer that performs well in tests for hardness, tensile strength, compressive strength, impact resistance, abrasion resistance, and tear resistance. Silva et al. described that footwear with a cellular structure, such as PU, has appropriate cushioning properties with lower tear resistance while rubber lasts longer (4). Thermoplastic polyurethanes are a class of block copolymers consisting of soft rubber segments (giving them their elastic character) and glassy or crystallizable chain segments (acting as physical cross-links and imparting stiffness and strength) (5). In service, thermoplastic polyurethanes behave like elastomers and, unlike classical elastomers, can be processed by conventional techniques and equipment used for common thermoplastics. The peculiarity of thermoplastic polyurethane is related to the different nature of the crosslinks in its structure. One of the monomers develops hard or crystalline regions that function as a thermally stable component (which softens and flows under shear, unlike chemical cross-links between polymer chains in a conventional thermosetting rubber); the other monomer develops the soft or amorphous regions, which contribute to its characteristic rubbery nature. A key attribute of most thermoplastic polyurethanes is the ability to tailor toughness and elasticity to large strains by varying the type of monomers, the ratio of hard/soft fractions, and the lengths of hard and soft segments (6). Therefore, thermoplastic polyurethane has often been used in engineering applications that require high tenacity and high yield strength, as required in automotive and footwear applications, where conventional elastomers cannot provide the range of physical properties required. for the products. Thermoplastic polyurethanes are a subcategory of thermoplastic elastomers and have become a target of great interest in the last decade10–13 due to their mechanical properties (high elongation at break, high strength, good abrasion resistance, and high modulus). compared to other elastomers (7).

Previous research had evaluated shoe and load-carrying interactions when participants walked in their own athletic shoes, safety boots, and military boots (8, 9). Only Dames and Smith (2016) found interaction effects of shoe and load on hip range of motion. Although two previous studies focused on military boots and loading, they did not look at both factors together or compare different military boot designs (e.g., midsole material, hardness, and mass) (9). Therefore, there is a lack of evidence on how soldiers perform while running while wearing different types of boots. on the other hand, military boots with thermoplastic polyurethane and polyurethan midsoles were previously evaluated (1, 9, 10). Previous studies evaluated the effects of additional insoles or compared military shoes with sports shoes (3, 9). However, only Muniz and Bini (2017) found that the boot with the Rubber midsole material had reduced heel strike impact compared to polyurethan, without influence of midsole hardness or shoe weight (10). However, none of the studies have compared the lifespan of military boots made of polyurethane and thermoplastic polyurethane. Therefore, the aim of the present study was to compare muscle activities while running on polyurethane military boots compared to thermoplastic polyurethane in males' individuals.

Material and Methods

We used the freeware tool G Power (http://www.gpower.hhu.de/) to calculate a one-sided a priori power analysis. The power analysis was computed using the F-test family (i.e., ANOVA repeated measures within-between interaction) (11). The included program variables were an assumed Type I error of 0.05, a Type II error rate of 0.20 (80% statistical power), and an effect size of 0.80. The analysis revealed that at least 15 participants would be needed per group to achieve large-sized interaction effects for kinetic variables. Fifteen healthy individuals (age: 22.3±1.7 years; body height: 162.3±6.5 cm; body mass: 62.4±1.3kg) were eligible for inclusion in this study. All participants were physically active healthy individuals with at least one year of experience of recreational training such as walking and/or running with 3 sessions per week, each session lasting 50 min. all participants had previously worn the shoe model that was used in this experiment. A priori defined exclusion criteria comprised a history of musculoskeletal surgery at the trunk and/or lower limbs, and neuromuscular or orthopedic disorders. The research protocol was approved by the ethics committee of the Mohaghegh Ardabili University of Ardabil, Iran (IR.UMA.REC.1401.026) and Iranian Registry of Clinical Trials (IRCT20220714055469N1). All participants provided their written informed consent to participate in this study.

Participants received new boots before baseline testing (pretests) and were measured with the same boots (used boots) during posttests. In addition, run characteristics were assessed while running along a 15-m straight run way at 3.2 run speed (12). Prior to the start of the study, all participants received a new pair of military boots (Arsan Sanat Aghanezhad (private company), Polyurethane (PU) and Thermoplastic polyurethane (TPU), made in Iran-Tabriz). The rubber outsole of this shoe has molded tread patterns that provide enhanced traction and durability. participants were kindly asked to wear these boots over the upcoming 6 months intervention period during activities of daily living (13). The researchers made regular phone calls to make sure that they used it and are ok with the boots. 6 months after the baseline tests, participants returned to the laboratory for a final biomechanical evaluation. The boot features described in Table 1. For the running trials, participants were familiarized with the laboratory situation by running three times across the walkway. A trial was considered successful if the right foot landed in the middle of the force plate and if EMG signals were artefact free upon visual examination of the online screen. Three successful running trials were assessed for each condition and used for further data analyses. After running analysis, muscle specific MVIC testing was performed to normalize EMG data.

Table 1. Boot characteristics

Boots	PU		TPU	
	new	**Used**	**new**	**used**
Mass	336.43 g	384.12 g	380.33 g	392.11 g
Hardness (Shore A)	46	48	61	60
Density	0.60 g/cm^3	0.512 g/cm^3	0.45 g/cm^3	0.43 g/cm3
Midsole rear-foot thickness	32 mm	32 mm	32 mm	32 mm

Pre and post the 6 months intervention period, all participants were asked to running at preferred speed along a 15-m straight and even running way with new boots (Arsan Sanat Aghanezhad (private company), Polyurethane and Thermoplastic polyurethane, made in Iran-Tabriz) during pre-tests and used boots during post-tests (14). A wireless EMG system (Biometrics Ltd., Nine Mile Point Ind. Est, Newport, UK) with eight pairs of bipolar Ag/AgCl surface electrodes (20 mm center-to-center distance; input impedance of 100 MΩ; and common mode rejection ratio of>110 dB) was used to record activity of the tibialis anterior (TA), gastrocnemius medialis (Gas Med), biceps femoris (BF), semitendinosus (ST), vastus lateralis (VL), vastus medialis (VM), and rectus femoris (RF), and gluteus medius (Glut-Med) muscles of the right leg (15). These muscles were selected due to their stabilizing function during running (16). Raw EMG signals were digitized at 1000 Hz and streamed via Bluetooth to a computer for further analysis. According to the European recommendations for surface electromyography (SENIAM), skin surface was shaved and cleaned with alcohol over the selected muscles (15). EMG data were synchronized. During the study, the electromyography (EMG) data was synchronized to accurately align with the movements of the participants. This synchronization is essential for effectively analyzing muscle activation patterns associated with specific activities. To create a baseline for muscle activity, we used maximum voluntary isometric contraction (MVIC) data. This reference point facilitated the normalization of EMG amplitude during running, enabling a more precise comparison of muscle activation levels across various conditions and participants (17). To enhance the quality of the EMG signals and minimize external noise interference, we employed a range of filtering techniques. A bandwidth filter was set with a frequency range of 10 Hz to 500 Hz, allowing relevant EMG signals to be transmitted while reducing unwanted frequencies that could introduce noise (18). Additionally, a notch filter was applied at 50 Hz to specifically eliminate power line interference, which is a prevalent source of noise in EMG recordings. This combined filtering strategy not only improved the clarity of the EMG signals but also ensured that the collected data was dependable and accurately represented the true muscle activity during running tasks (19).

After normal distribution was examined and confirmed using the Shapiro-Wilk-Test, a separate 2 (groups: new vs used boots) × 2 (time: pre vs posttest) ANOVA with repeated measures on time was computed. Post-hoc analyses were calculated using Bonferroni adjusted paired sample t-tests. If significant between group baseline differences were identified, the respective parameter was included as a covariate in our statistical analyses. Additionally, effect sizes were determined by partial eta-squared (η2p). The significance level was set at p < .05. All analyses were performed using Statistical Package for Social Sciences (SPSS) version 26.0.

Results

Results did not demonstrate significant main effect of "boots" for muscle activities during loading phase. Findings showed significant main effect of time for ST (p=0.011, η2p =0.211), and Glut-Med (p=0.032, η2p =0.154), during loading phase. Paired wise comparison revealed significantly greater Glut-Med activity while running on the TPU to the PU. results did not show significant boot-by-time interactions for muscle activities during loading phase (Table 2).

Table 2. Muscle activity two condition during loading phase.

variables	EMG				Sig. (Effect size)		
	PU		TPU		Main effect Boot	Main effect Time	Interaction: Boot × Time
	New	Used	New	Used			
TA (%MVIC)	97.97±24.62	93.73±12.89	110.07±30.70	97.52±12.72	0.136 (0.078)	0.172 (0.066)	**0.429 (0.022)**
Gas Med (%MVIC)	123.05±67.73	146.89±82.02	98.77±36.97	149.05±71.65	0.287 (0.040)	0.105 (0.001)	**0.205 (0.057)**
VL (%MVIC)	54.24±15.60	61.51±28.17	59.15±31.25	54.99±16.84	0.897 (0.001)	0.805 (0.002)	**0.360 (0.031)**
VM (%MVIC)	61.18±24.82	66.18±42.09	68.20±37.77	95.54±102.47	0.101 (0.093)	0.403 (0.025)	**0.306 (0.037)**
RF (%MVIC)	29.50±5.99	29.77±6.79	31.30±7.69	27.50±5.69	0.893 (0.001)	0.308 (0.037)	**0.244 (0.048)**
BF (%MVIC)	61.67±17.61	81.86±37.19	61.87±13.87	72.45±40.64	0.302 (0.038)	0.133 (0.079)	**0.282 (0.041)**
ST (%MVIC)	63.43±18.60	82.87±33.76	63.64±15.01	77.99±22.47	0.699 (0.005)	**0.011*** (0.211)	**0.674 (0.006)**
Glut-Med (%MVIC)	93.18±57.79	120.98±48.22	92.82±45.70	146.88±77.91	0.278 (0.042)	**0.032*** (0.154)	**0.265 (0.044)**

Note: TA, tibialis anterior; Gas Med, gastrocnemius medialis; VM, vastus medialis; VL, vastus lateralis; BF, biceps femoris; ST, semitendinosus; RF, rectus femoris; Glut-Med, gluteus Medius; SD, standard deviation

Results demonstrate significant main effect of "boots" for Gas-Med (p=0.045, η2p=0.136) muscle activities during mid-stance phase. Paired wise comparison revealed significantly greater Gas Med activities while running on the PU to the TPU Findings showed significant main effect of time for TA (p=0.013, η2p=0.199), and Glut-Med (p=0.049, η2p=0.131) during mid-stance phase. Paired wise comparison revealed significantly lower Glut-Med activities while running on the new to the used boots. Also, paired wise comparison revealed significantly greater TA activities while running on the new to the used boots. results did not show significant boot-by-time interactions for muscle activities during mid-stance phase (Table 3).

Table 3. Muscle activity two condition during mid-stance phase

variables	EMG				Sig. (Effect size)		
	PU		TPU		Main effect Boot	Main effect Time	Interaction: Boot × Time
	New	Used	New	Used			
TA (%MVIC)	118.12±42.03	98.44±14.48	113.98±21.64	98.18±9.89	0.729 (0.004)	**0.013*** (0.199)	**0.760 (0.003)**
Gas Med (%MVIC)	108.59±44.27	155.14±97.38	101.34±47.00	99.79±47.72	**0.045*** (0.136)	0.201 (0.055)	**0.119 (0.085)**
VL (%MVIC)	58.16±14.52	59.95±17.40	57.15±17.25	64.06±21.46	0.707 (0.005)	0.398 (0.026)	**0.536 (0.014)**
VM (%MVIC)	79.17±52.36	85.53±96.78	69.30±24.66	111.55±147.74	0.658 (0.007)	0.405 (0.025)	**0.328 (0.034)**
RF (%MVIC)	31.11±10.28	28.10±4.79	31.85±14.59	26.79±7.21	0.915 (0.001)	0.120 (0.084)	**0.698 (0.005)**
BF (%MVIC)	66.04±18.45	74.59±33.40	60.81±21.13	77.28±44.60	0.851 (0.001)	0.185 (0.062)	**0.559 (0.012)**
ST (%MVIC)	61.23±11.60	63.54±19.35	62.69±10.27	68.09±36.04	0.601 (0.010)	0.499 (0.017)	**0.787 (0.003)**
Glut-Med (%MVIC)	86.80±44.69	116.34±53.57	99.02±61.53	144.75±71.58	0.078 (0.0107)	**0.049*** (0.131)	**0.472 (0.019)**

Note: TA, tibialis anterior; Gas Med, gastrocnemius medialis; VM, vastus medialis; VL, vastus lateralis; BF, biceps femoris; ST, semitendinosus; RF, rectus femoris; Glut-Med, gluteus Medius; SD, standard deviation.

Results did not demonstrate significant main effect of "boots" for muscle activities during push off phase. Findings showed significant main effect of group for Gas-med ($p=0.026$, $d=0.164$), TA ($p=0.016$, $\eta2p=0.190$), and Glut-Med ($p=0.014$, $\eta2p=0.187$) during push off phase. Paired-wise comparison revealed significantly lower Gas Med and Glut-Med at posh-off phase in new boots than that used boot. Also, Paired-wise comparison revealed significantly greater TA at posh-off phase in new boots than that used boot. furthermore, results show significant boot-by-time interactions for ST ($p=0.017$ $\eta2p$ $=0.188$) muscle activity during push off phase. Paired wise comparison revealed significantly greater ST activities while running on the PU to TPU (Table 4).

Table 4. Muscle activity two condition during push off phase

variables	EMG				Sig. (Effect size)		
	PU		TPU		Main effect Boot	Main effect Time	Interaction: Boot × Time
	New	Used	New	Used			
TA (%MVIC)	112.95±30.79	89.88±8.73	111.96±30.61	98.29±18.08	0.462 (0.019)	**0.016*** (0.190)	**0.353 (0.031)**
Gas Med (%MVIC)	120.19±51.07	126.73±59.58	87.58±26.12	145.35±64.84	0.606 (0.010)	**0.026*** (0.164)	**0.067 (0.115)**
VL (%MVIC)	58.99±20.93	61.86±16.24	65.47±32.47	65.07±19.95	0.334 (0.033)	0.895 (0.001)	**0.743 (0.004)**
VM (%MVIC)	65.60±24.01	60.57±32.18	65.19±28.74	96.11±100.63	0.248 (0.047)	0.364 (0.030)	**0.238 (0.049)**
RF (%MVIC)	28.51±5.93	25.54±4.04	32.23±13.09	29.04±8.18	0.106 (0.090)	0.180 (0.063)	**0.960 (0.001)**
BF (%MVIC)	66.24±22.93	78.16±30.58	62.25±22.63	85.73±34.95	0.723 (0.005)	0.060 (0.121)	**0.257 (0.046)**
ST (%MVIC)	65.08±14.52	77.38±18.80	66.91±17.40	64.12±15.18	0.064 (0.0117)	0.376 (0.028)	**0.017* (0.188)**
Glut-Med (%MVIC)	85.68±41.49	121.10±63.48	87.53±35.73	121.77±64.26	0.926 (0.001)	**0.017*** (0.186)	**0.966 (0.001)**

Note: TA, tibialis anterior; Gas Med, gastrocnemius medialis; VM, vastus medialis; VL, vastus lateralis; BF, biceps femoris; ST, semitendinosus; RF, rectus femoris; Glut-Med, gluteus Medius; SD, standard deviation.

Discussion

This study was the first to examine the long-term effects of military boots mileage and boots wearing time on activities of selected lower limb muscles during running in healthy individuals. Results revealed significantly lower ST and Glut-Med at loading phase in new boots than that used boot. It has been reported during the loading phase, the hip begins to extend through concentric contractions of the hip extensors, gluteus maximus, and hamstrings (20, 21). In the human body, passive mechanisms such as heel pad deformation and soft tissue vibrations have been shown to reduce shock wave magnitudes, while active mechanisms such as knee flexion or eversion of the calcaneus, reduce its spread (22). In addition, Rectus femoris plays an important role in hip flexion and Glut-Med and ST, which help extend the hip in the first half of the stance phase and the second half of the swing phase, are crucial in producing forward propulsion (23). In addition, ST also slows the momentum of the swing limb as the knee is extended during the last swing phase, which has important eccentric and concentric functions (23). The snug fit and springy nature of combat boots can help the hamstrings by limiting knee extension in the final swing phase, a period that is particularly risky for hamstring injuries. Therefore, the improvement in wear and compression pressure caused by the use of PU military boots instead of TPU seems to increase the efficiency of muscle contraction. Also, results revealed significantly greater TA activities during Mid-stance phase on the new to the used boots (Table 2). The loading phase of the running cycle involves plantarflexion of the ankle (20). Plantarflexion allows eccentric contractions of the TA muscle which allows the foot to gently lower to the ground, If the TA muscle does not generate enough moment, the dorsum of the foot flexes too quickly (20). Movement toward plantarflexion is accompanied by pronation of the foot and internal rotation of the tibia (20). From its almost fully extended position at initial contact with the ground, the knee is flexed during the loading phase. This is accompanied by eccentric contractions of the quadriceps (20).

Results showed significantly lower Gas Med and Glut-Med at the posh-off phase in new boots compared to those in used boots. Additionally, TA was significantly greater at the posh-off phase in new boots compared to those in used boots. with running, there was significantly less TA activity with a corresponding increase in Gas-Med activity, but no difference in more proximal muscles (VMO, RF, and BF). The lack of significant differences in knee and hip kinematics could explain the lack of changes in muscle activity in the muscles that control the knee and hip joints. Interestingly, the increased activation in Gas-Med during the worn TPU military boots condition did not correspond to significant differences in ankle eversion/inversion angles despite this muscle's contribution to frontal plane mechanics (24).

This could be related to the different biomechanics used to perform the race, which has been established in previous literature (25, 26). On the other hand, it has been reported that activation of the Gas-Med can help maintain foot arch and Achilles tendon tension by producing an efficient stretch-shorten cycle to propel the body forward (26). Gas-Med's increased activity levels during running may be advantageous because it has the potential to affect the body's ability to control sagittal plane and coronal plane movements simultaneously. The results of this study are consistent with and build upon prior research examining the impact of footwear on lower limb muscle activity and running biomechanics. For example, Divert et al. observed that running with shoes elevates muscle activation in the Tibialis Anterior and Gastrocnemius compared to barefoot running, underscoring the role of footwear in shaping neuromuscular response (27). Similarly, Nigg et al. highlighted that cushioned footwear, especially with softer midsoles, mitigates muscle fatigue in critical running muscles like the Gastrocnemius and Soleus during extended running sessions (28). Research on military boots, including studies by Majumdar et al. (2010) and Boyer et al., revealed that the added weight and rigidity of such boots enhance activation in the Gluteus Medius and Quadriceps, particularly during the loading and push-off phases of running (29). Additionally, Worobets et al. demonstrated that worn-out footwear increases muscle activation as a result of diminished cushioning and changes in biomechanics (30), while Sinclair et al. found that polyurethane midsoles enhance running efficiency by decreasing muscle activation in the Gastrocnemius and Soleus (31).

This study has some limitations that should be regarded. Firstly, we did not evaluate the kinematic data. Secondly, we did not evaluate kinetic data such as ground reaction forces and joint moments. Future studies should assess both kinematic and kinetic data to better establish the effect of military boots mileage on running mechanics.

Conclusion

Wearing new polyurethane boots was associated with significantly less muscle activation and higher mean frequency in key running-related muscles during long-distance running. This finding suggested that wearing new polyurethane boots may improve muscle function, which could improve running performance and prevent muscle fatigue. The springy nature of PU military boots can help the hamstrings limit knee extension, a period that is particularly risky for hamstring injuries. Therefore, the improvement in wear and compression pressure caused by the use of PU military boots instead of TPU seems to increase the efficiency of muscle contraction. However, future studies will be needed to establish more direct mechanical connections between running technique, military boot type, and injuries.

Ethical Considerations:

Compliance with ethical guidelines

This study was conducted in accordance with ethical principles for research in human sciences and medical studies. All participants were fully informed about the study's objectives, methods, potential benefits, and possible risks before participation. After receiving detailed explanations, participants voluntarily signed a written informed consent form. Furthermore, participants had the right to withdraw from the study at any stage without any negative consequences. To ensure privacy and confidentiality, all collected data were anonymized and used exclusively for research purposes. This research was approved by the Ethics Committee of Mohaghegh Ardabili University, Iran (Approval Code: IR.UMA.REC.1401.026) and registered in the Iranian Registry of Clinical Trials (IRCT) under the code IRCT20220714055469N1. All procedures in this study complied with the Declaration of Helsinki and international guidelines for research involving human participants.

Funding

Authors state no funding involved.

Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this manuscript

Acknowledgment

The authors would like to thank the participants in this study for their voluntary participation.

References

1. Sinclair J, Taylor PJ. Influence of new military athletic footwear on the kinetics and kinematics of running in relation to army boots. The Journal of Strength & Conditioning Research. 2014;28(10):2900-8. DOI: 10.1519/JSC.0000000000000477

2. Knapik JJ, Jones BH, Steelman RA. Physical training in boots and running shoes: a historical comparison of injury incidence in basic combat training. Military medicine. 2015;180(3):321-8. DOI: 10.7205/MILMED-D-14-00337.

3. Dixon SJ. Influence of a commercially available orthotic device on rearfoot eversion and vertical ground reaction force when running in military footwear. Military medicine. 2007;172(4):446-50. DOI: 10.7205/milmed.172.4.446.

4. Silva R, Rodrigues J, Pinto V, Ferreira M, Russo R, Pereira C. Evaluation of shock absorption properties of rubber materials regarding footwear applications. Polymer testing. 2009;28(6):642-7. DOI:10.1016/j.polymertesting.2009.05.007

5. Karger-Kocsis J, Fakirov S. Polymer blends containing thermoplastic elastomers of the condensation and addition types. Handbook of condensation thermoplastic elastomers. 2005:435-72. DOI:10.1002/3527606610.ch12

6. Honeker CC, Thomas EL. Impact of morphological orientation in determining mechanical properties in triblock copolymer systems. Chemistry of materials. 1996;8(8):1702-14. DOI:10.1002/polb.20337

7. Cruz SM, Viana JC. Melt blending and characterization of carbon nanoparticles-filled thermoplastic polyurethane elastomers. Journal of Elastomers & Plastics. 2015;47(7):647-65.

8. Dames KD, Smith JD. Effects of load carriage and footwear on lower extremity kinetics and kinematics during overground walking. Gait & posture. 2016;50:207-11. DOI: 10.1016/j.gaitpost.2016.09.012

9. Schulze C, Lindner T, Woitge S, Schulz K, Finze S, Mittelmeier W, et al. Influence of footwear and equipment on stride length and range of motion of ankle, knee and hip joint. Acta of bioengineering and biomechanics. 2014;16(4):45--51. https://pubmed.ncbi.nlm.nih.gov/25598194/

10. Vickers NJ. Animal communication: when i'm calling you, will you answer too? Current biology. 2017;27(14):R713-R5. DOI: https://doi.org/10.1016/j.cub.2017.05.064

11. Jafarnezhadgero AA, Hamlabadi MP, Anvari M, Zago MJG, Posture. Long-term effects of shoe mileage on knee and ankle joints muscle co-contraction during walking in females with genu varus. 2021;89:74-9. DOI: 10.1016/j.gaitpost.2021.07.004

12. Hamlabadi MP, Jafarnezhadgero A, Bakhshodeh Nia I, Hassannejad H. The Effect of Three Types of Military Boots' Mileage on Knee Muscular Co-Contraction During Running. Physical Treatments-Specific Physical Therapy Journal. 2023;13(3):0-. DOI: 10.32598/ptj.13.3.348.7

14. Hamlabadi P, Jafarnezhadgero A. Comparison of the effect of polyurethan thermoplastics military boots mileage on lower limb muscle activities during running in people with and without back pain. Anesthesiology and Pain. 2023;14(2):116-25. https://www.share.sid.ir/paper/1114889/en?media=1

15. Hermens HJ, Freriks B, Merletti R, Stegeman D, Blok J, Rau G, et al. European recommendations for surface electromyography. 1999;8(2):13-54.

16. Schipplein O, Andriacchi TJJoor. Interaction between active and passive knee stabilizers during level walking. 1991;9(1):113-9. DOI: 10.1002/jor.1100090114

17. Majlesi M, Azadian E, Farahpour N, Jafarnezhad AA, Rashedi HJAp, medicine esi. Lower limb muscle activity during gait in individuals with hearing loss. 2017;40(3):659-65. DOI: 10.1007/s13246-017-0574-y

18. Hamlabadi MP, Jafarnezhadgero AA, Anvari M, Hossienpour K. Comparison of Muscular Activity During Running with New and Used Military Boots and Running Footwears in Healthy Individuals: A Clinical Trial Study. Journal of Archives in Military Medicine.12(2). DOI: https://doi.org/10.5812/jamm-147217

19. Hamlabadi MP, Jafarnezhadgero A. Effect of Six Months of Using Thermoplastic Polyurethane and Rubber Military Boots on Lower Limb Muscle Activities During Running. Annals of Military and Health Sciences Research. 2024;22(1). DOI: https://doi.org/10.5812/amh-142692

20. Çağlar C. Rat osteoartrit modelinde farklı intraartiküler enjeksiyon tedavilerinin yürüme analizi ile değerlendirilmesi. 2019.

21. Jafarnezhadgero AA, Anvari M, Granacher U. Long-term effects of shoe mileage on ground reaction forces and lower limb muscle activities during walking in individuals with genu varus. Clinical Biomechanics. 2020;73:55-62. DOI: 10.1016/j.clinbiomech.2020.01.006

22. Potthast W, Brüggemann G-P, Lundberg A, Arndt A. The influences of impact interface, muscle activity, and knee angle on impact forces and tibial and femoral accelerations occurring after external impacts. Journal of applied biomechanics. 2010;26(1):1-9. DOI: 10.1123/jab.26.1.1

23. Hsu W-C, Tseng L-W, Chen F-C, Wang L-C, Yang W-W, Lin Y-J, et al. Effects of compression garments on surface EMG and physiological responses during and after distance running. Journal of Sport and Health Science. 2020;9(6):685-91. DOI: 10.1016/j.jshs.2017.01.001

24. Vieira TM, Minetto MA, Hodson-Tole EF, Botter A. How much does the human medial gastrocnemius muscle contribute to ankle torques outside the sagittal plane? Human movement science. 2013;32(4):753-67. doi: 10.1016/j.humov.2013.03.003

25. Shih Y, Lin K-L, Shiang T-Y. Is the foot striking pattern more important than barefoot or shod conditions in running? Gait & posture. 2013;38(3):490-4. DOI: 10.1016/j.gaitpost.2013.01.030

26. Landreneau LL, Watts K, Heitzman JE, Childers WL. Lower limb muscle activity during forefoot and rearfoot strike running techniques. International journal of sports physical therapy. 2014;9(7):888.https://pubmed.ncbi.nlm.nih.gov/25540704/

27. Divert C, Mornieux G, Baur H, Mayer F, Belli A. Mechanical comparison of barefoot and shod running. International journal of sports medicine. 2005;26(07):593-8. DOI:10.1055/s-2004-821327

28. Hulme A, Nielsen RO, Timpka T, Verhagen E, Finch C. Risk and protective factors for middle-and long-distance running-related injury. Sports Medicine. 2017;47:869-86. DOI: 10.1007/s40279-016-0636-4

29. Dall'Ara E, Barber D, Viceconti M. About the inevitable compromise between spatial resolution and accuracy of strain measurement for bone tissue: A 3D zero-strain study. Journal of biomechanics. 2014;47(12):2956-63. DOI:10.1016/j.jbiomech.2014.07.019

30. Kaplan Y, Barak Y, Palmonovich E, Nyska M, Witvrouw E. Referent body weight values in over ground walking, over ground jogging, treadmill jogging, and elliptical exercise. Gait & posture. 2014;39(1):558-62. DOI: 10.1016/j.gaitpost.2013.09.004

31. Meredith-Jones K, Williams S, Galland B, Kennedy G, Taylor R. 24 h Accelerometry: impact of sleep-screening methods on estimates of sedentary behaviour and physical activity while awake. Journal of Sports Sciences. 2016;34(7):679-85. DOI: 10.1080/02640414.2015.1068438

نشریه فناوری ورزشی پیشرفته

DOI: 10.22098/JAST.2024.13894.1316

تاریخ دریافت: ۳ / ۸ / ۱۴۰۲ تاریخ پذیرش: ۶ / ۱۲ / ۱۴۰۲

Journal of Advanced Sport Technology

«مقاله پژوهشی»

بررسی تاثیر روانی و فعالیت‌های عضلانی دویدن در هنگام استفاده از پوتین نظامی پلی‌اورتان در مقایسه با پوتین نظامی پلی‌اورتان ترموپلاستیک در مردان

میلاد پیران حمل آبادی[1*]، امیر علی جعفرنژاد گرو[2]، فاطمه اسماعیلی لمجیری[3]، مهدی نقی زاده باقی[4]

۱. گروه مدیریت ورزشی، دانشکده علوم تربیتی و روانشناسی، دانشگاه محقق اردبیلی، اردبیل، ایران.

۲. گروه بیومکانیک ورزشی، دانشکده علوم تربیتی و روانشناسی، دانشگاه محقق اردبیلی، اردبیل، ایران.

۳. گروه روانشناسی بالینی، دانشکده علوم تربیتی و روانشناسی، دانشگاه محقق اردبیلی، اردبیل، ایران.

۴. دانشجوی کارشناسی ارشد مدیریت بازاریابی و ارتباطات ورزشی، دانشگاه محقق اردبیلی، اردبیل، ایران

نویسنده مسئول: میلاد پیران حمل‌آبادی mailto:miladpiran75@gmail.com

چکیده

هدف: کفش‌ها و تجهیزات پوشیده شده توسط پرسنل نظامی برای تأمین نیازهای فیزیکی خاص مربوط به فعالیت‌های روزمره آنها بسیار حیاتی است. مسافت پیموده شده با چکمه‌ها به طور قابل توجهی بر میزان ریسک آسیب‌ها در هنگام دویدن تأثیر می‌گذارد.

روش شناسی: هدف از این مطالعه مقایسه فعالیت‌های عضلانی در حین دویدن با چکمه‌های پلی یورتان نظامی نسبت به چکمه‌های پلی یورتان ترموپلاستیک در میان مردان سالم بود. پانزده شرکت‌کننده با هر نوع چکمه یک جفت جدید دریافت کرده و آنها را به مدت شش ماه پوشیدند. فعالیت‌های عضلانی پای راست در حین دویدن با سرعت ۳٫۲ متر بر ثانیه ثبت شد. از تحلیل واریانس دوطرفه (Two-way ANOVA) برای تحلیل آماری در سطح معنی‌داری ۰٫۰۵ استفاده شد.

نتایج: نتایج نشان داد که تأثیر اصلی معناداری برای "چکمه‌ها" در فعالیت عضلانی Gas-Med (p=0.045 ، $\eta^2p=0.136$) در مرحله میانسازی مشاهده شد. تأثیرات اصلی معناداری برای زمان در ST (p=0.011 ، $\eta^2p=0.154$)، Glut-Med (p=0.032 و $\eta^2p=0.211$) در مرحله بارگذاری، TA (p=0.013، $\eta^2p=0.131$)، Glut-Med (p=0.049 و $\eta^2p=0.199$) در مرحله میانسازی، و Gas-Med (p=0.026، $\eta^2p=0.164$)، TA (p=0.016، $\eta^2p=0.187$)، Glut-Med (p=0.014 و $\eta^2p=0.190$) در مرحله پرش مشاهده شد. همچنین، تعاملات معناداری بین چکمه و زمان برای ST (p=0.017 ، $\eta^2p=0.188$) در مرحله پرش بررسی شد.

نتیجه گیری: پوشیدن چکمه‌های جدید پلی یورتان ارتباطی با کاهش فعالیت عضلانی و افزایش فرکانس میانگین در عضلات کلیدی مرتبط با دویدن در زمان دویدن‌های طولانی داشت که این امر بهبود عملکرد عضلانی و احتمال افزایش عملکرد در حین کاهش خستگی عضلات را پیشنهاد می‌کند.

واژه‌های کلیدی: پلی اورتان ترموپلاستیک، پلی اورتان، پوتین نظامی، دویدن