Journal of Advanced Sport Technology *8(1): 57-67.*

Received: January, 05, 2024 *Accepted: March, 08, 2024*

The Effect of American Academy of Sports Medicine (NASM) Exercises on Ground Reaction Forces in People with Back Pain During Running

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Abstract

The purpose of this research was to compare the effects of the American Academy of Sports Medicine (NASM) exercises on ground reaction forces in people with back pain during running. The current research was semi-experimental and applied research. Using G-Power software, the minimum sample size of 15 people was estimated for each group. The statistical population of this research was men with back pain among the students of Mohaghegh Ardabili in the age range of 20-25 years. A foot scan device (RSScan) with a sampling rate of 300 Hz was used to record plantar pressure variables. An attempt was made to run correctly on the 18-meter track to record the pressure of the soles of the feet. The effect of the group factor in the peak values of the ground reaction force during heel contact with the ground in the internal-external direction was higher in the control group compared to the experimental group (p=0.012; d=0.302). The effect of the group factor in the peak values of the ground reaction force during heel contact with the ground in the anterior-posterior direction was higher in the control group compared to the experimental group (P=0.027; d=0.243). The effect of the group factor in the peak values of the ground reaction force when lifting the foot off the ground in the vertical direction was higher in the control group compared to the experimental group (P=0.005; d=0.360). According to the obtained results, NASM exercises can improve back pain during running by affecting the ground reaction forces.

Key Words: Running, Plantar pressure, Exercise, Ground reaction force.

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INTRODUCTION

One of the most common pains in the spine is back pain [1]. The World Health Organization has reported that this complication has a prevalence of 84%, and this statistic is different in Iran, and it has been reported in children, nurses, and pregnant women at around 55% [2, 3]. The increase in back pain and disability caused by it causes difficulty in doing daily tasks and social activities, mental and emotional problems, and negative effects on the economy of the family and society [4]. Biomechanical problems can be caused by increasing the variability of the force produced by the trunk, increasing the stiffness of the trunk, reducing the kinematic variability of the lower limbs, disrupting the mechanisms of the trunk muscles, increasing the rate and speed of the center of pressure and center of mass, change in posture (tendency to front side) decreasing the speed of nerve conduction, increasing thigh and trunk movements, decreasing the isometric torque produced by the trunk and increasing its variability, and increasing the level of antagonistic co-contraction of the trunk muscles [5]. The foot is the only part of the body that comes into contact with external surfaces while walking or running, and it plays an important role in maintaining balance while running and standing [6]. The lower limb should control the tensile, scissor and rotation force well in walking and running [7]. One of the important functions of the sole is shock absorption in activities such as running, jumping, and walking [8].

Abnormal kinetics and inappropriate performance of thigh muscles are related to several injuries such as back pain injuries [9] and hip joint injuries [10]. According to the available evidence, the persistence of back pain affects the control of lumbar movement, and structural changes cause kinetic changes in patients with back pain [11]. In 2016, Farahpour et al investigated the characteristics of the ground reaction force during walking in back pain patients with foot pronation and healthy people without foot pronation. The results of this study showed that in people without back pain with foot pronation, the reaction forces the action in the internal-external direction, and the impulse and the initial peak have increased, compared to people with peritonitis without back pain, the vertical ground reaction force and the loading rate and the time to reach the peak of the driving force have increased [12]. Together, these factors are one of the significant reasons for increasing the components of the ground reaction force during running and as a result, creating and aggravating back pain [12].

Nowadays, it is very important to use therapeutic interventions to investigate the range of ground reaction forces in back pain patients during running movements due to the change of forces and pressures applied [13]. In the past, due to the high therapeutic force, many rehabilitation exercises were performed to improve and increase the performance of people suffering from back pain disease [14]. There are different exercise protocols for patients with back pain, all of which seem to be useful. Some researchers showed that general exercises can be useful for the treatment of back pain in the long term [15]. Also, other training protocols such as Mackenzie, Pilates, central stabilization exercises, and movement control were investigated in various studies [16-19]. Reducing injuries caused by running in patients with back pain has always been one of the most important goals of biomechanical research [20, 21]. One of the therapeutic interventions that is recently used to rehabilitate patients with back pain includes the exercises of the American Academy of Sports Medicine. However, due to the importance of the topic, no research has yet investigated the effect of NASM exercises on people with back pain, so in this study aimed to evaluate the effect of NASM exercises on ground reaction forces in people with back pain during running was investigated.

METHODOLOGY

The current research is a semi-experimental and clinical trial type and was approved by the Ethical Committee of Mohaghegh Ardabil University with the code (IR.UMA.REC.1402.086). This study has been registered with the Clinical Trial Code (IRCT20200912048696N2) in the Iranian Trial Center. The statistical population of this research was men with back pain among the students of Mohaghegh Ardabili in the age range of 20-25 years. The number of subjects was determined using G*Power software with an effect size of 0.7, significance level of 0.05, and statistical power of 0.8 in the two-way analysis of variance test with repeated measures of at least 15 subjects to enter the present study. Subjects' names were randomly placed in a bag and they were selected randomly and one among the groups. The subjects were divided into two groups: training and control. The inclusion criteria for the present study included male gender, age range of 20 to 25 years, and a pain index higher than 14 in the lower back based on the scientific questionnaire of Roland Morris [22]. No history of trauma, recent fracture, nerve or spinal cord injury in the lumbar spine, also no history of severe lumbar spine disorders such as disc herniation, rheumatic, inflammatory disease, peripheral nerve damage, severe mental illness, previous surgery in the lumbar region, spondylitis, neuromuscular or joint disease, systemic disease, organic and malignant diseases, pregnancy, cardio-respiratory, and metabolic disease were among the inclusion criteria. Exclusion criteria from the study included a history of fracture, neuromuscular problems, absence of back pain during the test, or heavy physical activity during the two days before the test. Due to the elimination of the physiological effects caused by heavy physical activity and fatigue on the research results, the subjects were prohibited from heavy activity two days before the test. The superior leg of all the subjects was identified with the soccer ball shot test. In addition, it was observed in all stages and the consent form was obtained from the participants to participate in the research. In addition, in all stages, research ethics were observed and consent forms were obtained from the participants to participate in the research. All cases of research implementation were by the Declaration of Helsinki.

Kinetic data were smoothed using a fourth-order Butterworth filter with a frequency cutoff of 20 Hz. The parameters that were used for further analysis included the maximum three-dimensional GRF values and the time to reach the peak of internal-external components (Fx), anterior-posterior component (Fy), and vertical component (Fz). The peak of the vertical curve of GRF (active peak Fz) was considered for further analysis. In the internal-external direction, the peak internal (Fxpo) and external (Fxhc) forces were investigated. In the anterior-posterior direction, peak posterior force (Fyhc) and peak anterior force (Fypo) were investigated. Forces were normalized with body mass and reported as a percentage of body mass [23]. The Shapiro-Wilk test was used to check the normality of the data distribution. To analyze the statistical data, a two-way analysis of variance was used. All analyses were done using SPSS 24 software.

RESULTS

Descriptive information related to the individual characteristics of the participants including their age, height and weight in both control and experimental groups is presented in Table 1. The results indicate that there was no statistically significant difference in any of the anthropometric variables between the two groups (P<0.05).

Table 1. Characteristics of subjects participating in the study

Variable	Control group	Experimental group	Sig.
age (years)	24.21 ± 1.05	24.28 ± 1.06	0.642
height (cm)	177.38 ± 4.36	177.64 ± 5.07	0.766
weight (kg)	80.92 ± 6.75	82.07 ± 12.13	0.889

*Significance level P<0.05

The findings of the present study showed that the effect of the group factor in the peak values of the ground reaction force during heel contact with the ground in the internal-external direction was greater in the control group compared to the experimental group (P=0.012; d= 0.302). The effect of the group factor in the peak values of the ground reaction force during heel contact with the ground in the anterior-posterior direction was higher in the control group compared to the experimental group (p=0.027; d=0.243). The effect of the group factor in the peak values of the ground reaction force when lifting the foot off the ground in the vertical direction was higher in the control group compared to the experimental group (P=0.005; d=0.360). The effect of the time factor in the values of the time to reach the peak when lifting the toe off the ground in the internal-external direction was greater in the post-test compared to the post-test (P=0.030; d=0.236). The effect of the group factor in the loading rate values was higher in the control group compared to the experimental group (P=0.020; d=0.267) (Table 2).

Table 2. The peak values of the forces and the time to reach the peak in both control and experimental groups while running in people with back pain (percentage of body weight)

Variable	Control group		Δ	Experimental group		Δ	Effect of time	Effect of Group	Effect of Time * Group
	Pre test	Pos test		Pre test	Pos test				
Fxhc	8.91 ± 3.15	10.30 ± 5.36	0.33	5.76 ± 1.13	6.35 ± 2.35	0.34	0.237 (0.077)	*0.012 (0.302)	0.624 (0.014)
Fxpo	-9.15 ± 1.94	-8.77 ± 1.86	0.20	-8.40 ± 2.35	-6.86 ± 2.17	0.68	0.088 (0.153)	0.101 (0.143)	0.293 (0.061)
Fyhc	-23.61 ± 5.71	-22.93 ± 7.04	0.11	-19.55 ± 5.56	-16.67 ± 3.56	0.63	0.188 (0.094)	0.027* (0.243)	0.410 (0.038)
Fypo	14.28 ± 4.02	14.22 ± 3.12	0.02	14.22 ± 2.39	13.45 ± 2.96	0.29	0.603 (0.015)	0.724 (0.007)	0.565 (0.011)

Fzhc	118.57 ± 20.53	122.64 ± 33.84	0.15	182.15 ± 20.29	77.43 ± 8.08	7.38	0.131 (0.122)	0.792 (0.004)	0.105 (0.140)
Fzpo	197.61 ± 29.07	194.08 ± 35.00	0.11	161.97 ± 23.43	156.32 ± 16.62	0.28	0.202 (0.089)	0.005 * (0.360)	0.762 (0.005)
TTP- Fxhc	33.38 ± 6.63	21.70 ± 5.48	1.93	27.14 ± 10.54	24.04 ± 6.90	0.36	0.108 (0.137)	0.339 (0.051)	0.622 (0.014)
TTP- fxpo	102.36 ± 30.89	122.90 ± 36.48	0.61	107.46 ± 17.36	119.40 ± 23.14	0.59	0.030 * (0.236)	0.940 (0.000)	0.540 (0.021)
-TTP fyhc	58.55 ± 4.61	43.39 ± 4.61	3.29	57.93 ± 4.76	49.57 ± 4.76	1.76	0.403 (0.039)	0.057 (0.187)	0.309 (0.057)
TTP- Fypo	227.95 ± 19.48	228.08 ± 18.38	0.01	222.01 ± 18.61	230.78 ± 28.05	0.38	0.471 (0.028)	0.831 (0.003)	0.484 (0.028)
TTP- Fzhc	17.88 ± 6.29	18.76 ± 2.90	0.19	21.52 ± 7.46	17.15 ± 3.09	0.83	0.316 (0.056)	0.553 (0.020)	0.138 (0.118)
TTP- Fzpo	116.26 ± 11.40	122.50 ± 19.57	0.40	122.91 ± 11.49	127.51 ± 15.68	0.34	0.138 (0.118)	0.319 (0.055)	0.817 (0.003)
LR	36.03 ± 17.63	41.09 ± 23.45	0.25	29.52 ± 15.68	17.59 ± 6.33	1.08	0.483 (0.028)	0.020 * (0.267)	0.093 (0.148)
FM Positive	-0.036 ± 0.01	0.026 ± 0.06	1.77	-0.034 ± 0.01	-0.034 ± 0.01	0.00	0.098 (0.145)	0.437 (0.034)	0.127 (0.125)
FM Negative	0.032 ± 0.01	0.034 ± 0.01	0.20	0.032 ± 0.08	0.032 ± 0.07	0.00	0.782 (0.004)	0.779 (0.004)	0.726 (0.007)
Imp Fz	269.56 ± 29.12	269.80 ± 28.38	0.01	280.64 ±51.69	267.13 ± 55.13	0.49	0.421 (0.036)	0.812 (0.003)	0.404 (0.039)

*Significance level P<0.05

DISCUSSION

The purpose of this study was to investigate the effect of exercises based on the principles of the NASM on walking kinetics in men with back pain. The findings of the present study showed that the effect of the group factor for the peak values of the ground reaction force during heel contact with the ground in the internal-external direction was greater in the control group compared to the experimental group. The effect of the group factor in the peak values of the ground reaction force during the contact of the heel with the ground in the anterior-posterior direction was greater in the control group compared to the experimental group, which shows that they had more fluctuation in walking and the possibility of injury and falling increases. The effect of the group factor in the peak values of the ground reaction force when lifting the foot from the ground in the vertical direction was higher in the control group compared to the experimental group, which indicates greater strength and speed. This study is in some way consistent with the research of Abdullah Pour et al. [24] and inconsistent with the results of Seifi et al. [25]. Abdullah Pour et al. found that the frequency content of ground reaction forces decreased after a period of elastic walking exercises in people with back pain. Research also showed that elastic walking exercises in people with back pain can have clinical value for the rehabilitation of these people [24]. In a study they conducted on young people with back pain, Seifi et al showed that the peak force on the outer part of the heel increased and the peak pressure on the fourth and fifth plantar sections decreased. The reason why the present results are inconsistent with the results of Seifi et al. can be related to the age range of the subjects and the way of performing elastic walking exercises [25]. In the current explanation, it can be stated that fascia is a collagen fiber tissue that forms a part of the body's extensive force transmission system, which, with its many deep receptors and special anatomy, plays a significant role in stabilizing the central region of the body [26]. The thoracolumbar fascia tissue has sensory nerves with small receptors that can be activated by mechanical stimulation [27]. Research has shown that in back pain patients, the fascia increases in thickness and decreases tissue mobility [28]. Studies have also shown that reducing the amount of pressure during dynamic movements in the spine requires healthy fascia. Elastic walking exercises are a method in which increasing strength and power is associated with increasing the flexibility of joints and reducing the number of injuries [27, 28].

The effect of the time factor in the values of the time to reach the peak when lifting the toe off the ground in the internal-external direction was greater in the post-test compared to the pre-test, which indicates that the exercises were effective or that fatigue had an effect. The effect of the group factor on the loading rate values was higher in the control group compared to the experimental group. Previous studies showed that people with back pain had a lower center of pressure during walking than healthy people, which could be due to compensatory mechanisms to reduce pain [29]. In addition, it has been reported that the center of pressure in people with back pain leans towards the heel when they are standing, and the reason for this action is to reduce the pressure and relieve the fatigue of the extensor muscles of the trunk [30]. In addition, patients with back pain during walking and running have internal rotation of the tibia and femur and anterior tilt of the pelvis [31]. To compensate for this situation, the trunk may be moved backward and the body weight vector moved backward [32, 33]. Weakness of proprioceptive receptors in patients with back pain causes a decrease in balance, so the patient tries to walk slowly and with short steps to avoid losing balance [34].

The current research had limitations, among which we can mention the absence of female subjects in the statistical sample. Also, in the present study, only the ground reaction forces were examined, while the activity level of the deep and superficial muscles of the pelvis and lower limbs can provide more information about the reason for these changes in the ground reaction forces in people with It can cause back pain. Also, there is a need for more studies in the field of kinematics and kinetics of the lower body during tasks such as walking in people with back pain.

CONCLUSION

According to the obtained results, NASM exercises can improve back pain during running by affecting the ground reaction forces.

Author Contributions: Hamed Sheikhalizadeh, Sara Imani Brouj has done the initial idea of reading and writing the article, and laboratory work. Neghar Ashrafi, Fatemeh Mehralian done the coding process of the data.

Funding: This research received no external funding.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data will not be available at request.

Acknowledgments: We thank all the people who helped us in conducting this research.

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تأثیر تمرینات آکادمی پزشکی ورزشی آمریکا (NASM) بر نیروهای واکنش زمینی در افراد مبتلا به کمردرد در حین دویدن

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چکیده:

هدف از این تحقیق مقایسه تأثیر تمرینات آکادمی پزشکی ورزشی آمریکا (NASM) بر نیروهای واکنش زمینی در افراد مبتلا به کمردرد در حین دویدن بود. پژوهش حاضر نیمه تجربی و کاربردی بود. با استفاده از نرم افزار G-Power حداقل حجم نمونه ۱۵ نفر برای هر گروه برآورد شد. جامعه آماری این پژوهش مردان مبتلا به کمردرد دانش‌آموزان محقق اردبیلی در محدوده سنی ۲۰ تا ۲۵ سال بودند. دستگاه اسکن پا (RSScan) با نرخ نمونه برداری ۳۰۰ هرتز برای ثبت متغیرهای فشار کف پا استفاده شد. دویدن در مسیر ۱۸ متری انجام شد تا فشار کف پا در این حین ثبت شود. تأثیر عامل گروه در مقادیر اوج نیروی عکس‌العمل زمین در هنگام تماس پاشنه پا با زمین در جهت داخلی-خارجی در گروه کنترل بیشتر از گروه آزمایش بود (p=۰/۰۱۲؛ d=۰/۳۰۲). تأثیر عامل گروه در مقادیر اوج نیروی عکس‌العمل زمین در هنگام تماس پاشنه پا با زمین در جهت قدامی-خلفی در گروه کنترل در مقایسه با گروه آزمایش بیشتر بود (P=۰/۰۲۷؛ d=۰/۲۴۳). تأثیر عامل گروه در مقادیر اوج نیروی عکس‌العمل زمین هنگام بلند کردن پا از زمین در جهت عمودی در گروه کنترل بیشتر از گروه آزمایش بود (P=۰/۰۰۵؛ d=۰/۳۶۰). با توجه به نتایج به‌دست‌آمده، تمرینات NASM می‌تواند با تأثیر بر نیروهای عکس‌العمل زمین، کمردرد را در حین دویدن بهبود بخشد.

واژگان کلیدی: دویدن، فشار کف پا، ورزش، نیروی عکس‌العمل زمین.