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# The Effect of Corrective Exercises on Lordosis and Kyphosis Angles and the Functional Ability of Elderly Men

Leyla ALIZADEHEBADI[1A], Merve UCA[2B], Gıyasettin BAYDAŞ[3C]

[1] *Sport Science, Independent Researcher, USA*
[2] *İstanbul Esenyurt University, School of Physical Education and Sports, Sports Management Department, İstanbul, TÜRKİYE*
[3] *İstanbul Altınbas University, Faculty of Medicine, Basic Medical Sciences Department, İstanbul, TÜRKİYE*
*Address Correspondence to: Merve UCA e-mail:.* merveuca@esenyurt.edu.tr



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A: Orcid ID: 0000-0001-6418-1873 B: Orcid ID: 0000-0003-3325-8828 C: Orcid ID: 0000-0002-9206-3177

**Abstract**

An important consideration in maintaining and improving the elderly's health and quality of life is preserving their independence in performing daily activities and making it possible for them to live actively and independently. The purpose of this study was to investigate the effects of NASM (National Academy of Sports Medicine) -based hybrid exercise on the functional ability, lordosis, and kyphosis angles of elderly people. Out of the population of elderly men in Istanbul, 40 participants were selected using the convenience sampling technique and were randomly divided into an experimental group that received NASM-based exercises and a control group with no treatment (each group containing 20 participants). The entry criteria were absence of any particular illness, lack of taking particular medications, and being 65-85. The experimental group performed the hybrid NASM-exercises for 8 weeks, whereas the control group did not receive a special training program. Static and dynamic forms of balance were evaluated using Romberg's test (with open and closed eyes) and the Timed Up and Go Test, respectively. Data analysis was conducted using repeated measures covariance analysis at $p<0.05$. The statistical findings showed that the scores of the experimental group in terms of static balance with open eyes and dynamic balance improved after receiving the intervention ($p<0.05$), whereas no such improvement was observed in the control group. A significant difference was observed in the participants' functional ability according to the indicators of static and dynamic balance. It seems that the NASM-based hybrid exercise program that included several posture-control factors is an effective program to improve the elderly's functional ability; thus, the program is recommended to be implemented for the rehabilitation of the elderly at home and particularly in elderly rehabilitation centers due to its effectiveness and the fact that costly equipment is not needed for them.

**Keywords:** Corrective exercises, functional ability, lordosis and kyphosis angles, static and dynamic balance.

**Düzeltici Egzersizlerin Yaşlı Erkeklerde Lordoz ve Kifoz Açıları ile Fonksiyonel Yeteneğe Etkisi**

**Özet**

Yaşlıların sağlığının ve yaşam kalitesinin korunmasında ve geliştirilmesinde önemli bir husus, onların günlük yaşam aktivitelerini yerine getirirken bağımsızlıklarını korumak, aktif ve bağımsız yaşamalarını mümkün kılmaktır. Bu çalışmanın amacı, NASM temelli hibrit egzersizin İstanbul'daki yaşlılarda fonksiyonel yetenek ile lordoz ve kifoz açıları üzerine etkilerini araştırmak. İstanbul'daki yaşlı erkek popülasyonundan kolayda örnekleme tekniği kullanılarak 40 katılımcı seçildi ve rastgele olarak NASM tabanlı egzersizler alan bir deney grubu ve herhangi bir tedavi uygulanmayan bir kontrol grubu (her grup 20 katılımcıdan oluşuyor) olarak ayrıldı. Giriş kriterleri herhangi bir hastalığın bulunmaması, belirli ilaçları almamak ve 65-85 yaş arasında olmaktı. Deney grubu 8 hafta boyunca hibrit NASM egzersizlerini gerçekleştirirken, kontrol grubunun özel bir eğitim programı yoktu. Dengenin statik ve dinamik formları sırasıyla Romberg Testi (açık ve kapalı gözlerle) ve Zamanlı Kalkma ve Yürüme Testi kullanılarak değerlendirildi. Veri analizi, $p<0,05$'te tekrarlanan ölçümler kovaryans analizi kullanılarak yapıldı. İstatistiksel bulgular, deney grubunun açık gözlerle statik denge ve dinamik denge açısından skorlarının müdahale sonrasında arttığını gösterdi ($p<0,05$), ancak kontrol grubunda böyle bir gelişme gözlenmedi. Ayrıca katılımcıların fonksiyonel yeteneklerinde statik ve dinamik denge göstergelerine göre anlamlı bir farklılık gözlendi. Çeşitli duruş kontrol faktörlerini içeren NASM tabanlı hibrit egzersiz programının, yaşlıların fonksiyonel yeteneğini geliştirmede etkili bir program olduğu görülmektedir; bu nedenle programın etkinliği ve pahalı ekipmanlara ihtiyaç duyulmaması nedeniyle yaşlıların evde rehabilitasyonunda ve özellikle yaşlı rehabilitasyon merkezlerinde uygulanması önerilmektedir.

**Anahtar Kelimeler:** Düzeltici egzersizler, fonksiyonel yetenek, lordoz ve kifoz açıları, statik ve dinamik denge.

## INTRODUCTION

An important consideration in maintaining and improving the elderly's health and quality of life is preserving their independence in performing daily activities of life and making it possible for them to live actively and independently (19). One of the best ways to evaluate the elderly's health is investigating their functional status in their daily lives to provide healthcare workers with the sufficient information to make convenient planning according to their needs (6). Convenient posture is guaranteed when the body is placed in an appropriate direction to the line of gravity (45). As the number of disorders among the elderly – particularly in developing countries – was increasing, the WHO developed the 2020 global program with the slogan "seeing is everybody's right" and obliged all governments to execute preventive and rehabilitation programs to control and minimize the issues and their consequences (34). The results indicating the significant reduction of lumbar lordosis angle, the improved timing for the static balance, and the achievement distance in the dynamic balance, perhaps the NASM exercises (America's National Academy of Sport Medicine) are effective in enhancing the coherent performance of muscles and the reduction of the lumbar lordosis angle and can be implemented by athletes to improve examinees' balance (25). Body posture, its direction to the line of gravity, and the effects that changing it has on different body organs like the respiratory system, blood circulation, and the nervous system need considerable attention. The elderly significantly use their heads, necks, and faces to transfer concepts and communicate with others and their surroundings, and this leads to skeletal-muscular malformations (1).

Human spinal column naturally has two convex and concave curves shown as letter S, though it has been frequently observed that the muscles bearing one's stature suffer from the lack of balance in terms of strength and length around the spinal column. In such situations, some muscles become atrophied and weak, while others get shortened. Thus, the balance of the spinal column curves gets disturbed, and unnatural curves like lordosis, kyphosis, and scoliosis appear in that region (47). The term "posture" refers to the way of standing or the placement of different body organs. Convenient posture helps the appropriate and natural function of internal organs, the nervous system, and the respiratory system and increases people's self-confidence, security, and attractiveness (26). As the nervous efficiency of muscles is maintained by a convenient combination of correct posture (static/dynamic) and stability strength, any failure in the direction of the body and the lumbar-pelvic-femoral belt can change various parts or even the function of certain systems and organs related to the motor system by changing the mechanical function and coupled relationships of all muscles (46). Balance is a complicated process that relies on the coordination of several sensory and motor components (29). Balance disorders can arise due to sensory-somesthetic, visual, auricular, muscular, muscular-skeletal, or cognitive problems (27). Various studies including Rogers et al. (36), Salar et al. (38), and Valizadeh et al. (50) have shown that the elderly's children perform weaker in static and dynamic balance

tasks compared to their other children. Weakness of the muscles that bear the spinal column may disturb the static and dynamic balance of one's stature, and this is typically called skeletal malformations. Various protocols have been proposed for the treatment of such malformations, but the U.S. National Academy of Sports Medicine proposed a new set of corrective exercises in 2010 that included four levels of inhibition, lengthening, activation, and integration. According to the protocol, it is better to first perform inhibition and then lengthening exercises on a muscle instead of merely lengthening a shortened or stiffened one (5). In addition, as Mahdavinejad and Badihi (25) found a significant reduction of the lumbar lordosis angle and improved balance time in terms of the static balance and enhanced achievement distance in the dynamic one, the NASM exercises are probably effective in improving the integrated function of one's muscles and recuing their lumbar lordosis angle. The exercises can be implemented by athletes to improve their balance conditions (25). As another study to investigate the effects of various exercises and intervention on the increased lumbar lordosis, Okhli et al. (30) studied the effects of the NASM corrective exercises (Pilates) on the disorder. The reported findings showed the positive and more significant effects of the NASM exercises on reducing the lumbar lordosis (30). The effects of the NASM corrective exercises on the elderly's functional abilities and lordosis and kyphosis angles have not been investigated, and few studies have focused on the nature of preventing and reducing skeletal-muscular disorders among patients with sensory disabilities. Thus, the current study aimed to investigate the effects of an 8-week intervention consisting of the NASM exercises on the elderly's functional abilities and lordosis and kyphosis angles. Body posture, its direction to the line of gravity, and the effects of changing it on various organs of the body like the respiratory system, blood circulation, and the nervous system are significant matters. Typically, ignoring structural weaknesses like inadequate functional abilities and lordosis/kyphosis angles can bring about irreversible issues in later periods of one's life (particularly during old ages), and this can disturb the natural function of the body and even reduce the length of one's life. Moreover, investigating the related literature revealed no study exactly focusing on the effects of the NASM exercises on the elderly's functional abilities and lordosis and kyphosis angles. As the old age and inappropriate lifestyles among the elderly make them prone to such malformations, it seems necessary to prevent the emergence and development of such issues in that group of society by proposing convenient solutions via performing corrective exercises. Thus, the present study aimed to investigate the effects of corrective exercises on the male elderly's functional abilities (static and dynamic balance) and lordosis and kyphosis angles.

## METHOD

### Participants and procedure

The examinees participating in the present study were the elderly people, and all interfering factors were controlled in non-absolute manner. Thus, the present study was considered a quasi-experimental one according to the specified goals and content. The examinees were selected according to the purposive sampling technique and the entry and exit criteria, and the effects of physical activities on their functional abilities and lordosis and kyphosis angles were investigated. An assumption was that performing exercises that involved muscular receptors helped the elderly and people with balance problems maintain balance. Out of the population of the male elderly in Istanbul, 40 people were selected for the sample using the convenience sampling technique. The elderly who had no particular illness, did not take any medications, and were 65-85 years old were selected for the study and were randomly divided into an experimental group that received the NASM intervention and a control group that was provided with no intervention (each group consisted of 20 members). A summary of the research design was provided for the examinees, and their preliminary screening was performed according to the entry and exit criteria. Then, the participants who were willing to cooperate received the informed written consent forms. After identifying the participants who were qualified to participate in the study, the examinees visited the relevant laboratories and gymnasiums according to a pre-specified schedule.

### Ethical approval and institutional permission

In order to conduct the research, ethical approval was received from İstanbul Esenyurt University Ethics Committee (Decision number: 2023/11-7, Meeting Date: 05.12.2023).

**Table 1.** The stages of the study

| |
|---|
| 1. Presenting the introduction letter of the provincial welfare organization to the elderly rehabilitation center |
| 2. Receiving an introduction letter from the deputy-manager and presenting it to the clinical ward of the center to gain the approval of the doctor in charge of the ward |
| 3. Receiving an introduction letter from the nursing and physiotherapy wards and presenting it to the manager of the gym to start the required procedures |
| 4. When the questionnaires were returned and the medical files were investigated by the collaboration of the experience doctors in the clinical ward of the center, the eligible people who could participate in the study according to the entry criteria were identified according to their medical and sport histories. |
| 5. The examinees were introduced to the procedures of the study, and provided written informed consent forms to participate in the intervention. |
| 6. The pretest was given before starting the intervention, and the posttest was given after it. |

**Table 2.** The entry and exit criteria of the study

| | |
|---|---|
| Entry criteria | Being 65-85 years old |
| | The lack of any cardiac disorders or high blood pressure |
| | The presence of kyphosis |
| | The presence of lordosis |
| | The lack of consuming tobacco products during the intervention |
| | Informed consent to participate in the study |
| | The lack of any surgical history in the spinal column or lower limbs, the lack of serious injuries in the spinal columns, ligament damages, or a torn meniscus over the past year |
| | The lack of any visible skeletal-muscular malformation in the lower limbs |
| | Not consuming any drugs that influence the central nervous system (e.g., tranquilizers) on the day of the test |
| Exit criteria | Participants' lack of voluntary consent |
| | The emergence of pain in part of the examinees' bodies in a way they cannot continue to cooperate |
| | The researchers' conclusion that a certain examinee does not cooperative conveniently during the intervention |
| | Cardiac problems in the examinees |
| | Being absent for more than two sessions |
| | The examinees' lack of willingness to continue |

The examinees' background information including their height, weight, age, sport histories, and the name of the sport were recorded in the data collection form after they filled the informed written consent forms on the day of the test. When the examinees' height, weight, and foot length were measured, the following procedures were performed as pretest measures of both groups: the lordosis and kyphosis angles using a flexible ruler, Romberg's test to investigate functional abilities in the static mode, and the Times Up and Go test for the dynamic mode. When the NASM exercises were performed by the experimental group, the examinees (experimental and control groups) were re-evaluated using the same procedures implemented in the pretest stage to measure the above variables.

**Instrumentation**

**Kyphosis and lordosis**

A 60cm flexible ruler was implemented to measure the examinees' kyphosis and lordosis angles. The instrument was considered a valid and non-aggressive tool compared to X-ray (42). de Oliveira and et al. (31) determined the reliability of the instrument at 97 and 84, respectively. Measuring the kyphosis and lordosis curves were performed in the following manner: the examinees stood having naked upper bodied with their feet shoulder-width apart. Then, the examiner specified and marked the spinous processes of the second thoracic vertebra (T2), twelfth thoracic vertebra (T12), second lumbar vertebra (L2), and second sacral vertebra (S2). When the vertebrae were marked, the ruler was placed on the examinees' spinous processes between the

T2 and T12 vertebrae and also between the L2 and S2 vertebrae so that the instrument could take the shame of their kyphosis and lordosis curves.

Then, the ruler was placed carefully and without the slightest change in its form on white paper to draw the shape of the curves. The spinous processes of the T2, T12, L2, and S2 vertebrae that had been specified on the ruler were marked on the paper. Then, the points indicating the T2 and T12 vertebrae and the ones indicating the L2 and S2 vertebrae were connected using a straight line. The line is indicated with letter L in the formula. Then, the curve perpendicular bisector line (indicated with letter h in the formula) was drawn to obtain the forms of the kyphosis and lordosis curves. Following that, the kyphosis and lordosis angles were calculated according to the following formula (14) (Figure 1).

$\theta=4rctan2H/L$

In the above formula, h indicated the distance from the deepest point of the curve to the line L, and L was the distance between two landmarks (the distance between T2 and T12 in kyphosis, and the distance between L2 and S2 in lordosis) 13(20).

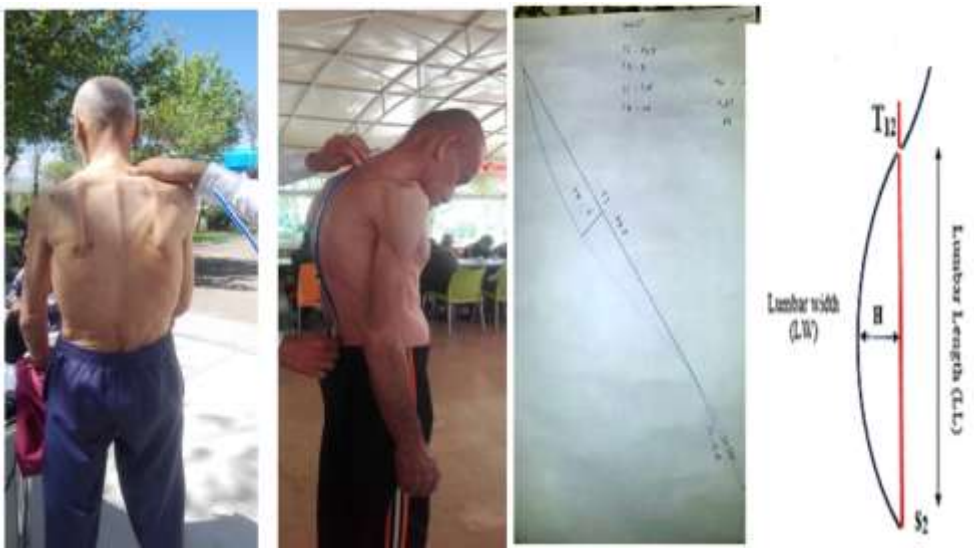


**Figure 1.** Measuring the kyphosis and lordosis curves

Static balance: Romberg's test (reliability coefficients to measure static balance with open and closed eyes determined at 0.90 and 0.91, respectively) was implemented to measure static balance. The examinees were supposed to stand with naked legs in a way that their dominant foot was placed in front of the non-dominant one, and the arms were crossed on the chest. The time each examinee could maintain this position with open and closed eyes was recorded as their scores. Errors included displacing one's feet, extreme tremor, and stretching one's arms. Moreover, opening the eyes in the closed-eye section was also considered an error (49).

Dynamic balance: The times up and go test (TUG) was implemented to measure dynamic balance with a reliability coefficient determined at 0.99. The examinees were asked to get up from a chair without using their hands, walk for three meters, and sit again. Using hands to get up from the chair was considered an error (39).

**The NASM corrective exercises**

The protocol (Tale 3) consisted of four stages that included inhibit, lengthen, activate, and integrate (10). The examinees were asked to perform warm-up exercises and then participate in the main program that included the above four sections.

**Table 3.** The protocol of the NASM exercises

| NASM techniques | | Number | Rounds | Repetition | Duration |
|---|---|---|---|---|---|
| Inhibition | | Daily (unless in special situations) | 1 | Not necessary | 30-90s on the trigger points (depending on the intensity of the application |
| lengthening | Static | Daily (unless in special situations) | Not necessary | 1-4 | 20-30s |
| | PNF | Daily (unless in special situations) | Not necessary | 1-3 | Contraction: 7-15s<br>Stretch: 20-30s<br>Intensity: submaximal up to 20-25%<br>Maximal contraction |
| Activation | Separate strengthening | 3-5 days a week | 1-2 | 10-15 | Maintaining the isometric contraction at the end of the motion range for 2 seconds and maintaining the eccentric contraction for 4 seconds |
| | Conditional isometric | To the extent that is necessary | 1 | 4 | Maintaining the isometric contraction for 4 seconds at 25%, 50%, 75%, and 100 intensities<br>Maximal voluntary contraction |
| Integration | | 3-5 days a week, Voluntary and controlled | 1-3 | 10-15 | Taking a rests for 2 seconds between the contractions |

Inhibition: The technique is implemented to release the tension or reduce the extreme activity of the neuro-myofascial tissues in the body. The solid foam roller was used in this section to increase pressure on the structures of the soft tissues and gain access to the more profound layers of the fascia. In this protocol, the examinees were supposed to rub the foam roller on the intended area for 30 seconds (10).

Lengthening: The technique is used to increase the elasticity, length, and range of the movements of the neuro-myofascial tissues in the body. The strain on the first point of resistance was maintained for 30 seconds (10).

Activation: It was implemented to retrain or increase the activity of the less-active tissues. The exercises were performed in 10 to 15 iterations where each iteration lasted for 1 to 2 seconds. In addition, the isometric contraction was maintained at the end of the ranges of motion with four seconds of eccentric contraction (10).

Integration: The technique is used to retrain and coordinate the performance of the nerves and muscles via progressive functional motions. They included the use of dynamic physical exercises that focused on the coordination of the stabilizing and motor muscles in the body (10).

## FINDINGS

The descriptive statistics and the measures of central tendency and dispersion were implemented to analyze the findings of the study. Then, the difference between the pretest and posttest scores of the examinees was calculated using inferential statistics and the analysis of variance.

The measures of central tendency and dispersion concerning the examinees' age, weight, and height are presented in Table 4.

**Table 4.** The measures of central tendency and dispersion concerning the examinees' age, weight, and height (N=40)

| Variable | Age | | Weight (kg) | | Height (cm) | |
|---|---|---|---|---|---|---|
| Statistic / Group | Mean | SD | Mean | SD | Mean | SD |
| Experimental (20) | 69.36 | 11.01 | 74.18 | 8.91 | 175.27 | 8.06 |
| Control (20) | 68.57 | 12.91 | 71.40 | 7.53 | 172.80 | 3.79 |

M= mean, SD= standard deviation

First, the normality of all variables was investigated using the Kolmogorov-Smirnov test. Then, the analysis of variance (ANOVA) was implemented to investigate intra- and inter-group differences in terms of the mean scores of the two groups. By controlling the effects of the pretest, a significant difference was observed between the experimental and control groups in terms of static and dynamic balance after 8 weeks of NASM exercises at $p<0.05$ (Table 5).

Table 5 illustrates the mean and standard deviation of the two groups in terms of balance in various modes. Thus, it was found that static balance with open eyes was improved in the control group after the intervention, and the improvement was significant at $p<0.05$. Moreover, significant improvements were recorded in terms of static balance with closed eyes and dynamic balance ($p<0.05$). However, the improvement in the measures of the static and dynamic balance with open and closed eyes in the control group was not significant ($p<0.05$).

**Table 5.** The pretest and posttest scores of the experimental and control groups in terms of balance

| Variables | Groups | Test | M ±SD | Intergroup df | F(P) interaction df | Intra-group df |
|---|---|---|---|---|---|---|
| Static balance with open eyes | Experimental | Pre test | 39.3 ±59.36 | 0.002 (0.962) | 35.55 (0.001) | 11.04 (0.002) |
| | | Post test | 100.2 ±62.76 | | | |
| | Control | Pre test | 39.1±59.65 | | | |
| | | Post test | 38.4 ±78.32 | | | |
| Static balance with closed eyes | Experimental | Pre test | 23.2 ±50.07 | 0.009 (0.925) | 6.926 (0.014) | 4.80 (0.037) |
| | | Post test | 36.3 ±40.10 | | | |
| | control | Pre test | 22.3 ±83.26 | | | |
| | | Post test | 22.2 ±89.02 | | | |
| Dynamic balance | Experimental | Pre test | 34.6 ±2.68 | 0.011 (0.902) | 31.25 (0.001) | 14.02 (0.032) |
| | | Post test | 48.7 ±36.05 | | | |
| | Control | Pre test | 34.5 ±63.56 | | | |
| | | Post test | 33.5 ±68.15 | | | |
| | | Post test | 38.5 ±25.15 | | | |

M= mean, df= degree of freedom, P= significance, F= coefficient F, SD= standard deviation

Table 6 presents the man and SD values obtained for the examinees' kyphosis and lordosis angles in addition to the results of the ANOVA for the repeated data. Statistical analyses indicated the significance of the interactive effects of the changes in both groups. In other words, a significant reduction was observed in the mean kyphosis and lordosis angles of the examinees in the experimental groups by comparing their pretest and posttest scores. On the other hand, such a reduction was not observed in the control group ($p<0.05$). In addition, the results of the statistical analyses related to the interaction of intragroup effects were significant concerning the changes of kyphosis and lordosis, and the kyphosis angle of the examinees in the control group increased according to the posttest scores. However, the examinees in the experimental group showed a significant reduction in this respect, and the malformation was improved in them.

**Table 6.** The pretest and posttest results of the experimental and control groups concerning lordosis and kyphosis

| Variables | Groups | Test | M ±SD | Intergroup df | F(P) interaction df | Intra-group df |
|---|---|---|---|---|---|---|
| Lordosis | Experimental | Pretest | 37.2 ±12.58 | 0.025 (0.812) | 35.25 (0.001) | 13.58 (0.042) |
| | | Posttest | 34.2 ±3.10 | | | |
| | Control | Pretest | 35.3±50.29 | | | |
| | | Posttest | 36.2±57.58 | | | |
| Kyphosis | Experimental | Pretest | 48.2 ±16.36 | 0.009 (0.925) | 6.926 (0.014) | 4.80 (0.037) |
| | | Posttest | 45.3 ±20.14 | | | |
| | Control | Pretest | 49.4 ±32.21 | | | |
| | | Posttest | 49.1 ±72.56 | | | |

M= mean, df= degree of freedom, P= significance, F= coefficient F, SD= standard deviation

## DISCUSSION AND CONCLUSION

The present study aimed to investigate the effect of physical activities on functional performance and the kyphosis and lordosis angles in elderly men. The findings showed that performing the NASM exercises resulted in a significant difference in the posttest scores of the experimental group compared to that of the control group in terms of balance, functional performance, and the reduction of lordosis and kyphosis angles. As no intervention was implemented in the control group, the increased balance and reduced lordosis and kyphosis angles in the elderly men could be attributed to the effects of the exercises. The present work was the first research study the effects of the NASM exercises on this area.

Corrective exercises have been reported to be among the most effective methods of retaining one's functions (2). Performing corrective exercises for 8 weeks introduces balance to the muscles and modifies skeletal-muscular malfunction in the upper-body areas (3). Hajihosseini et al. (17) found that hybrid exercises were more effective to separate stretch and endurance exercises and recommended combining the stretch exercises of the shortened anterior muscles of shoulders with the strengthening of the weak posterior muscles, simultaneously attending to the changes in the upper quarter of the body, and considering corrective exercises to simultaneously modify the three malformations (17). In the resent study, four-stage exercises based on the NASM principles simultaneously focused on the three malformations involved in the UCS, and this was in line with Janda's chain reaction mechanism and Bragger's cogwheel mechanism (32).

Sahrmann et al. (37) published an overview of the motion impairment syndromes of the body. He investigated the alignment or the conditions related to one's stature as measures that could predict variations in the length of muscles. He also investigated the alignment of the muscles that needed to be modified to achieve convenient motion ranges and found the significant relationship of kyphosis and the forward head posture with the shoulder impingement syndrome via constraints in the elevation mechanism. Increased posterior kyphosis results in more significant protraction of the shoulder and rotates it downward. This increases pressure below the acromion and its tissues including the bursae and rotator cuff tendons as the forward head posture is correlated with the increased kyphosis angle and the forward shoulders. Such position relatively increase the elevation, protraction, downward rotation, and anterior tilt of shoulders (37). Thus, motions selected in the first stage of activation according to the NASM principles focused on these muscles. Individuals are forced to perform special motions on their joints and keep their bodies in certain condition due to the inconvenient condition of the body and its skeletal malformations, and performing such repetitive motions and the manner of keeping one's body mutually plays a significant role in the intensification of the skeletal-muscular malformations. Consequently, it is believed that correcting such malformations need to be conducted based on functional performance using integrated activities to influence the whole body. Thus, the activation stage that included a hybrid set of integrated activities could play a significant role in improving such malformations. In addition, the muscles that bend the neck were found to have a significant role in maintaining the condition of the neck (23).

The findings of the present study were in line with the findings of Shumway et al. (44) that showed implementing a multidimensional exercise program had significant effects on the elderly's balance and

mobility and reduced the risk of falling in them (44). Moreover, Madureira et al. (24) investigated the effects of balance exercises on improving the functional performance and reducing the risk of falling among the elderly women with osteoporosis and showed that the elderly's balance could improve using the training intervention using Berg's balance scale (24). Gunendi et al. (16) investigated the effects of a 4-week aerobics program on the posture balance of the menopausal women with osteoporosis and showed the significant effects of using the intervention on the examinees' posture balance according to Berg's balance scale (16).

Hessari et al. (18) compared the effects of core stability exercises on elderly women's Berg balance scores. They showed that the examinees' balance improved as a result of the exercises, and the risk of falling got reduced among them (18). Moreover, Jacobson et al. (22) investigated the effectiveness of static balance exercises on increasing stability and functional performance among the elderly people and showed that the participants' Berg balance scores significantly increased after 12 weeks (22). Clemson et al. (11) showed that performing endurance and balance exercises for 12 months beside the routine activities reduced the risk of falling in the elderly's by 31% and improved their balance performance (11). On the other hand, Sauvage et al. (40) reported a 5-10% improvement in the elderly's balance and walking ability after 12 weeks of endurance and aerobic exercises, which was not significant. Buchner et al. (8) found that the effect of a 6-month strength and endurance training program (at 60-70% the max heart rate) on the elderly's abilities and balance capacity was not significant. The reason for the discrepancy between the results of the present study and the one conducted by Buchner et al. 8(37) can be justified on the grounds of the types of exercises implemented in the two studies (8).

The results of the present study showed that performing physical education exercises by elderly men for 16 weeks significantly increased the duration of the static balance test with open eyes in them. As examinees were supposed to maintain their balance using their visual, auricular, and somesthetic systems, it was concluded that performing functional exercises could improve and facilitate the input to each of those systems to maintain balance. Moreover, the NASM exercises significantly increased the duration of the static balance test with closed eyes. In the test, the input to the visual system was cut as the examinees closed their eyes. Then, they needed to rely only on their auricular and somesthetic systems to maintain their balance (28). Thus, as the examinees' duration of static balance with closed eyes significantly increased after the 16-week intervention, it was concluded that the NASM exercises facilitated the transmission of messages from one or both of the above senses to high-order nervous centers to maintain balance. Improved balance can be achieved when attention is conveniently divided between the intended motor tasks. Indeed, performing exercises based on special tasks can increase concentration on such tasks.

The findings of the present study showed that the kyphosis and lordosis angles in the experimental group significantly decreased after the 16-week intervention. This was in line with Mahdiavinejad and Badihi (25) who reported the improvement of the spinal column by performing physical activities. It appears that strength exercises influence the length of tendons in muscles, displace various skeletal components, and add to the stability and strength of ligaments. On the other hand, stretching exercises act as the coordinators of the protagonist and antagonist muscles. Thus, such exercises increase the length of muscles in their concave sides, increase their strength and power in their convex sides, and reduce the rates of malformations (35). In the present study, a significant reduction was observed in the participants' kyphosis angles after performing the NASM exercises. This was similar to the results of Sayari et al. (41) that investigated and compared the effects of two sets of exercises (i.e., corrective-structural and corrective-aerobic) on the participants' kyphosis angles and concluded that performing either set had positive effects on reducing the kyphosis angles. Moreover, they showed that performing a hybrid set of exercises including the corrective-structural exercises followed by aerobic running made a more significant impact on the reduction of the kyphosis angle (41). As it was mentioned in the theoretical background of the study, there is a direct link between abdominal obesity and backache. Thus, a main reason for the reduced backache in the experimental group can be the reduction of their abdominal obesity. Being aware of body parts, using muscles smartly, being informed of the messages that muscles send, and the motion ranges of the joints that comprise the fundamental principles of sports exercises prevent the damages of overusing, stretching, and pressuring muscles. The principle of stretch in exercises combines one's physical concentration and the convenient direction of the body so that muscles can be stretched up to their full motion ranges necessary to maintain the muscular balance and contract at the same by the support of the body (4). On the other hand, the results of the present study showed a reduction

in the examinees' abdominal obesity that led to the significant reduction of their backache, and this was in line with the findings of Shavandi et al. (43)

Moreover, the improvement observed in terms of maintaining balance and functional abilities was line with the findings of Cao et al. (9) and Iwamato et al. (21) though it contradicted some of the findings of Irez et al. (20) who argued that performing land-based endurance exercises had no significant impact on the functional ability of walking. Though the nature of the interventions implemented in the studies is the same, the differences in the obtained results can be attributed to ignoring factors like the examinees' readiness, their bodily activity, motivation, gender, age, height, and weight. Moreover, the variations can be justified on the grounds of the implemented methodologies and other variables. Though muscular strength gets reduced as people undergo ageing, the trend can be modified in the elderly (12). Performing physical exercises compensates the functional changes that emerge as a result of ageing and maintain the elderly's independence for longer periods. The findings of the related studies show that performing regular physical activities reduces the fat reserves of the body and increases' people muscular strength and endurance and ability to perform daily activities (12). In this regard, Trueblood et al. (48) investigated the effects of performing an 8-week fall-proof exercise program on people with high and low functional levels. In the study, 52 elderly people at the age of 53-91 were divided into the high and low functional groups. The results showed that performing the 8-week program of multidimensional fall-proof exercises reduced the elderly's risk of falling, and this was in line with the results of the present study (48). This can be attributed to the implementation of the similar exercises and components in the protocol of the present study. In a study by Park (33) to investigate the effects on a 10-week eyeball and functional exercises on the balance and falling risk of the elderly people with a history of falling, it was shown that the eyeball exercises had more significant impacts on improving the balance and reducing the risk of falling among the elderly 33(48). Moreover, Bjerk et al. (7) found that the Otago exercise program had a significant impact on the balance and life quality of the elderly under care services (7). In addition, (Kusuma Wati) Wati et al. (51) investigated the effects of Lafiska exercises on the elderly's risk of falling, balance, and health and showed that the exercises had significant effects on reducing the risk of falling and increasing balance and health among the participants (51). In addition, muscular atrophy that emerges as people's ages increase can be delayed or reverted by performing physical exercises that are convenient for the elderly (15). As sports like Pilates or NASM are new to our country and can be performed using a few tools everywhere imaginable, they are recommended to be implemented by people – particularly the elderly - to increase the features of their functional readiness like the speed and balance of functional abilities and reduce physical pains related to the backache.

## CONCLUSION

It can be argued that regularly performing the NASM-based corrective exercises by the elderly can improve malformations in their spinal columns and enhance their balance and walking speed. Thus, participating constantly in physical activities like the NASM exercises can reduce the rates of malformations and increase the quality of maintaining balance and functional abilities among the elderly. The exercises align the gravity line of the body with its natural direction by strengthening the central organs of the body and its nervous-muscular system and maintains the balance of the body in a convenient mode. Consequently, such exercises should be implemented along other rehabilitation and routine programs for the elderly.

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