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The effect of proprioceptive training in the STAR Excursion Balance Test (SEBT)

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Abstract

Introduction. To control the movement, the brain must process proprioceptive information provided by mechanoreceptors. The role of proprioception in carrying out daily activities and physical exercises, was presented, using the SEBT technique and the proprioceptive mechanisms that represent the base of dynamic postural control.
Objective. The aim was to highlight the effects of proprioceptive training on lower limb balance in subjects with lower limb injuries but also in healthy subjects, and to evaluate the effectiveness of proprioceptive programs based on postural instability to reduce knee sprains by developing proprioceptive control. These findings indicate the improvement of proprioceptive control which may be a key factor in reducing knee sprain.
Working hypothesis. Applying a kinetic intervention protocol, consisting of static proprioceptive exercises, stimulates the body to maintain balance in situations of imbalance and increases the stability of the knee joint in Ministry of National Defense workers with a history of sprained knee or predisposition to injury.
Methods. The research was performed on 30 subjects, male and female, employees of the Ministry of National Defense, distributed in two experimental groups: G1 and G2. *Results.* The results demonstrate the effectiveness of the applied program, both for therapeutic and prophylactic purposes, in increasing postural balance and proprioceptive control. *Conclusions.* Knee sprain is a trauma that occurs frequently among athletes. Like athletes, the Ministry of National Defense employees represent a population at high risk of injury or recurrence.

Key words: *knee sprain, postural control, neuromuscular control, dynamic balance test*

Rezumat

*Introducere***.** Pentru a controla mişcarea, creierul trebuie să proceseze informaţii proprioceptive, furnizate de mecanoreceptori. Rolul propriocepţiei în desfăşurarea activităţiilor zilnice şi exerciţiilor fizice, a fost prezentat utilizând tehnica SEBT şi mecanismul proprioceptiv, care reprezintă baza controlului postural dinamic.
Scop. Obiectivul a fost de a evidenţia efectele antrenamentului proprioceptiv asupra echilibrului membrelor inferioare la subiecţi cu leziuni ale membrelor inferioare, dar şi la subiecţi sănătoşi şi de a evalua eficacitatea programelor proprioceptive, bazate pe instabilitate posturală, pentru a reduce entorsele de genunchi prin dezvoltarea controlului proprioceptiv. Aceste descoperiri indică îmbunătăţirea controlului proprioceptiv, care poate fi un factor cheie în reducerea entorsei genunchiului.
Ipoteza de lucru. Aplicarea unui protocol de intervenţie kinetică, constând în exerciţii proprioceptive statice stimulează menţinerea organismului în echilibru în situaţii de dezechilibru şi măreşte stabilitatea articulaţiei genunchiului la lucrătorii Ministerului Apărării Naţionale cu antecedente de entorsă a genunchiului sau predispoziţie la accidentare.
Metode. Cercetarea a fost efectuată pe 30 de subiecţi, bărbaţi şi femei, angajaţi ai Ministerului Apărării Naţionale, repartizaţi în două grupuri experimentale: G1 şi G2. *Rezultate.* Rezultatele demonstrează eficienţa programului aplicat, atât în scop terapeutic, cât şi profilactic în privinţa creşterii echilibrului postural şi a controlului proprioceptiv. *Concluzii.* Entorsa genunchiului este o traumă care apare frecvent în rândul sportivilor. Asemenea sportivilor, angajaţii Ministerului Apărării Naţionale reprezintă o populaţie cu risc crescut de accidentare sau recidivă.

Cuvinte cheie: *entorsa genunchiului, control postural, control neuromuscular, test de echilibru dinamic*

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Introduction

This dynamic postural control test has received attention in clinical and research settings is the Star by subjects and normalization of contact distances, SEBT to be used to differentiate deficits and improve dynamic postural control related to lower limb injuries and induced fatigue, and has the ability to prevent lower limb injuries. SEBT is a specific test for joint injuries and is applied and described for over 22 years (Gribble & Hertel, 2003).

Researchers are continuously committed to investigate and analyze the biomechanical and neuromuscular factors that contribute to joint damage and their early recovery (Prakash et al., 2017).

We mention here injuries such as the anterior cruciate ligament injury without contact at the knee joint and the development of chronic instability of the ankle. SEBT has ability to report the postural the two instruments may not be directly comparable (Alnahdi et al., 2015).

Standardized testing (Gribble, Hertel & Plisky, 2012) must meet the following conditions: lines drawn on the ground, starting position on the

Implementation of SEBT in the medical recovery- SEBT has been shown to be an effective test for highlighting chronic unilateral instability of the ankle and knee, but it has also been used to monitor patients with painful femur-patellar syndrome. The opinions of specialists converge towards the use of this test in other pathologies of the lower limb that may lead to disorders in terms of body stability. The test can also be predictable, as it can determine deficits and balance asymmetries in unipodal support, which help specialists in making decisions that are prophylactic, preventing injury.

Anterior, posteromedial and posterolateral directions appear to be important in identifying individuals with chronic ankle and knee instability, and athletes at higher risk of injury. When the person shows a significant decrease in balance while standing on the affected lower limb, compared to the healthy lower limb, the star's balance test highlights the loss of dynamic postural control (Hegedus et al., 2015).

SEBT requires endurance, flexibility, neuromuscular control, basic stability, balance and proprioception. It proves to be an excellent test for physical and clinical examinations. SEBT is an excellent tool that

Excursion Balance Test. Specialists recommend, with correct instructions and practices control problems between limbs, both among the healthy population and among populations with lower limb joint injuries (Plisky et al., 2006). In this context, adding the fact that the literature considers it one of the best tools for measuring the dynamic balance of the lower extremity, we considered that we can also apply it to monitor the performance of researched subjects (Munro & Herrington, 2010). Note that, in its current form, the SEBT has been reduced to three directions becoming similar to the Y Test. Although the directions of touch are the same (anterior, posteromedial, posterolateral) and participants move in similar patterns (modified SEBT test and Y test), research indicated that previous contact distances were different when comparing the two tests. Therefore, central point, hands positioned on hips, moving along the line and touching the line easily, the subject does not rest or pause on the line, the body weight is not transfer to the leg that reaches the maximum distance on that line. helps us adapt our rehabilitation programs and sports training programs to address specific mechanical, sensory and functional issues (Calatayud et al., 2014).

It is a dynamic balance test that offers a significant challenge for athletes and physically active individuals, used to assess physical performance and to detect deficiencies in postural control.

How to perform SEBT-protocol:

1. The properly equipped subject is required to stand in the center of the star and wait for additional instructions, shoes removed to avoid measurement errors. You can perform some practical tests as a learning effect, you can show video instructions to increase the efficiency of the test protocol and standardize the instructions, you can perform the control test to improve the image in performing the test.
2. SEBT was described as a rehabilitation test consisting of placing the subject in the center of the star, in a standing position. The right foot is the touch leg and the left foot is for balance, the athlete must do it the circuit, in a clockwise. After the balancing on the right leg is done, the athlete must do it the circuit, in the counterclockwise.

3. With the hands positioned at the hips, the subject must to reach with the foot, far as possible along the drawn line and with the tip of the foot of the lower contralateral limb lightly touch, in turn, each line (branch of the star), trying to slide as far away from the center of the star as possible along one of the eight directions before returning to the starting position. Throughout the test, the hands remain fixed on the hips and a squatting position is maintained on the lower support member, and the heel remains in constant contact with the support surface.

4. Mark with a pencil or chalk the point at which the subject touches the line of that direction of movement. The subject returns to the original vertical position. The distance between the maximum point reached and the center point is measured in centimeters. Repeat the movement and the measurement procedure with the same lower limb in all 8 directions of movement. After each movement performed in one direction, return to the center point. The lower support member is changed and the movement and measurement procedure are repeated with the other lower limb, in each direction, performing again the 8 movements whose length is measured. The correct execution of the movements in the 8 directions represents a complete circuit.

5. Repeat the movements with the same foot for all eight other directions, and then change the leg.

6. To complete a full circuit this process must be performed three times on one leg, three circuits in the anterior direction for the right leg and three for the left, keeping the same direction of movement.

7. After performing the three circuits, the subject moves away from the test area.

8. Record the distance to reach each successful attempt and calculate the subject's SEBT score when the test is finished.

Failure to follow one of these instructions resulted in the test being repeated in the direction in which the execution failed.

The protocol involves making 3 complete circuits with each leg. Thus, 3 performances are measured and recorded for each direction performed with each foot (distance 1 - at the first determination, distance 2 - at the second determination and distance 3 - at the third determination). The subject is then allowed to move away from the test area (Herrington et al., 2009).

In order to ensure the reproducibility of the measurement, we created a support for this test. I covered the floor with linoleum and drew on this support four lines intersected in the same central point, thus obtaining 8 branches, which represent the 8 directions of movement; the lines are extends from a central point and have 45 °, to each other. The test subject must maintain balance on one lower limb (sitting on one lower limb) in the middle of the star test, while using the foot of the other lower limb to successively touch the 8 different directions, named, depending on foot orientation, as follows: anterior, anteromedial, medial, posteromedial, posterior, posterolateral, lateral and anterolateral direction. The objective is to determine the subject to set a base of support on the position member and to maintain it, while the opposite member makes a maximum trip in one of the mentioned directions.

Scoring system- once the test is completed and all measurements are recorded, SEBT scores can then be calculated using this equations:

Average distance in each direction (cm) = distance 1 + distance 2 + distance 3/3

Relative distance (normalized) in each direction (%) = Average distance in each direction / lower limb length x 100

Total score = $\frac{A+AL+L+PL+P+PM+M+AM}{8} \times$

After these calculations, resulting in a total of 16 scores.

We took as a benchmark the values offered by Gribble and Hertel (2003), shown as a percentage of the length of the lower limbs, because from the literature, all bibliographic references refer to them, being considered normative values (Table 1). We mention that these data were obtained on sedentary subjects.

Table I. Data on the normal values of the Star Excursion Balance Test (Star Excursion Balance Test, 2017)

Direction	Normalized relative distances (expressed as a percentage of lower limb length)	
	Men	**Women**
Anterior (A)	79.2 +/- 7.0	76.9 +/- 6.2
Posterior (P)	93.9 +/- 10.5	85.3 +/- 12.9
Medial (M)	97.7 +/- 9.5	90.7 +/- 10.7
Lateral (L)	80.0 +/- 17.5	79.8 +/- 13.7
Anterolateral (AL)	73.8 +/- 7.7	74.7 +/- 7.0
Anteromedial (AM)	85.2 +/- 7.5	83.1 +/- 7.3
Posterolateral (PL)	90.4 +/- 13.5	85.5 +/- 13.2
Posteromedial (PM)	95.6 +/- 8.3	89.1 +/- 11.5

To compare the performance of an individual's limbs, comparisons can be made between the absolute touch distance on each limb. However, the reach distances must be normalized to the length of the limbs of each participant, measured from the anterosuperior iliac column to the medial ankle, being correlated with the touch performance. This performing is expressed as a percentage of limb length. The body height can be also correlated with touch distance.

The muscular activity of the medial vastus was higher in the anterior direction than in the other directions. The activity of the lateral vastus muscles was lower during the lateral excursion compared to the other directions. The activity of the hamstrings was higher in the anterolateral direction than in the anterior, anteromedial and medial directions. The activity of the femoral biceps muscles was higher in the posterior, posterolateral and lateral directions compared to the anterior and anteromedial directions. An important factor is also the gender. After different fatigue protocols, it was found that there was no difference in performance between the sexes.

In conclusion, the performance of SEBT became more consistent and more pronounced after fatigue. Fatigue changes the effectiveness of the ability to contract extrafusal muscle fibers that alter neuromuscular control. Basic idea, it is that fatigue can influence SEBT performance. Fatigue is a factor that could affect the dynamic postural control measured with SEBT.

SEBT's ability to differentiate the effects of external influences and interventions- in addition to identifying problems in dynamic postural control. SEBT can be used to highlight the influence of external interventions and influences on dynamic postural control. These comparisons demonstrate that SEBT can be used to address effective methods of recovery and prevention of lower limb joint injuries in clinical settings. Taping and orthoses are devices used to increase the stability and biomechanics of the joints, which show increased postural control (O'Sullivan et al., 2009).

It is understood that the touch distance will be affected by limb length and sex. Thus, there is a considerable percentual difference between the two lower limbs or between the subjects with injuries and the healthy, control ones.

Because the performance on SEBT varies by sport, gender, and age, specialists must collect normative data using different populations (in addition to those who practice different sports, even military, youth, the elderly, etc.). With normative data and objective studies resulting from SEBT, we can determine lesions for each population (Calatayud et al., 2014) .

All directions have the ability to identify movement deficits in participants compared to healthy controls, however, the posteromedial direction is the most representative for the overall assessment.

The deficit in performance, before the implementation of a medical rehabilitation protocol, was confirmed, the injured lower limbs producing a weaker dynamic postural control than the healthy limbs for posteromedial, posterolateral and lateral directions.

Reconstruction of the anterior cruciate ligament- anterior cruciate ligament injuries are common in pathological conditions of the lower limbs, and many studies about anterior cruciate ligament problems. The performance of SEBT compared with the performance of the healthy limb, in the anterior, lateral, posteromedial and medial directions, the limb with anterior cruciate ligament problems showed weaker dynamic postural control than the healthy limb, patients have low resistance of the quadriceps, which showed a reduced ability to touch in the anterior directions (Clag et al., 2015). But upon returning to work, we hope that there will be no differences from one limb to another. This requires that this test be instituted earlier in our recovery plans.

Patellofemoral pain syndrome- SEBT performance was compared in the anterior direction due to its ability to cause a high level of quadriceps muscle activation, dorsiflexion in the ankle joint and a greater tension of the patellofemoral joint. There were shorter touch distances, this finding demonstrating a lack of dynamic postural control of those with femuropatellar syndrome (Aminaka & Gribble, 2008).

This direction of touch (anterior) is usually the most limited and highlights the patient's reduced ability to walk on slopes and stairs.

Use of SEBT to detect clinical deficiencies- SEBT was initially designed as a rehabilitation tool for pathological diseases of the joints of the lower limbs, specialists use this tool for diagnosing and detecting the risk of injury (Ahlden et al., 2012). SEBT can be a diagnostic tool in 4 clinical situations: 1) the ability to prevent the risk of injury; 2) the ability to differentiate patients with diseases of the joints of the lower limbs from healthy patients.; 3) the ability to differentiate the influence of certain factors on sports performance.; 4) the ability to demonstrate clear and objective results following the application of the SEBT.

Establishing these qualities will help specialists evaluate and establish the best way to implement SEBT in coordinating lower limb joint injuries. At the same time, it helps to carry out a comprehensive review of the general purpose of evaluating the effectiveness of SEBT as a tool for diagnosing and preventing joint injuries.

Working hypothesis

The application of a kinetic intervention protocol consisting of static proprioceptive exercises stimulates the maintenance of the body in balance in unbalanced situations and increases the stability of the knee joint in Ministry of National Defense workers with a history of sprained knee or predisposition to injury.

The purpose of the research

The proprioceptive system stimulated by specific exercises can restore segmental stability through static and dynamic tasks.

The population groups approached, respectively employees of the Ministry of National Defense services, underwent a complex evaluation using the star balance test, which is a novelty in our literature and a program of proprioception exercises used both as a means of primary prophylaxis, as well as therapy and secondary prophylaxis, prevention of recurrences in knee sprain in workers in the Ministry of National Defense services.

We emphasize that the detection of knee instability and its treatment before joint trauma is particularly important for this professional category who must be in very good physical condition to cope with regular physical tests and regular requests for training.

Methodology

Research methods

The research was performed on 30 subjects, male and female, employees of the Ministry of National Defense, distributed in two experimental groups: G1 and G2. Both groups were selected based on common criteria, namely: volunteers, who currently carry out a program of continuous physical-military training, aged between 25 and 45 years and with a length of service of at least 5 years in the practice of the physical activities previously mentioned. Healthy people were included in group G2. The G1 group was put together also based on specific criteria that we present below. The research took place between November 2019 and September 2020. The protocol was established taking as a reference the training sessions for a period of 4 weeks. The period was preceded by a week devoted to the testing of the researched subjects (initial testing) and followed by a week in which we performed the final testing.

Common inclusion criteria

- the Ministry of National Defense employees, who are currently carrying out a continuous physical-military training program;

- ages between 25 and 45 years;
- seniority of at least 5 years in practicing a sports activity;

Criteria for inclusion in group G1

- at least one history of a previous knee injury;
- without knee surgery;
- without knee pain greater than or equal to 4, on VAS scale (visual analog scale).

Exclusion criteria from group G1

- ages under 25 and over 45;
- persons who have suffered injuries / surgeries in the knee (sprains, resections or ablations of the meniscus, etc.).

Healthy people were included in group G2.

The program applied to the researched subjects included:

1. *Warm-up program* - with a duration of 10-12 minutes and consisted of:
   - low-speed walking exercises, walking and high-speed walking variants;
   - stretching targeting:
- the muscles of the anterior thigh (right femur, intermediate vastus, lateral vastus, medial vastus), which together make up the quadriceps muscle, with a major extensor role of the knee;
- posterior thigh muscles (femoral biceps, semimembranosus, semitendinosus, gracilis);
- calf muscles (gastrocnemius, popliteal, plantar);
-

2. *A program of proprioceptive reeducation through static exercises= the classic form of therapeutic intervention* in the studied pathology.

The program consisted of *static proprioceptive physical exercises to destabilize* the body performed with the lower limbs in a closed kinematic chain.

Proprioceptive exercise protocol

Weeks 1 and 2:

- posterior, anterior and lateral destabilizations (left / right); 4 series lasting 45 seconds, 2 for each leg.

Weeks 3 and 4:

- posterior, anterior and lateral destabilizations (left / right); 4 series lasting 1 minute.
- an altitude component, consisting of a unipodal support on a device 70 cm high.

Destabilization on increasingly unstable planes, from bipodal support and then from unipodal support, using a series of accessories such as: bicycle, stepper, balance board, balls (double load).

3. *SEBT - The Star Excursion Balance Test*

Results

Group G1 *Mean distances*

Table II presents the statistical indicators of the mean distance, resulting from the initial and final evaluation for the subjects of group G1.

Table II. Mean distances Group G1

Directions	Affected lower limb				Healthy lower limb			
	Effect size	Size difference (cm)	P value (p<0.05)	Null Hyphotesis	Effect size	Size difference (cm)	P value (p<0.05)	Null hyphotesis
A	1.52 Very big difference	7.13	0.001	Rejected	0.84 Large to very large difference	7.60	0.006	Rejected
AL	0.76 Middle to large difference	4.27	0.001	Rejected	0.86 Large to very large difference	4.44	0.005	Rejected
L	1.37 Very big difference	5.73	<0.001	Rejected	1.59 Very large difference	5.40	<0.001	Rejected
PL	1.18 Very big difference	4.58	0.001	Rejected	0.06 Very small difference	0.73	0.830	Accepted
P	1.03 Very big difference	4.85	0.001	Rejected	0.58 Medium to large difference	4.29	0.041	Rejected
PM	0.55 Middle to	3.69	0.050	Rejected	0.74 Medium to	3.91	0.013	Rejected

	large difference				large difference			
M	1.40 Very big difference	7.18	0.001	Rejected	1.00 Large difference	4.68	0.002	Rejected
AM	0.25 Small to medium	3.00	0.356	Accepted	0.49 Small to medium difference	3.45	0.077	Accepted

The calculated mean distance values are uniformly scattered for all directions of movement. For the affected lower limb, the null hypothesis has been rejected in all directions, except the anteromedial one. The progress obtained is statistically significant. As for the healthy lower limb with the exception of the posterolateral and anteromedial directions, the results were statistically significant.

The null hypothesis was rejected, and the research hypothesis has been accepted, which has justified the effectiveness of the established program and its primary prophylactic effect.

Table III presents the statistical indicators of the mean distance, resulting from the initial and final evaluation for the subjects of group G2.

Table III. Mean distance Group G2

Directions	Right lower limb				Left lower limb			
	Effect size	Size difference (cm)	P value (p<0.05)	Null Hypothesis	Effect size	Size difference (cm)	P value (p<0,05)	Null hypothesis
A	1.11 Very large difference	4.62	0.001	Rejected	1.12 very large difference	4.22	0.001	Rejected
AL	0.58 Middle to large difference	2.13	0.043	Rejected	0.67 Medium to large difference	2.62	0.021	Rejected
L	0.98 Large to very large difference	3.05	0.002	Rejected	0.99 Large to very large difference	5.78	0.002	Rejected
PL	0.55 Medium difference	3.18	0.052	Accepted	0.61 Medium to large difference	2.56	0.034	Rejected
P	0.90 Large to very large difference	3.14	0.004	Rejected	0.65 Medium to large difference	2.96	0.024	Rejected
PM	1.11 Very large difference	4.89	0.001	Rejected	0.37 Small to medium difference	-3.14	0.179	Accepted
M	0.84 Large to very large difference	4.91	0.006	Rejected	0.52 Medium to large difference	4.89	0.064	Rejected
AM	0.88 Large to very large difference	5.71	0.004	Rejected	0.73 Medium to large difference	4.53	0.013	Rejected

The calculated mean distance values are uniformly scattered for all directions of movement, except the medial direction, for both limbs. For the right limb, only in the posterolateral direction, the difference in averages is statistically insignificant, the null hypothesis is accepted. As for the left limb just on posteromedial direction the result in statistically insignificant and the null hypothesis is accepted.

All the results recorded on the other directions justify the effectiveness of the applied program and confirms the research hypothesis.

Table IV presents the relative distance data for group G1.

Table IV. Relative distance Group G1

Directions	Affected lower limb				Healthy lower limb			
	Effect size	Size difference (%)	P value (p<0.05)	Null hypothesis	Effect size	Size difference (%)	P value (p<0.05)	Null hypothesis
A	1.39 Very large difference	8.59	<0.001	Rejected	0.85 Large to very large difference	9.06	0.005	Rejected
AL	0.74 Medium to large difference	5.25	0.012	Rejected	0.83 Large to very large difference	5.37	0.006	Rejected
L	0.94 Large to very large difference	7.80	0.003	Rejected	1.54 very large difference	5.95	<0.001	Rejected
PL	1.18 Very large difference	5.46	<0.001	Rejected	0.06 Very small difference	0.21	0.083	Accepted
P	1.04 Very large difference	5.82	0.001	Rejected	0.63 Medium to large difference	3.60	0.029	Rejected
PM	0.52 medium to large difference	4.30	0.064	Accepted	0.69 Medium to large difference	4.46	0.018	Rejected
M	1.30 Very large difference	8.64	<0.001	Rejected	0.98 Large to very large difference	5.53	0.002	Rejected
AM	1.00 Very large difference	6.23	0.002	Rejected	0.79 Medium to large difference	4.83	0.009	Rejected

The calculated relative distances are homogeneously dispersed in both tests for all directions of movement, both for the affected limb and for the healthy one. Regarding the data recorded for the affected limb with the exception of the posteromedial direction, all the results obtained in the other directions are statistically significant. As for the healthy limb except posterolateral direction, in all other directions the null hypothesis was rejected and the obtained progress is statistically significant.

Table V shows the statistical indicators for G2 group -relative distance.

Table V. Relative distance Group G2

Directions	Right lower limb				Left lower limb			
	Effect size	Size difference (%)	P value (p<0.05)	Null Hypothesis	Effect size	Size difference (%)	P value (p<0.05)	Null hypothesis
A	1.13 Very large difference	5.32	0.001	Rejected	1.13 Large to very large difference	4.87	0.001	Rejected

AL	0.58 Medium to large difference	2.48	0.041	Rejected	0.68 Medium to large difference	3.01	0.019	Rejected
L	1.01 very large difference	3.58	0.002	Rejected	1.00 Large to very large difference	6.75	0.002	Rejected
PL	0.58 Medium to large difference	3.85	0.042	Rejected	0.64 Medium to large difference	3.11	0.026	Rejected
P	0.90 Large to Very large difference	3.71	0.004	Rejected	0.68 Medium to large difference	3.60	0.020	Rejected
PM	1.10 very large difference	5.72	0.001	Rejected	0.48 Small to medium difference	7.27	0.084	Accepted
M	0.85 Large to Very large difference	5.77	0.005	Rejected	0.54 Small to medium difference	5.74	0.057	Accepted
AM	0.90 Large to very large difference	6.49	0.004	Rejected	0.75 Medium to large difference	5.15	0.012	Rejected

The relative distance values are uniformly dispersed for group G2. It is proven that for the right lower limb there have been significant progress in all directions, the null hypothesis is rejected in each case. At the level of the left lower limb there were significant increases in 6 of the 8 directions of movement, exceptions being recorded in the posteromedial and medial directions (the null hypothesis being accepted).

The average total score showed very large increases in all 8 directions for both groups, the progress being statistically significant.

Table VI presents the effect size obtained from average total score by group G1 and G2

Table VI. Average total score

G1		G2	
Affected limb	Healthy limb	Right limb	Left Limb
Effect size			
2.03	1.06	1.57	1.22

Significant increases in average distances and normalized relative distances in almost all directions, as well as increases in the total score in both groups, highlight the effectiveness of the program applied to both people groups who have experienced a sprained knee and those at risk of injury.

Discussion

Clinicians and researchers commonly use the Star Excursion Balance Test (SEBT) to assess dynamic balance. Anterior, posteromedial, and posterolateral directions appear to be important in identifying individuals with chronic knee instability and athletes at higher risk of lower limb injury.

In this research the results showed validity for SEBT, considered a representative instrumented dynamic balance test to prevent the risk of injury to the joints of the lower limbs, to identify the deficit of dynamic postural balance in patients with disorders of the joints of the lower limbs and subjects without joint injuries of the lower limbs. Following the results the research hypothesis is confirmed, namely the application of a kinetic intervention protocol consisting of static proprioceptive exercises, performed with the lower limbs, stimulates the body to maintain balance in unbalanced situations and increases the stability of the knee joint among workers at the Ministry of National Defense with a history of sprained knee, predisposition to injury. It is obvious that by the evolution of the mean distances, the relative average distances and total score, calculated by the SEBT test, even if in some directions the increases were small or small to medium, still there were increases, and most of them were very large or large to very high.

Conclusions

Knee sprain is a trauma that occurs frequently in athletes. Like athletes, the Ministry of National Defense employees represent a population at high risk of injury or recurrence. The sensory impairment caused by a sprain alters the sensorimotor integration that leads to the reorganization of motor control, consisting in decreased stability of the knee joint and postural stability.

The average seniority in practicing a sports activity is significantly close to the two groups, taking into account the type of employees. This is explained by the fact that keeping the staff active implies undertaking of regular specific tests of effort, involving a permanent physical training.

The average seniority in service within the Ministry of National Defense structures is 13.46 years for women (15 years for group G1 and 12.1 years for group G2), while for men the average is 15.41 years (15.11 years for G1 and 15.75 years for G2).

Proprioception plays a key role in balance control, and knee proprioception is very important. Proprioceptive re-education improves stability and balance control and reduces recurrences. Postural stability is considered a predictive factor of chronic knee instability and dynamic stability as an intrinsic risk factor for injury.

Significant increases in average distances and normalized relative distances in almost all directions, as well as increases in the total score in both groups, highlight the effectiveness of the program applied to both people who have experienced a sprained knee and those at risk of injury.

The research hypothesis is confirmed: applying a kinetic intervention protocol consisting of static proprioceptive exercises, performed with the lower limbs, stimulates the body to keep in balance in unbalanced situations and increases the stability of the knee joint in the Ministry of National Defense employees with a history of knee sprain or predisposition injury.

Authors´ Contribution

All authors have equally contributed to this study and should be considered as main authors.

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