IMPROVING QUALITY OF LIFE AMONG MINISTRY OF NATIONAL DEFENCE WORKERS THROUGH PROPRIOCEPTIVE EXERCISES

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Abstract. Proprioceptive re-education improves stability and balance control and reduces the risk of injury. Through this research, we intend to emphasise that simple exercises such as simple assessment tests are equally useful in preventing knee sprain, in terms of primary prophylaxis and recurrence prevention. The study involved 15 active military workers (11 male and 4 female) from the Ministry of National Defence, who were included in the category of people practising the sports activities required by their profession. These sports activities are varied and consist of: athletics, martial arts, football, volleyball and military application routes specific to the training of this professional category. We aim to verify the effectiveness of proprioceptive exercises included in an original programme. We applied the Star Excursion Balance Test (SEBT), which is used by clinicians and researchers to assess static and dynamic balance, track performance changes after implementing a prevention or rehabilitation programme and identify people at risk of injury. For the assessment of knee function-related quality of life following the programme applied to participants, we used the Lysholm Scale and 2000 IKDC questionnaires. The statistical results obtained using the dependent t test indicate significant increases in dynamic balance and postural control for both the affected and healthy lower limbs, which demonstrates the effectiveness of the exercise programme used as well as its therapeutic and prophylactic effects. Consequently, the implementation of such a programme can be a measure aimed at improving the health-related quality of life of active military personnel in the Ministry of National Defence.

Keywords: knee sprain, proprioceptive exercises, dynamic balance test, prophylaxis.

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Introduction

A knee sprain is an injury due to the overstretching or tearing of one or more ligaments of the knee, thus affecting the stability of this joint (Kiadaliri et al., 2016). This type of trauma frequently occurs in athletes or people who practise sports activities by the nature of their professions, such as military employees in the Ministry of National Defence. The sensory impairment caused by a sprain alters sensory-motor integration, which entails reorganisation of motor control. The motor programmes are modified, which leads to a decline in the vigilance of the knee protection system due to a decrease in sensitivity, more precisely, an insufficient activity of the neuromuscular spindles, with multiple functional consequences...
that consist in decreasing the knee joint and postural stability (American College of Sports Medicine et al., 2006).

According to the literature, neuromuscular reprogramming after a sprain is based on two theories whose principles complement each other: Freeman’s theory and Thornard’s theory. After an acute sprain, the joint receptors (proprioceptors) are differentiated. As a result, proprioceptive information can no longer be transmitted or is partially transmitted to the central nervous system, which changes muscle reactions into feedback (Freeman et al., 1965). Thus, the knee muscles (hamstrings) contract to counteract the lesion movement and to position the knee joint at physiological amplitude (Patel & Villalobos, 2017).

Thornard et al. (1996) used EMG recordings to show that normal muscle responses to stimuli appeared after 60 ms, whereas movement in the injured areas appeared first, after 20 ms. In this context, proprioceptive re-education in feedback was rethought in feed-forward, which means that all proprioceptive information should be used to create motor schemes of anticipation in the central nervous system. Therefore, for neuromuscular reprogramming to be as effective as possible, the two theories should be combined to require coordination and anticipation of muscle contractions. In order to implement such a re-education programme, all proprioceptive information involved in the knee protection mechanism should be stimulated (Prakash et al., 2017). We considered that an effective way to stimulate the proprioceptive system would be represented by exercises specific to the practised sport in order to “bomb” the central nervous system with motor experiences similar to those lived by Ministry of National Defence workers.

Quality of life is a broad multidimensional concept that usually includes subjective assessments of positive and negative aspects of an individual’s life (Centers for Disease Control and Prevention, 2018). The concept of health-related quality of life refers to those aspects that demonstrate effects on either physical or mental health. Health-related quality of life is a measure that mirrors the health impact on a person’s ability to function independently and achieve physical, mental and social balance, regardless of political, economic or social status. Knee injury is frequently encountered in specialist care and is responsible for a significant number of days of inactivity for working people, including Ministry of National Defence employees. Knee sprain management is a public health issue, and optimising the recovery of this condition would improve the health-related quality of life of these individuals (Bindawas et al., 2015).

The link between quality of life research and medical practice is quite weak and is the subject of much wider discussion. Through this research, we aim to observe and put together the information extracted from the analysis of the participants’ quality of life and health status, along with their statistical parameters.

The concept of quality of life refers to both physical and social well-being and an individual’s ability to perform usual tasks in their profession and daily activities, as a measurable goal for the effectiveness of the kinetic prevention programme, in order to determine the needs of participants and plan their exercise programmes.
Methodology

Research purpose

The study aims to verify the effectiveness of proprioceptive exercises included in an original programme, as a method of preventing knee sprains or their recurrence in employees of the Ministry of National Defence. We also intend to check the impact of our interventions on the health-related quality of life of workers in the Ministry of National Defence with a view to recommending programmes applicable to this population, which is not yet included in research of this type.

Objectives

- Increasing the database of kinetic programmes applicable for primary or secondary prophylactic purposes in order to prevent knee sprains or their recurrence.
- Demonstrating that the proprioceptive system, if stimulated by specific exercises, can restore segmental stability through static and dynamic tasks.
- Identifying asymptomatic employees of the Ministry of National Defence who are at risk of injury and helping them to prevent knee sprains.
- Assessing the effectiveness of proprioceptive programmes on postural stability by applying proprioceptive exercises preceded by warm-up exercises.
- Assessing the knee function-related quality of life on completion of the experimental programme through the Lysholm Scale and 2000 IKDC questionnaires.
- Designing individual kinetic programmes aimed at enhancing the health-related quality of life of the research participants.

Tasks

- Documentation, consisting in the review of national and international publications on the topic addressed;
- Establishing the experimental group; in compliance with the principles of ethics in scientific research, we asked for and obtained the participants’ informed consent to get involved in the study;
- Selection of assessment tests;
- Analysis and interpretation of the assessment results;
- Systematisation of the obtained results;
- Drawing a conclusion from the analysis and interpretation of the study results.

Hypothesis

Stimulating the proprioceptive system through dynamic and static proprioceptive exercises that reproduce gestures specific to the sports practised by the research participants leads to
increased stability and balance control, thus preventing the recurrence or occurrence of knee sprains in Ministry of National Defence employees.

**Research group**

The research was conducted with Ministry of National Defence workers, who were included in the category of people practising the sports required by their professional activities carried out within the departments to which they belonged. These sports activities are varied and consist of: athletics, martial arts, football, volleyball and military application routes specific to the training of this professional category. All of these fall into the category of sports that require frequent pivoting and physical contact between players, being practised for recreational and social purposes but also to maintain a good level of physical training.

The research involved 15 active military workers (11 male and 4 female) from the Ministry of National Defence, who were included in an experimental group. The selection of participants was made using specific criteria as follows:

**Inclusion criteria:**
- Ministry of National Defence employees engaged in a continuous physical-military training programme at the time of the research;
- ages between 25 and 45 years;
- experience of at least 5 years in practising a sports activity;
- at least one history of previous knee injury;
- no knee surgery;
- no knee pain greater than or equal to 4 on the Visual Analogue Scale (VAS).

**Exclusion criteria:**
- ages under 25 and over 45;
- people who had undergone knee surgery (meniscus resection or ablation, etc.).

**Measurements**

**Star Excursion Balance Test (SEBT)** – a reliable and reproducible functional assessment test, which is easy to administer to the study population and highly representative of dynamic postural balance and lower extremity injury risk (Gribble et al., 2012). The literature review shows that it is widely used internationally in research on both healthy individuals (Ness et al., 2015) and people with previous injuries or lower extremity injury risk (Uebayashi et al., 2019). We also aimed to check the reliability of this relatively simple test when assessing the population category included in the present study.

**Lysholm Scale (Lysholm Knee Scoring Scale)** – a questionnaire introduced into the medical community in 1982 and modified in 1985, which is an important tool for the knee-function assessment in a multitude of medical situations: meniscus injury, patellar instability, patellofemoral pain, traumatic knee dislocation, osteochondritis, ligament surgery (Briggs et al., 2009). The current version of the Lysholm Scale includes 8 items that measure: limp (5 points), need for support (5 points), squatting (5 points), stair climbing (10 points), swelling (10 points), locking (15 points), instability (25 points) and pain (25 points), all of which
determine the overall result (Smith et al., 2009). The total score is the sum of the scores obtained from each response to the 8 items. The maximum total score is 100 points.

IKDC – a questionnaire developed in 1987, which has undergone several changes over time. In our research, we used the 2000 IKDC version. This is one of the most reliable assessment tools for patients with knee-related problems, which can be constantly used by all healthcare providers (Metsavaht et al., 2010). It is also a simple and quick-to-apply instrument that takes about 10 minutes to complete and uses an understandable language for the patient. The questionnaire items involve three aspects: symptoms, sports activity and knee function (Fu & Chan, 2011). The total score is the sum of the scores obtained from the three above-mentioned categories and ranges from 0 to 100 points. High scores indicate higher levels of knee function. The ‘symptoms’ subscale helps to measure pain, stiffness/locking, swelling and giving-way/instability of the knee. The ‘sports activity’ subscale focuses on functions such as going up and down the stairs, rising from a chair, squatting and jumping. The ‘knee function’ subscale asks patients one simple question: how is their knee at present versus how was their knee prior to injury?

Procedure

The proprioceptive re-education programme consisted of warm-up exercises and the programme itself or the experimental protocol.

The proprioceptive programme was carried out in conditions of body balance destabilisation and by performing some sporting gestures common to the physical activities in which the study participants were involved.

The exercises were done on unstable surfaces such as Bosu Ball, proprioception disc and stepper or on foam mattresses with different densities. Destabilising objects represented by elastic bands and specific balls were also used to perform dual-task exercises.

Given that jumping is a common sporting gesture for the study participants regardless of their sports disciplines, the proprioceptive programme consisting of destabilisation exercises was associated with jumping exercises on flat ground, on steps or unstable surfaces.

Participants benefited from individualised proprioceptive programmes with progressive difficulty in order to develop optimal proprioceptive sensitivity and detect the most effective adaptation and postural stability.

The proprioceptive re-education programme

To strictly highlight the effects of the experimental protocol, we respected the stages, principles and content of the warm-up exercises.

The training sessions performed over a period of 4 weeks, namely 12 workouts, were taken as benchmarks. This was preceded by one week allocated to testing the study participants (initial testing) and ended with one week in which the final testing was conducted.

Warm-up exercises preceded the experimental protocol and addressed structures used in the proprioceptive programme as follows:

The warm-up programme: lasted 10-12 minutes and consisted of low-speed walking exercises, walking and high-speed walking variants;
Stretching exercises: consisted of dynamic stretches performed while doing specific knee movements. The duration of these exercises was 10 minutes. It has been taken into account that progression is an important condition for ensuring the success of a stretching programme. Progression was gradual, moving from an easier to a more difficult task. The intensity of stretches was controlled by monitoring the associated pain. Stretches were performed at various hip and knee joint angles and through full range of motion to provide progressive lengthening and increased muscle flexibility. Stretching targeted the following: anterior thigh muscles (rectus femoris, vastus intermedius, vastus lateralis, vastus medialis, which together make up the quadriceps femoris muscle, with a major role as a knee extensor); posterior thigh muscles (biceps femoris, semimembranosus, semitendinosus, sartorius, gracilis); calf muscles (gastrocnemius, popliteus, plantaris).

Proprioceptive exercises: were performed as follows:
- in the first two weeks: posterior, anterior and lateral (left/right) destabilisations, 4 sets of 45 seconds, 2 for each leg;
- in weeks 3 and 4: posterior, anterior and lateral (left/right) destabilisations, 4 sets of 1 minute each; an altitude component was added, consisting of one-leg support on a stool 70 cm high.

The second stage of our programme involved assessing the study participants by means of the Star Excursion Balance Test (SEBT). We recall that the purpose of this test is to obtain leg control in stable support while the opposite leg performs successive movements in eight different directions.

SEBT protocol:
- The athlete stands on one leg in the centre of the star, with their hands firmly placed on their hips.
- The athlete should reach with one foot as far as possible from the centre of the star in one of the eight directions and lightly touch the line with the toe of the supporting leg before returning to the starting upright position. Throughout the test, the participant should hold their hands on their hips and maintain the squat position on the supporting leg, whose heel should be in permanent contact with the support surface.
- When using the right foot as the reaching foot and the left leg to balance, the athlete should complete the circuit in a clockwise direction, and when balancing on the right leg, the athlete should perform the circuit in an anti-clockwise direction.
- With a pencil or chalk, the test administrator should mark the spot at which the athlete has touched the line with their toe in every reach direction.
- Reach distances from the centre spot are measured in centimetres.
- The athlete should repeat the movement with the same foot in all reach directions before changing foot. After completing a full circuit (every reach direction) with each foot, the athlete should repeat this process three times per leg.
- After performing three successful reaches with each foot in all directions, the athlete is allowed to step away from the testing area. (Figure 1)

Failure to comply with one of these instructions leads to repeating the test in the direction of the unsuccessful execution (Herrington et al., 2009).
To ensure the reproducibility of the measurement, we created a support for this test: we covered the floor with linoleum on which we drew four lines intersecting at the same central point and thus obtained eight branches representing the eight directions of movement; the lines extended from a central point and were at 45-degree intervals from each other (Figure 2).

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

Average distance in each direction (cm) = Reach 1 + Reach 2 + Reach 3 / 3
Relative (normalised) distance in each direction (%) = Average distance in each direction / leg length x 100
Total score = \( \frac{\text{A} + \text{AL} + \text{L} + \text{PL} + \text{P} + \text{PM} + \text{M} + \text{AM}}{8} \) x 100

These calculations result in a total of 16 scores per athlete.

We took as benchmarks the values indicated by Gribble and Hertel (2003) as a percentage of leg length. We mention that these data were obtained on sedentary people.

To measure the performance of an individual’s lower limbs, comparisons can be made between absolute reach distances for each leg. However, reach distances should be normalised to each participant’s leg length measured from the anterosuperior iliac crest to the medial ankle and correlated with reach performance. This is expressed as a percentage of leg length. Body height can also be correlated with reach distance.
Muscle differences between certain distances in the SEBT directions can be helpful to specialists, who can decide which direction to use for patients with specific conditions such as lack of muscle strength.

Finally, SEBT performance became more consistent and pronounced after fatigue. Fatigue changes the effectiveness of the ability to contract extrafusal muscle fibres, which alters neuromuscular control (Gribble et al., 2012). Specifically, during local muscle fatigue, nociceptors are activated by the metabolic products of muscle contraction, including bradykinin, potassium and lactic acid. The basic idea is that fatigue can influence SEBT performance.

In the stage following the SEBT assessment, the Lysholm Scale and 2000 IKDC questionnaires were used to assess the knee function-related quality of life of the research participants. The two questionnaires were applied after the experimental programme.

The research included five steps:

- Establishing the experimental group based on the inclusion and exclusion criteria;
- Selecting the assessment tests and conducting the initial testing;
- Establishing the intervention protocol consisting of proprioceptive exercises;
- Applying the prophylactic programme to employees of the Ministry of National Defence in order to increase their knee stability;
- Assessing the functional level reached by the study participants, which was expressed by the likelihood of occurrence/recurrence of knee sprains at the end of the kinetic intervention period;
- Carrying out the statistical processing and analysis of the results.

The research methods used in this study were: literature review, interview survey (anamnesis), pedagogical observation, experiment, statistical mathematics and graphical representation. The results of the initial and final tests were summarised in tables, and then statistically processed and interpreted both individually and intragroup.

Statistical analysis

The processing of the results was performed using software programs such as IBM SPSS version 25.0., SPSS V23, Microsoft Office 2016, Word and Excel. Statistical data processing consisted of descriptive and inferential statistics. Descriptive statistics allow data to be presented in a meaningful way, and important characteristics of the data are described by statistical indicators: measures of central tendency (arithmetic mean), measures of dispersion and effect size. Inferential statistics apply statistical procedures through which correlations between variables are targeted, and the phenomena subject to statistical analysis are anticipated and understood. In this research, the paired \( t \) test is used to verify whether, during the application of experimental methods, significant progress has been recorded or not, and thus whether the null hypothesis is rejected or accepted. Rejection and acceptance of the null hypothesis also depend on the \( p \) value; if the value of the significance threshold is \( p < 0.05 \), then the mean difference is statistically significant. Interpretation of the \( d \) effect size was made according to Cohen’s recommendations (Cohen, 1988).
Results

*Proprioceptive exercises*

Proprioception played an essential role in balance control, the tone of the muscles concerned showed a significant improvement, and knee proprioception also improved. This explains the reduction of postural control disorders in these patients with a history of knee sprain.

*Star Excursion Balance Test*

- Statistical indicators for average distances (Table 1)

Following the statistically processed measurements, results were obtained for each direction in terms of average distances as regards both the affected and healthy lower limbs.

For the affected lower limb, the mean values of average distances indicate statistically significant differences from one test to the other ($p \leq 0.05$) for six directions: anterior, posterolateral, medial, lateral, posterior and anterolateral; the effect size ranges from 0.74 to 1.45. For the posteromedial direction, the effect size (0.55) shows an average difference between the two means. The increase of the mean in the final test is marginally significant ($p = 0.051$); the null hypothesis is rejected. Regarding the anteromedial direction, there have been increases in dynamic balance and postural control, but they are statistically insignificant ($p = 0.358, p > 0.05$); the null hypothesis is accepted.

Between the two tests performed with the healthy leg, the resulting statistical indicators highlight a significant improvement in dynamic balance and postural control ($p \leq 0.05$) for seven of the eight directions: anterior, anterolateral, lateral, posteromedial, medial, posterior and anteromedial. For these directions, the effect size has values ranging from 0.77 to 2.22; the null hypothesis is rejected. For the posterolateral direction, the effect size (0.20) shows a small difference between the two means, so the progress is insignificant ($p > 0.05$); the null hypothesis is accepted.

Table 1. *Average distances – statistical indicators*

<table>
<thead>
<tr>
<th>Directions</th>
<th>Effect size</th>
<th>Size difference (cm)</th>
<th>$p$ Value</th>
<th>$t$ Dependent</th>
<th>Effect size</th>
<th>Size difference (cm)</th>
<th>$p$ Value</th>
<th>$t$ Dependent</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.45</td>
<td>6.91</td>
<td>&lt; 0.001*</td>
<td>5.63</td>
<td>1.02</td>
<td>9.33</td>
<td>0.001*</td>
<td>3.96</td>
</tr>
<tr>
<td>AL</td>
<td>0.74</td>
<td>3.99</td>
<td>0.012*</td>
<td>2.87</td>
<td>1.16</td>
<td>6.11</td>
<td>0.001*</td>
<td>4.49</td>
</tr>
<tr>
<td>L</td>
<td>0.98</td>
<td>6.24</td>
<td>0.002*</td>
<td>3.80</td>
<td>2.22</td>
<td>7.33</td>
<td>&lt; 0.001*</td>
<td>8.60</td>
</tr>
<tr>
<td>PL</td>
<td>1.20</td>
<td>4.36</td>
<td>&lt; 0.001*</td>
<td>4.65</td>
<td>0.20</td>
<td>2.58</td>
<td>0.457</td>
<td>0.77</td>
</tr>
<tr>
<td>P</td>
<td>0.95</td>
<td>4.54</td>
<td>0.002*</td>
<td>3.68</td>
<td>0.82</td>
<td>5.98</td>
<td>&lt; 0.001*</td>
<td>8.60</td>
</tr>
<tr>
<td>PM</td>
<td>0.55</td>
<td>3.67</td>
<td>0.051*MS</td>
<td>2.14</td>
<td>1.06</td>
<td>4.09</td>
<td>0.001*</td>
<td>4.09</td>
</tr>
<tr>
<td>M</td>
<td>1.41</td>
<td>6.96</td>
<td>&lt; 0.001*</td>
<td>5.47</td>
<td>1.37</td>
<td>6.38</td>
<td>&lt; 0.001*</td>
<td>5.31</td>
</tr>
<tr>
<td>AM</td>
<td>0.25</td>
<td>2.98</td>
<td>0.358</td>
<td>0.95</td>
<td>0.77</td>
<td>5.36</td>
<td>0.010*</td>
<td>3.00</td>
</tr>
</tbody>
</table>

*Note:* Directions: A - anterior, AL - anterolateral, L - lateral, PL - posterolateral, P - posterior, PM - posteromedial, M - medial, AM - anteromedial; * $p \leq 0.05$ - statistically significant results; MS - marginally significant difference.
Statistical indicators for relative distances (Table 2)

For the affected lower limb, the mean values of relative distances indicate statistically significant differences from one test to the other \( (p \leq 0.05) \) for six directions: anterior, posterolateral, medial, lateral, posterior and anterolateral; the effect size ranges from 0.75 to 1.48. For the posteromedial direction, the effect size \( (0.55) \) indicates an average difference between the two means. The increase of the mean in the final test is statistically significant \( (p = 0.05) \); the null hypothesis is rejected. For the anteromedial direction, the resulting difference between the two means is statistically insignificant \( (p > 0.05) \), the effect size \( (0.25) \) indicating weak progress from one test to the other; the null hypothesis is accepted.

For the healthy lower limb, the effect size ranges from 0.75 to 2.30 for seven directions: anterior, anterolateral, lateral, posteromedial, medial, posterior and anteromedial, with statistically significant differences \( (p \leq 0.05) \) from one test to the other; the null hypothesis is rejected. Only for the posterolateral direction, the effect size \( (0.19) \) shows a statistically insignificant difference recorded in the final test \( (p > 0.05) \); the null hypothesis is accepted.

Table 2. Relative distances – statistical indicators

<table>
<thead>
<tr>
<th>Directions</th>
<th>Affected lower limb</th>
<th>Healthy lower limb</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Effect size</td>
<td>Size difference (%)</td>
</tr>
<tr>
<td>A</td>
<td>1.48</td>
<td>7.80</td>
</tr>
<tr>
<td>AL</td>
<td>0.75</td>
<td>4.57</td>
</tr>
<tr>
<td>L</td>
<td>0.99</td>
<td>7.07</td>
</tr>
<tr>
<td>PL</td>
<td>1.21</td>
<td>4.90</td>
</tr>
<tr>
<td>P</td>
<td>0.97</td>
<td>5.09</td>
</tr>
<tr>
<td>PM</td>
<td>0.55</td>
<td>4.15</td>
</tr>
<tr>
<td>M</td>
<td>1.42</td>
<td>7.88</td>
</tr>
<tr>
<td>AM</td>
<td>0.25</td>
<td>3.45</td>
</tr>
</tbody>
</table>

Note: Directions: A - anterior, AL - anterolateral, L - lateral, PL - posterolateral, P - posterior, PM - posteromedial, M - medial, AM - anteromedial; * \( p \leq 0.05 \) - statistically significant results; MS - marginally significant difference.

Total mean score

The total mean score for the affected lower limb increased (Figure 3) in the final test of the group by 495.56 cm, from 9,890.83 cm to 10,386.39 cm. The dispersion of scores is homogeneous in both tests. The effect size, 1.94 (according to Cohen’s \( d \) coefficient for the dependent \( t \) test), reveals a very large difference between the two means. The mean difference indicates a significant increase in dynamic balance and postural control for the affected lower limb, with a significance threshold of \( p < 0.001 \) for \( t = 7.51 \). The null hypothesis is rejected.
Figure 3. Total mean score – affected lower limb

The total mean score (Figure 4) for the healthy lower limb increased in the final test of the group by 610.56 cm, from 10,209.72 cm to 10,820.28 cm. The dispersion of scores is homogeneous in both tests. The effect size, 1.50 (according to Cohen’s $d$ coefficient for the dependent $t$ test), reveals a very large difference between the two means. The mean difference indicates a significant increase in dynamic balance and postural control for the healthy lower limb, with a significance threshold of $p < 0.001$ for $t = 5.81$. The null hypothesis is rejected.

Figure 4. Total mean score – healthy lower limb

Statistical indicators for Lysholm Scale

Table 3 shows the total scores and grades obtained for knee function by the group of participants after applying the experimental protocol of proprioceptive exercises.

Table 3. Lysholm Knee Scoring Scale
It can be seen that, following the experimental programme applied to the 15 participants for both therapeutic and prophylactic purposes, 11 feel “excellent”, 3 feel “good” and 1 feels “fair”.

**Statistical indicators for the 2000 IKDC questionnaire**

Table 4 shows the number of points and total scores determined using the 2000 IKDC questionnaire as a knee-function assessment tool for the group of participants.

Table 4. 2000 IKDC items – score

<table>
<thead>
<tr>
<th>Participants</th>
<th>Symptoms</th>
<th>Sports activities</th>
<th>Knee function</th>
<th>IKDC score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I1</td>
<td>I2</td>
<td>I3</td>
<td>I4</td>
</tr>
<tr>
<td>P1</td>
<td>4 9 9 4 4 1 4 4 36 10</td>
<td>85</td>
<td>97.7%</td>
<td></td>
</tr>
<tr>
<td>P2</td>
<td>4 10 10 4 4 1 4 4 36 10</td>
<td>87</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>P3</td>
<td>4 10 10 3 4 1 4 4 36 10</td>
<td>86</td>
<td>98.9%</td>
<td></td>
</tr>
<tr>
<td>P4</td>
<td>3 8 8 3 3 1 3 3 31 8</td>
<td>71</td>
<td>81.6%</td>
<td></td>
</tr>
<tr>
<td>P5</td>
<td>4 9 9 4 4 1 4 4 36 9</td>
<td>84</td>
<td>96.6%</td>
<td></td>
</tr>
<tr>
<td>P6</td>
<td>4 10 10 4 4 1 4 4 36 10</td>
<td>87</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>P7</td>
<td>3 9 9 3 3 1 3 3 31 7</td>
<td>72</td>
<td>82.8%</td>
<td></td>
</tr>
<tr>
<td>P8</td>
<td>4 10 10 4 4 1 4 4 36 10</td>
<td>87</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>P9</td>
<td>4 10 10 4 4 1 4 4 36 10</td>
<td>87</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>P10</td>
<td>3 9 9 3 3 1 3 3 31 9</td>
<td>74</td>
<td>85.1%</td>
<td></td>
</tr>
<tr>
<td>P11</td>
<td>4 10 10 4 4 1 4 4 34 10</td>
<td>85</td>
<td>97.7%</td>
<td></td>
</tr>
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<td>98.9%</td>
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<tr>
<td>P13</td>
<td>3 8 8 3 3 1 3 3 27 8</td>
<td>67</td>
<td>77.0%</td>
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<tr>
<td>P14</td>
<td>4 10 10 4 4 1 4 4 36 10</td>
<td>87</td>
<td>100.0%</td>
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<tr>
<td>P15</td>
<td>4 10 10 4 4 1 4 4 36 10</td>
<td>87</td>
<td>100.0%</td>
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</table>

The scores of the study participants fall within the range of 67 to 87, with 67 as the lowest value and 87 as the highest value.

Of the total of 15 investigated participants (S), 6 obtained the maximum score (Figure 6).

Figure 6. Total score for the 2000 IKDC questionnaire
Discussion

The literature data show that, although proprioception has two components, a static one (position sense) and a dynamic one (motion sense), most studies addressing this topic have focused on the former. Moreover, they have emphasised that proprioceptive ability is influenced by many factors, including task difficulty and the lower extremity preference. All in all, research is scarce in this regard (Gribble et al., 2012). However, it is precisely the niche that we have detected and for which we have tried to provide solutions. The effects of warm-up exercises are controversial. According to some opinions, the warm-up performed before applying the proprioceptive programme itself leads to increased flexibility of the musculoskeletal structures, which is why they play a key role in injury prevention. There are also opinions that the warm-up induces fatigue and decreases proprioceptive acuity, thus increasing the risk of injury (Cheung et al., 2013).

In this context, it would be useful to monitor the magnitude and progression of fatigue over time in terms of its impact on dynamic postural stability (during motion). Further research is needed on the duration of a proper warm-up programme, which includes measurements performed after both warm-up exercises with different lengths and the proprioceptive programme.

As a result of assessing the study participants with the help of SEBT associated to the programme of dynamic and static proprioceptive exercises, the total mean score resulting from data processing highlighted statistically significant differences for our participants. The total mean score is the summative indicator that supports the formulated hypothesis according to which the proprioceptive exercise programme has both prophylactic and therapeutic effects on postural control and dynamic balance. In our study, all participants experienced significant increases in both their affected and healthy lower limbs.

Following the experimental programme, the study group was administered the Lysholm Scale and 2000 IKDC questionnaires focused on health-related quality of life after knee injuries. The above-mentioned instruments have previously been used in other specialised studies (Williams et al., 2020).

A positive aspect emerging from this study is that, following the proprioceptive exercise programme applied over a period of 4 weeks (12 sessions, 3 workouts per week), there has been a significant improvement in the participants’ dynamic balance and postural control. The training length and frequency used have previously been mentioned in other specialised studies (Prabhakar et al., 2020).

According to the literature, the duration of proprioceptive programmes varies between 8 and 36 weeks, with a frequency ranging from 20 minutes per week to 30 minutes per day. Despite the variability of the training parameters, an overall effect was still detected (Schiftan et al., 2014). We intend to extend the application period of the proprioceptive programme in further studies.

The average age of the study group is between 25 and 45 years and, as it is known that high-level physical training may lead to health impairment in the long term, this may also cause a decline in quality of life.

Through the research undertaken, we propose the development and implementation of a proprioceptive programme carried out in conditions of body balance destabilisation and by
performing some sporting gestures common to the physical activities in which the study participants are involved. Such a programme will lead to an increase in dynamic balance and will contribute to preventing injuries or traumatic sprains and their recurrence. Improving the prophylactic and therapeutic management of lower limb injuries can be achieved through proprioceptive exercise programmes, neuromuscular reprogramming and the use of simple tests in screening investigations of active personnel within the structures of the Ministry of National Defence to detect predisposition to injury.

The research results showed that the proprioceptive exercise programme applied to participants had functional outcomes, led to a decrease in pain, demonstrated the importance of strengthening the knee muscles, and ultimately increased health-related quality of life.

Awareness of the role played by the dynamic and static proprioceptive exercise programme in improving knee-related quality of life will result in increased working age, work quality and exercise capacity through injury prevention.

**Conclusion**

Loss of proprioceptive control could explain knee instability and the predisposition to joint trauma. Knee sprain management is a public health issue, and optimising the recovery of this condition would improve the health-related quality of life of these individuals. Knee injury is frequently encountered in specialist care and is responsible for a significant number of days of inactivity for working people, including Ministry of National Defence employees. Detection of knee instability and its treatment before the joint is traumatised is particularly important for this professional category, which must be in very good physical condition to cope with periodic physical tests and the daily demands of military training programmes. Through the statistical processing of the data obtained from the application of the proprioceptive exercise programme and SEBT to the group of active military participants, the research results highlight increases in all directions of movement from the initial to the final testing for both average and relative distances. Regarding the total mean scores of the study participants, a significant increase in dynamic balance and postural control can be observed. Also, after applying the questionnaire method and statistically processing the participants’ responses, a significant improvement in knee function is noted as an effect of the therapeutic programme. These findings confirm the research hypothesis.

Therefore, a kinetic programme based on proprioceptive exercises applied to employees of the Ministry of National Defence is intended to prepare them for a better health-related quality of life and an increased professional quality. At the same time, these exercises should be promoted and supported by improving the morpho-functional indices of the body to reduce health risk factors.

Extending the research to a larger sample of participants would provide more information on whether or not the hypothesis can be generalised. The effectiveness of the proposed programme should also be checked according to the participants’ gender and age.
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Informed Consent Statement: The patients/participants provided their written informed consent to participate in this study.

Data Availability Statement: Data are available upon request to the contact author.

Conflicts of Interest: The authors declare no conflict of interest.

References


