

Physical treatment matters: Improving endurance in law enforcement students through physical vascular therapy

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Abstract

Introduction: Adequate physical fitness is crucial for the effectiveness of law enforcement personnel. This study explores the potential for improving the fitness of law enforcement officers through physical vascular therapy, alongside traditional performance-enhancing techniques. Law enforcement students participated in an intensive four-week basic training program as part of their higher education. The research specifically investigates how endurance can be improved using the Bio-Electro-Magnetic-Energy-Regulation (BEMER) physical vascular therapy device, which is used in medicine and sports science for preventative, rehabilitative, and regenerative purposes. Numerous national and international studies have confirmed the device's positive effects. **Materials and Methods:** This study assesses students' performance through three exercises: two targeting strength endurance and one specifically measuring overall endurance. A randomized, controlled, double-blind trial was performed with 60 volunteers. The validity of the results was evaluated using statistical analyses, which also confirmed the changes in performance. **Results:** For the three exercises—jumping over a stool (JOS), medicine ball pass to the wall (MBP), and shuttle run (SR)—there was no significant difference between the Verum and control groups in the pre-test. However, in the post-test for the shuttle run, a significant difference was observed ($p = 0.001$). Specifically, regarding endurance, the treated group showed a positive and significant improvement compared to the control group, with the post-test shuttle run results demonstrating a clear advantage for the experimental group. **Conclusions:** The novel findings suggest that BEMER has a positive effect on the endurance of law enforcement students. Consequently, its future use as an adjunctive treatment to enhance student endurance is recommended.

Keywords: police, physical training, endurance, BEMER, physical vascular therapy

Introduction

Eligibility tests are designed to identify the most suitable candidates for specific positions, thereby improving the effectiveness of the organization. This holds true for law enforcement agencies as well. Despite the technical and tactical advances of recent decades, which have sometimes led to underestimating physical fitness, it remains crucial for officers working in the field to attain and maintain the appropriate physical condition to perform their duties effectively.

The effectiveness of law enforcement work depends on multiple factors, but physical fitness and endurance are undeniably crucial for practical tasks (Kukić et al., 2020). Police officers must perform physically demanding duties that require maintaining an appropriate level of fitness (Lockie et al., 2023). Their work is diverse, involving various tasks in unpredictable environments with fluctuating workloads (Dicks et al., 2023). Physical eligibility and technical skills are vital in policing because it is a high-risk profession with considerable physical demands (Barbosa et al., 2022). Beyond their roles as "crime hunters" and enforcers of the law, police officers are also expected to serve as public role models and fulfill responsibilities as problem solvers, order maintainers, public service providers, community observers, and chief executives with a strong understanding of social issues (Warsino et al., 2022).

Hungarian law enforcement officer training is performed by the Faculty of Law Enforcement at Ludovika University of Public Service. The Faculty is tasked with educating law enforcement professionals to advanced qualification levels for officer, public-sector employee, and civil service roles in the law enforcement sector. This includes agencies such as the Police, the Hungarian Prison Service, the Hungarian National Tax and Customs Administration, the Hungarian National Directorate General for Disaster Management, the Hungarian National Directorate-General for Aliens Policing, as well as civil national security services, private security, and local government sectors. Students at the Faculty pursue their studies through three- and four-year full-time programs, as well as three-year Bachelor's and two-year Master's correspondence courses. The admission process includes a physical fitness test. Enrolled officer candidates must pass this test every six months during their training. After graduation, officers are enlisted and continue to undergo physical fitness tests twice a year.

For certain law enforcement organizations overseen by the Minister of Interior, eligibility tests for professional and administrative staff specify regulations for assessing eligibility, health, psychological status, and physical fitness according to the service position and age group. The physical fitness assessment includes both dynamic tasks (e.g., *shuttle run*) and static tasks (e.g., *push-ups*), and the admission physical fitness test is also defined by this legislation.

There is insufficient time to fully develop and maintain law enforcement officers' physical abilities during university training, making it necessary to introduce new, effective methods. Because all university students have the same workload during basic training, they are an ideal group for testing innovative approaches. Roberto de Renzi and colleagues have explored the use of integrated circuit training alongside traditional methods to improve multiple physical abilities by optimizing training timing and promoting well-being and performance during work tasks. Their research led to the design and development of the Multifunctional Tactical Training (MTT) method, which comprises a series of multiple specific and functional exercises tailored for Mobile Units officers (de Renzi et al., 2021).

In our study, we aim to confirm the effectiveness of a development method with scientifically proven benefits in regeneration and rehabilitation, as well as performance enhancement. While previous studies involving athletes have shown promising results, they involved relatively small sample sizes. In contrast, our study enrolled a larger number of students. To date, no similar research has examined the positive impact of this method on performance in law enforcement organizations. The method under investigation uses pulsed electromagnetic fields in physiotherapy. This randomized, controlled, double-blind study included 30 participants in each group and demonstrated significant differences between pre- and post-test results. Specifically, in the shuttle run, the experimental group receiving Bio-Electro-Magnetic-Energy-Regulation (BEMER) physical vascular therapy showed significantly better post-test performance compared to the control group. This is the first study of its kind to assess the effects of a physical vascular therapy device.

Hypotheses

1. Individuals undergoing BEMER therapy will demonstrate a significant improvement in endurance compared to those using a placebo device.
2. No significant differences are expected between the Verum and control groups in any exercise during the pre-test.
3. A significant difference is expected in the post-test, likely driven mainly by the endurance assessment exercise, with changes expected particularly in the shuttle run results.

Participants are evaluated based on a detailed physical fitness test performed on day 0 (pre-test) and day 30 (post-test) of the study. Police officer candidates were randomly assigned to groups, remaining unaware of their group allocation.

Literature review

Conditioning abilities encompass the physical attributes of strength, speed, and endurance, all of which are essential for athletic performance. Each attribute has distinct manifestations, and developing these abilities depends on different muscle characteristics. Because of this, they cannot all be developed simultaneously, and beyond a certain point, improving one attribute may come at the expense of another.

Endurance is the capacity to sustain an activity continuously and at a relatively high intensity over an extended period. In police work, both speed endurance and strength endurance are important. Speed endurance relies on muscle resilience and involves recovery between efforts, supported by the aerobic system. Strength endurance refers to the ability to exert significant force over a prolonged duration.

Endurance training induces several specific changes in muscles, primarily affecting muscle metabolism. A trained muscle can consume more oxygen during exertion, which promotes faster recovery. It also stores greater amounts of glycogen and fat, increases lipid oxidation, and accumulates less lactic acid. The concentration of myoglobin, an oxygen reservoir, increases, enhancing the muscle's buffering capacity, while stores of adenosine triphosphate (ATP)—the basic unit of intracellular energy transfer—and creatine phosphate (CP) are replenished. Importantly, endurance training improves blood flow to the muscles by expanding the vascular network, increasing the number of capillaries, and enhancing the vasodilation capacity of blood vessels. The main factor contributing to the onset of fatigue is insufficient oxygen supply, meaning that endurance performance is ultimately limited by the capacity of the cardiovascular system.

The circulatory response differs between dynamic and static loads. During static load, cardiac output increases less, while peripheral resistance increases owing to increased muscle tone. In contrast, dynamic load accelerates venous circulation and increases heart rate, cardiac output, and blood flow. This leads to significant dilation of the skeletal muscle vascular network, a decrease in peripheral resistance, and typically a reduction in diastolic blood pressure at the end of exertion.

As muscles adapt to exercise, the cardiovascular system also enhances blood supply to the muscles. Several factors contribute to this effect, including morphological changes in trained muscle circulation—such as larger diameters of lower limb arteries and a denser capillary network. These adaptations result in faster capillary recruitment in trained muscles, more efficient and rapid blood redistribution, and greater overall blood volume. Additionally, in trained individuals, the circulatory system adapts more quickly and effectively to increased workloads (Pavlik, 2019).

Maintaining and improving performance is essential not only in elite sports. The unpredictable nature of police work often presents greater challenges than those faced by elite athletes. In action, there is no time for warming up or relying on rehearsed movements that apply uniformly across situations; only a well-trained, physically fit, and mentally prepared police officer can effectively meet these demands.

One key component of the police selection system is the assessment of physical abilities (Nutting & Maxwell, 1992; Copay & Charles, 1998; Lord, 1998; Anderson et al., 2001; Strating et al., 2010). The significance of physical fitness is reflected not only in the selection process but also in the ongoing training and education of police personnel (Nutting & Maxwell, 1992; Anderson et al., 2001; Chappell, 2008; Strating et al., 2010; Lagestad & Tillaar, 2014). Physical fitness evaluations serve both as part of the hiring procedure and as mandatory fitness tests for active officers. In my research, university students completed the tasks involved in the admission process. The aim of the following literature review is to examine the criteria for suitability in pursuing a professional law enforcement career in an international context.

USA

When recruiting for the New York Police Department (NYPD), the physical fitness test includes exercises measuring speed, agility, cardiorespiratory endurance, and muscular strength. Both men and women must complete the test within a time limit of 4 min and 28 s (URL5). In Alabama, the Huntsville Police Academy requires candidates to perform timed push-ups and sit-ups, followed by a series of five agility and ability tasks—pushing, climbing, window entry, balance, and weight drag—that simulate typical field activities. Each of these five tasks must be completed within 90 s. Finally, the test concludes with a one-and-a-half-mile run (URL6).

Austria

The sports test is no longer part of the selection process for Austrian police applicants but has been incorporated into basic training. However, applicants' physical fitness is still ensured through a sports medical examination during admission, which includes, among other assessments, a bicycle ergometer test. The physical performance test in police basic training consists of a push-up test (measuring strength) and an endurance test, which may involve running 3000 m, cycling 10 or 20 km, or swimming 300 m (URL7).

Norway

At the Norwegian Police University College, students must complete four physical tests—bench press, pull-up, standing long jump, and a 3000 m run—that assess basic physical skills required for police work. These tests evaluate abilities related to maximal strength, muscular endurance, and overall strength and endurance (Lagestad & Tillaar, 2014).

Serbia

The Basic Police Training Center in Sremska Kamenica, under the Serbian Ministry of the Interior, outlines its physical admission requirements on its website. Candidates are required to perform several exercises, including rolling three balls (slalom around buoys), push-ups, long jump, sit-ups, and the Cooper test (URL8).

Croatia

The required level of physical motor skills is assessed at the Police Academy in accordance with the Decree on the criteria for evaluating the physical motor skills of police recruits (URL9). According to the Ministry of the Interior's website, the Josip Jovic Police Academy measures the following exercises: long jump, a skill-testing course (Poligon natraške), arm strength (push-ups for men, and push-ups on a special bar for women), abdominal muscle strength measured on a bench, and a 2400-m run.

Slovakia

In the Slovakian training system, five age groups for men and three for women have been established, each with differentiated requirements for applicants. The men's exercises include a 100-m run, sit-ups, the Cooper test, 100-m swimming, long jump, pull-ups, and a 4 × 10 m shuttle run. The women's exercises consist of a 50 m run, sit-ups, the Cooper test, 100 m swimming, hanging, and a 4 × 10 m shuttle run (URL10).

It can be concluded that, regardless of continent or country, endurance measurement is a common component of all admission requirements. This emphasis reflects the demanding workload typical of law enforcement organizations. Additionally, training programs prioritize assessments of various aspects of dynamic strength. My research mainly focuses on the development and maintenance of endurance in police training.

The Role of Physical Vascular Therapy in Physiotherapy

Physiotherapy encompasses a range of ancient, natural remedies that use the energies of nature for healing. It includes all medical treatments that use natural methods to restore and maintain health. Beyond physical therapy, physiotherapy also uses chemical energies, the healing properties of thermal waters, and climatotherapy because these are natural therapeutic approaches.

The scientific practice of physiotherapy began in the 18th century, evolving alongside discoveries such as electricity. The 20th century brought rapid technological advancements, including the exploration of radiation in physiotherapy. Institutes and spas opened worldwide, greatly expanding the physiotherapeutic toolkit. Electrotherapeutic and advanced magnetotherapeutic devices were improved, and scientific research was initiated to confirm the therapeutic effects of magnetic fields.

Physiotherapy encompasses several therapeutic disciplines, including physical therapy, balneotherapy, dietotherapy, and climatotherapy. The largest subfield is physical therapy, which involves treatments that use

physical energy. Physiotherapy is categorized based on the type of energy applied: mechanotherapy (active, such as physiotherapy exercises; and passive, such as massage and ultrasound therapy), hydrotherapy, electrotherapy, phototherapy, and magnetotherapy. Physiotherapeutic interventions are essential for optimizing sports performance. The effectiveness and benefits of these techniques in improving athletic performance are widely recognized in the medical field. The use of evidence-based physiotherapy not only aids athletes in injury recovery but also plays a key role in injury prevention and performance optimization.

Magnetotherapy, a natural remedy in physiotherapy, involves the use of physical energy. It is defined as a physiotherapeutic procedure where an artificial magnetic field is applied to a dysfunctional or injured area—or the entire body—by controlling the direction, frequency, and intensity of the magnetic fields. The magnetic fields commonly used in physiotherapy fall into two categories: (a) *static* or *permanent magnetic fields*, delivered by small, high-performance magnets, whose effects remain not fully understood and are classified as magnetotherapy; and (b) *pulsed magnetic fields*, differentiated by their frequency. High-frequency applications, such as pulsed short waves, and low-frequency treatments, including magnetotherapy, are also used.

BEMER, Physical Vascular Therapy

The first systems of the current generation of electromagnetic field therapeutic devices were developed in the late 20th century by Prof. Dr. König and Dr. Warnke. In his research on electromagnetic fields, Prof. Dr. Wolf A. Kafka was the first to propose that measurable physiological effects could arise from inter- and intramolecular interactions, among other factors. Recognizing that only molecules and ions with a narrow range of masses and charges respond to the same impulses, he aimed to develop a signal shape capable of stimulating a wide variety of molecules with different masses and permanent bonds. Through his research, Kafka developed the BEMER 3000 signal shape, which led to the launch of the BEMER 3000[®] therapeutic device in 1999. This signal shape was further developed by Klopp in 2010, resulting in the introduction of the next-generation BEMER Classic Set[®] and BEMER Pro Set[®]. Today, a wide range of devices for home use are available on the market, though they differ considerably in both the type of stimulation and the intensity applied (Möbes, 2003). BEMER transmits a patented, biorhythmically defined therapeutic signal using pulsed electromagnetic fields (PEMF).

BEMER generates a broadband, low-frequency electromagnetic field with an intensity comparable to that of natural biological systems, thereby improving energy levels without causing any adverse side effects.



Figure 1. BEMER 3000, 1st generation device (Source: URL1)



Figure 2. BEMER Pro Set (Source: URL2)



Figure 3. BEMER EVO Set (Source: URL2)

By enhancing various physiological processes—such as improving blood circulation, increasing the partial pressure of oxygen in the blood, exerting anti-inflammatory effects, and activating the synthesis of certain proteins—the body's natural healing and regenerative capacity can be increased by approximately 40% (Klopp, 2008).

In a placebo-controlled study, R. Klopp examined microcirculation based on its functional characteristics. He evaluated the effectiveness of six different physiotherapeutic devices used as adjunctive therapies for impaired circulation. Of the six commercially available devices tested, two were found to be ineffective, while three showed only low therapeutic efficacy. Only one device demonstrated significant adjunctive therapeutic benefits: the BEMER device, which uses a specific biorhythm-based stimulation signal to improve circulation (Klopp et al., 2013).

Clinical trials have demonstrated the effectiveness of the BEMER vascular therapy device. It is currently used mainly in medicine to improve microcirculation, relieve pain, treat high blood pressure and fractures, and in sports for warming up, preventing and treating injuries, and improving performance (Nagy & Freyer, 2022).

BEMER is designed to stimulate vasomotion—the rhythmic contraction of the smallest blood vessels—using an electromagnetic field generated by a specially configured, multi-modulated, low-intensity pulsed signal. Owing to its specific biorhythmic modulation, BEMER also has a synergistic effect on the function of surrounding larger blood vessels, thereby enhancing microcirculatory blood flow in the treated areas. This improved circulation supports the body's natural regulatory mechanisms, strengthens the immune system, and promotes protein synthesis. BEMER technology is suitable for both disease prevention and use as an adjunctive therapy. As physiotherapeutic devices, BEMER systems exert a beneficial physiological effect on microvessels through the unique BEMER pulse.

Medical Results Achieved

The effectiveness of BEMER as a physical vascular therapy has been extensively studied and demonstrated across a wide range of medical fields, including dermatology, diabetology, endocrinology, otorhinolaryngology, dentistry, neurology, rehabilitation, ophthalmology, traumatology, and veterinary medicine, among others.

Below are specific examples of scientific evidence from double-blind, placebo-controlled studies evaluating the BEMER therapy system in medical applications.

Improved Microcirculation

Bernát's study evaluated the potential benefits of BEMER bio-electromagnetic-regulation therapy on microcirculation in patients with occlusive peripheral arterial disease, focusing on lower limb circulation and intermittent claudication (Bernát, 2013). Thirty patients with this condition were recruited. Initially, their pain-free and maximum walking distances were measured using a treadmill. After a placebo phase, patients underwent 16 sessions of bio-electromagnetic-regulation therapy with a BEMER device, each session lasting 8 and 20 min. After completing the therapy, their pain-free and maximum walking distances were reassessed. In the second phase of the study, patients received intravenous treatment with the drug pentoxifylline. Bio-electromagnetic-regulation therapy increased the pain-free walking time and maximum walking distance by 57.4% ($p = 0.005$) and 36.6% ($p = 0.042$), respectively. When combined with the second therapy, these improvements increased to 81.9% and 84.0%, respectively. The combination therapy was significantly more effective than both placebo-controlled and bio-electromagnetic-regulation therapies alone ($p = 0.000373$ and $p = 0.00741$, respectively). Clinical efficacy of the combination therapy was rated as good or excellent in 70% of patients (Bernát, 2013).

Improved Quality of Life

Between April 2011 and March 2013, Wolfgang Bohn et al. analyzed 658 valid patient questionnaires as part of mandatory market monitoring for certified medical devices. The questionnaires mainly used three scientifically recognized scales to assess changes in sleep, pain, and quality of life in patients who had undergone six weeks of physical BEMER® vascular therapy for various conditions. The results clearly demonstrated significant improvements across all measured areas with this adjunctive therapy, regardless of the patients' underlying health conditions (Bohn et al., 2013).

Pain Relief and Reduction

Gyulai et al. evaluated the effects of adjunctive BEMER therapy in patients with osteoarthritis of the knee and chronic low back pain in a randomized double-blind study. The study enrolled fifty patients with chronic low back pain and fifty with knee osteoarthritis, divided into four groups. Hospitalized patients received standardized physiotherapy for three weeks, followed by either BEMER therapy or a placebo. The results showed that BEMER physical vascular therapy provided short-term relief from pain and fatigue in patients with chronic low back pain, while long-term treatment appeared beneficial for patients with osteoarthritis of the knee (Gyulai et al., 2015).

Kyle et al. investigated the effects of osteopathic manipulative therapy (OMT) and BEMER therapy, both individually and combined, on low back pain in adults. Subjective pain ratings on the visual analog scale (VAS) showed a significant mean reduction of 50.8% in the group receiving both OMT and BEMER therapy compared to baseline. In contrast, the groups receiving either OMT or BEMER alone experienced reductions of

10.2% and 9.8%, respectively. These results highlight the increased therapeutic effect of combining OMT with BEMER therapy for low back pain (Auger et al., 2021).

Treatment of Conditions Related to High Blood Pressure

Stewart et al. examined the effects of 12 weeks of PEMF therapy on peripheral vascular function, blood pressure (BP), and nitric oxide (NO) levels in individuals with hypertension. The PEMF group demonstrated significant improvements in flow-mediated dilation (FMD) normalized to hyperemia after treatment. Additionally, reductions in systolic, diastolic, and arterial blood pressure were observed in all groups except the control group. These findings suggest that 12 weeks of PEMF therapy can improve blood pressure and vascular function in hypertensive patients. However, further research is needed to clarify the mechanisms by which PEMF influences endothelial function (Stewart et al., 2020).

Fracture Treatment

Participants were randomly enrolled in a fracture recovery study and divided into two groups of 16 each (control: $n = 16$, case: $n = 16$). The control group received conventional therapy only, while the case group received PEMF therapy in addition to conventional treatment. Patients in the case group underwent immediate postoperative PEMF therapy for 6 h, followed by 3 h of exposure daily for 6 days. This was then reduced to 1.5 h daily on postoperative days 8–13.

A study on jaw fracture recovery demonstrated that postoperative PEMF therapy promoted increased bone density, faster healing, increased new ossification, and pain relief (Mohajerani et al., 2019).

Cancer Management

Based on previous findings, electromagnetic field application influences cellular metabolism. Katja Storch and her colleagues evaluated the metabolism of A549 cancer cells using the BEMER system and found significant differences in metabolites from various pathways, particularly glycolysis and the TCA cycle, compared to untreated cells. Their results clearly demonstrate that the radiosensitivity of human cancer cells cultured in physiological environments can be increased in a time-dependent manner using the specific BEMER EMF pattern. In summary, research suggests that BEMER therapy improves cancer cell radiosensitivity through reactive oxygen species (ROS) in a manner dependent on both exposure time and intensity (Storch et al., 2016). Maria V. et al. examined the effects of PEMF therapy in oncology by summarizing and reviewing several related studies. In vitro research supports the anti-tumor and anti-angiogenic properties of PEMF therapy. This therapy can change cancer cell physiology and electrochemistry, impacting cell membrane systems and mitosis. Additionally, PEMFs exhibit immunomodulatory effects. PEMF therapy not only targets tumor cells directly but may also produce systemic effects. Two clinical studies have evaluated PEMF therapy for cancer treatment, demonstrating that it is a safe and promising option compared to existing cancer therapies (Vadalà et al., 2016).

Studies Highlighting the Effectiveness of BEMER in Sports

The effectiveness of BEMER-induced low-frequency pulsed magnetic field therapy in improving athletic performance was demonstrated in an earlier double-blind study (Malomsoki & Babindák, 2006). Athletes who received the therapy showed greater performance improvements compared to untreated participants. Specifically, treated athletes exhibited higher anaerobic lactic acid output and a more favorable Conconi transition—a non-invasive method for determining the anaerobic threshold (Conconi et al., 1982). Additionally, treated subjects were able to more rapidly compensate for lactic acidosis produced during exercise than those untreated.

Other physiological changes observed in the study indicated that tissue oxygenation was better in athletes treated with pulsed magnetic fields compared to untreated athletes. Tamulevicius et al. (2021) investigated the effects of BEMER therapy during pre-season training of endurance athletes. One key predictor of endurance performance, especially for long-distance runners, is the ventilation threshold (VT). Participants completed six runs at altitude, with one group receiving BEMER therapy before and after each training session, while the other group followed conventional training methods over a total of 12 sessions. The results showed that time had a significant effect on absolute and relative VT, as well as on maximum heart rate, heart frequency, and respiratory rate.

This study was the first to evaluate PEMF technology alongside high-altitude basic training. The results demonstrated that BEMER therapy could improve VT during short-term training camps by optimizing recovery and reducing fatigue through improved microvascular blood circulation (Tamulevicius et al., 2021). The regenerative effects of BEMER therapy are illustrated in the following study. Under normal physiological conditions, creatine kinase (CK)—an enzyme involved in cellular energy production—is present in the blood at very low levels. However, muscle damage caused by trauma, soreness, or other types of musculoskeletal overload leads to increased release of CK into the bloodstream, resulting in high concentrations. The timing and amount of CK release depend on the duration and intensity of exertion. In sports, exercise-induced stress accumulates, causing prolonged elevated CK levels, with resting CK activity reflecting the residual effects of prior physical stress. A double-blind study performed by Karin Möbes on subjects treated with the BEMER 3000 system showed significantly earlier reductions in CK levels. Recovery times were measured at 7.2 h for the treated group and 9.2 h for the placebo group ($p = 0.025$). With BEMER therapy, the increase in CK levels after exertion was delayed and returned to baseline more quickly. The decrease in CK was substantially faster in the group using the functional device compared to the placebo group. Subjective assessments also indicated that

participants using the placebo device reported more severe muscle pain and leg fatigue during exertion than those treated with the functional device (Möbes, 2003).

Moen et al. investigated whether physical exertion peaked on match days and how BEMER therapy influenced sleep duration and quality on match nights in Norwegian elite female players. The amount of time each player spent using BEMER therapy was included as a control variable. Most sleep parameters improved significantly during the experimental period when BEMER therapy was applied, compared to the control period before its introduction. Additionally, the analysis showed that the greatest benefits on sleep occurred in players who received more than 440 h of BEMER therapy, with these improvements being significantly greater than those seen in players with less than 440 h of therapy. Overall, both the duration and quality of sleep significantly increased during the experimental period on match nights and the following nights compared to the control period (Moen et al., 2023).

This innovative therapy targets the improvement of microcirculation, especially in the smallest blood vessels such as capillaries, which are vital for supporting cellular function and performance. BEMER microcirculation therapy optimizes cellular metabolism and increases blood flow to muscles, thereby improving both physical and mental performance. By stimulating blood circulation and increasing cellular metabolism, the therapy promotes faster muscle and tissue recovery, which is beneficial for athletes and anyone seeking to improve their physical capabilities. Adequate muscle blood supply can reduce injury risk, improve physical fitness, and support balanced preparation for competition. Thus, BEMER therapy is a valuable addition to sport performance enhancement programs.

Beyond its direct effects on blood circulation and cellular metabolism, BEMER therapy provides multiple benefits for individuals aiming to improve their health and quality of life. By providing biorhythmic stimulation of blood vessels, BEMER helps eliminate waste products that accumulate in muscles during exercise, thereby facilitating and speeding up recovery after intense training or competition. This reduction in downtime allows athletes to maintain a consistent training schedule, while faster recovery can also lead to improved long-term performance. By promoting optimal circulation and tissue oxygenation, BEMER therapy provides athletes with a safe and effective means to improve physical fitness, accelerate recovery, and gain a competitive advantage without the use of invasive procedures or substances (URL4).

Materials and Methods

BEMER therapy was performed using the BEMER Professional© device, a certified physical vascular therapy instrument authorized for medical use (CE0428; Class IIa).

Study Objective: To determine whether BEMER therapy has an effect on the physical condition of university students.

Description of Devices Used in the Study: BEMER Pro Controller Verum, BEMER Pro Controller Placebo, B.Body Applicator (Full-Body Therapy Mattress)

Study Participants: A total of 60 first-year undergraduate students from the Faculty of Law Enforcement at Ludovika University of Public Service participated in the study.

Study Period: 2022/23 academic year, first semester

Age and Sex of Enrolled Participants: Males aged 18–20 years

Inclusion Criteria: Healthy first-year university student volunteers

Exclusion Criteria: Participants were excluded if they had acute or chronic illnesses or had received BEMER therapy or magnetotherapy within the two months before the study.

The students in the experimental group used the BEMER PRO Set® (B. BOX console unit and applicators; BEMER International AG, Triesen, Liechtenstein), which delivers specific biorhythmically determined impulses that transmit energy to small arterioles acting as resonators through a weak electromagnetic field (flux density: $\leq 100 \mu\text{T}$). The electromagnetic field was applied as a whole-body therapy using a $180 \times 60 \times 2 \text{ cm}$ mattress (B. BODY Pro). Treatments were administered every morning between 06:00 and 07:00 for 8 min each, with controlled flux densities as follows: sessions 1–7 at $10.5 \mu\text{T}$, sessions 8–14 at $14.0 \mu\text{T}$, sessions 15–21 at $17.5 \mu\text{T}$, and sessions 22–28 at $21.0 \mu\text{T}$.



Figure 4. Preparation for BEMER therapy (Source: Prepared by the author)



Figure 5. BEMER therapy (Source: Prepared by the author)

Physical Assessment Exercises Used in the Study

1) 20-m Shuttle Run

The shuttle run, a component of the mandatory Hungarian National Student Fitness Test system used in public education, is designed to measure endurance.

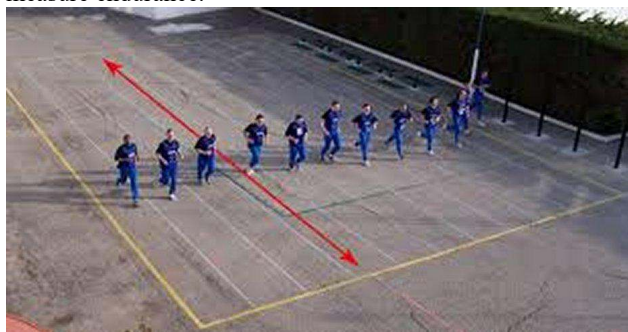


Figure 6. Shuttle run (Source: URL5)

Detailed Description

The students run or walk back and forth between two lines set 20 m apart, aiming to complete as many 20-m sections as possible. Their pace is controlled by a soundtrack to which they must synchronize. The test starts at an easy pace and progressively becomes more challenging, with the speed increasing by 0.5 km/h every minute. A section is counted as completed when a student touches or crosses the 20-m line with at least one foot exactly at the audible signal. The test ends when the student makes a second mistake—either failing to reach the line on time or being unable to continue running. The test is evaluated based on the number of sections completed.

2) Jumping Over a Cushion and Finishing in a Prone Position

The cushion jump assesses strength–endurance and dynamic leg strength of the lower limbs. It is a simple exercise that requires minimal equipment, involves natural movement, is easily measurable, and requires no previous training.



Figure 7. Cushion jump (Source: URL5)

Detailed Description

The candidates stand beside the cushions with their shoulders perpendicular to them. On the signal, they jump or step over the cushion and finish in a prone position, then stand up and jump or step back to the starting line, again finishing in a prone position. This sequence is repeated continuously for 1 min. The number of times the candidates finish in the prone position is recorded.

3) Medicine Ball Throw Against the Wall

The medicine ball throw against the wall assesses the strength–endurance of the arms and torso. It is a simple exercise requiring minimal equipment, involves natural movements, allows for accurate measurement, and does not require prior training.



Figure 8. Medicine ball throw against the wall (Source: URL5)

Detailed Description

The candidates stand 1.5 m from a wall, positioned behind a gym bench, holding a medicine ball. They continuously throw and catch the ball against the wall for 1 min—3 kg for female subjects and 5 kg for male subjects. The total number of throws is recorded. All participants participated in both the pre- and post-tests and attended all conditioning and therapy sessions. Assessments were performed before the first treatment and on the final day, with exercises monitored by staff from the Department of Physical Education and Combat Sports.

Descriptive Statistics

Initially, 60 individuals were enrolled in the study; however, owing to injuries and withdrawals, 24 participants in each group completed all therapy sessions.

Number of candidates, $n = 48$

Experimental group (Verum): $n = 24$

Control group (Placebo): $n = 24$

Age: 18–20 years

Sex: male

Results

1) Means and Standard Deviations

Table 1. Pre-test and post-test results presented in a single table

PRE-TEST	Experimental group (Verum)				
	M	SD	Median	Minimum	Maximum
Cushion jump	23.21	3.05	22.50	18	30
Medicine ball throw against the wall	53.58	5.69	54.00	40	65
Shuttle run	61.13	7.67	60.00	45	72
PRE-TEST	Control group (Placebo)				
	M	SD	Median	Minimum	Maximum
Cushion jump	22.33	2.58	22.00	18	26
Medicine ball throw against the wall	53.92	7.27	56.00	40	70
Shuttle run	57.58	8.03	54.50	47	75
POST-TEST	Experimental group (Verum)				
	M	SD	Median	Minimum	Maximum
Cushion jump	25.83	2.93	25.00	22	32
Medicine ball throw against the wall	57.79	6.11	57.50	46	68
Shuttle run	72.21	10.74	73.00	52	94
POST-TEST	Control group (Placebo)				
	M	SD	Median	Minimum	Maximum
Cushion jump	24.46	.41	24.00	20	28
Medicine ball throw against the wall	57.63	.61	56.00	46	73
Shuttle run	62.75	.26	62.00	48	82

Source: The table was created by the author.

Table 1 shows the mean, standard deviation, minimum, and maximum values for each exercise (cushion jump, medicine ball throw against the wall, and shuttle run) for both the treated and placebo groups. Based on the descriptive data alone, there appears to be no significant difference between the groups' mean values in the pre-test. Post-test results show higher mean values in both the experimental and control groups compared to the pre-tests. Specifically, the shuttle run demonstrated a more significant difference between the two groups in the post-test than the other exercises. The overall increase in post-test means suggests that the intensive basic training improved the physical condition of all students, enhancing performance and fitness. The pronounced improvement in the shuttle run may be attributed to the effects of BEMER physical vascular therapy. Statistical tests were then performed to assess the validity of these results.

2. Pre-test Comparison

Study subjects were randomly assigned to either the experimental or control groups. Consequently, no significant differences in the mean values of the three exercises were expected between the groups during the pre-test. This assumption was statistically tested for all three exercises using appropriate tests to compare the means of independent samples. To determine whether a parametric or non-parametric test was suitable, the assumption of normality was assessed using the Shapiro–Wilk test (Table 2).

Table 2. Normality test for the pre-test (Shapiro–Wilk test)

	Exercises	Statistics	df	Sig. (p) 2-site
Experimental group (Verum)	Cushion jump	0.922	24	0.066
	Medicine ball throw against the wall	0.945	24	0.214
	Shuttle run	0.939	24	0.158
Control group (Placebo)	Cushion jump	0.929	24	0.094
	Medicine ball throw against the wall	0.964	24	0.539
	Shuttle run	0.897	24	p = 0.019

Source: The table was created by the author

The distribution of each of the three test scores for both groups did not significantly differ from a normal distribution in all cases except one (control group, shuttle run) ($p < 0.05$). Therefore, parametric tests were used for all three exercises—either the independent samples t-test or Welch's test, depending on whether the homogeneity of variance assumption was met. Additionally, the non-parametric Mann–Whitney test was performed specifically for the shuttle run.

Table 3. Assessment of variance homogeneity (Levene's test)

	F	Sig. (p)
Cushion jump	0.030	0.863
Medicine ball throw against the wall	2.217	0.143
Shuttle run	0.255	0.616

Source: The table was created by the author.

For all exercise types, the variance between the two groups is not significantly different ($p > 0.05$); therefore, the equality of means can be assessed using the independent samples t-test (Table 3).

Table 4. Comparison of group mean scores in the pre-test (independent samples t-test)

	t	df	Sig. (p) 2-site
Cushion jump	−1.073	46	0.289
Medicine ball throw against the wall	0.177	46	0.860
Shuttle run	−1.562	46	0.125

Source: The table was created by the author.

In all cases, the t-test is not significant; therefore, no significant difference exists between the mean scores of the two groups (Table 4).

For the shuttle run, a non-parametric test was also performed owing to a partial violation of the normality assumption.

Table 5. Comparison of group mean scores in the pre-test (independent samples t-test and non-parametric Mann–Whitney Test) for the shuttle run

Mann–Whitney U	212.500
Z	−1.561
Asymp. Sig. (p) 2-site	0.118

Source: The table was created by the author.

Based on the non-parametric test, no significant difference ($p > 0.05$) was found between the mean scores of the two groups in the shuttle run pre-test (Table 5).

In summary, we can conclude that randomization successfully created two groups with no significant differences in mean scores across all exercise types during the pre-test.

3. Comparison – Change

The difference between pre- and post-test results was analyzed using paired sample t-tests to assess the mean differences in correlated samples for both the experimental and control groups. It is important to verify the assumption of normality for this analysis as well. While normality was previously examined for the pre-test, it should also be assessed for the post-test (Table 6).

Table 6. Normality test for the post-test (Shapiro–Wilk test)

		Statistics	df	Sig (p)
Experimental group	Cushion jump	0.915	24	0.045
	Medicine ball throw against the wall	0.964	24	0.534
	Shuttle run	0.967	24	0.584
Control group	Cushion jump	0.938	24	0.146
	Medicine ball throw against the wall	0.942	24	0.178
	Shuttle run	0.980	24	0.901

Source: The table was created by the author.

In one of the six cases (experimental group, cushion jump), the assumption of normality was violated ($p < 0.05$). Therefore, when testing the significance of the changes, a non-parametric test was also performed in two cases (control group: shuttle run; experimental group: cushion jump) because normality was violated in either the pre- or post-test. For comparison, parametric tests were performed for these cases as well.

Table 7. Comparison of pre- and post-test mean scores (paired samples t-test)

		M (Pre-test–Post-test)	SD	t	df	Sig (p) 2-site
Experimental group	Cushion jump	2.63	1.84	7.000	23	0.000
	Medicine ball throw against the wall	4.21	3.90	5.285	23	0.000
	Shuttle run	11.08	9.64	5.635	23	0.000
Control group	Cushion jump	2.13	2.33	4.472	23	0.000
	Medicine ball throw against the wall	3.71	5.38	3.374	23	0.003
	Shuttle run	5.17	7.74	3.271	23	0.003

Source: The table was created by the author.

The difference between pre- and post-test scores is significant in all cases, with positive mean differences indicating a significant increase in scores across each test (Table 7). In the two cases mentioned earlier, a non-parametric test was also performed owing to partial violation of the normality assumption (Table 8).

Table 8. Comparison of pre- and post-test mean scores using a non-parametric test (Wilcoxon signed-rank test)

		Z	Asymp. Sig. (p) 2-site
Experimental group (Verum)	Cushion jump	–4.135	0.000
Control group (Placebo)	Shuttle run	–2.789	0.005

Source: The table is created by the author.

The non-parametric tests also indicate a significant difference between the mean values of the pre- and post-tests in both experiments.

In summary, both the experimental and control groups showed a significant increase in the mean scores for each type of exercise from pre-test to post-test. This confirms that the basic training led to significant improvements in both groups, demonstrating that all exercises produced measurable improvements in performance.

4. Post-test comparison

The effect of the intervention (Verum) is evaluated by comparing the post-test results of the experimental and control groups. Because no significant difference was observed in the pre-test, any significant difference found in the post-test can reasonably be attributed, at least in part, to the use of the Verum device. This is further tested using an independent samples t-test for the mean. As noted earlier, the distribution of the three test scores for both groups in the post-test did not significantly deviate from normality in all but one case (experimental group, cushion jump) ($p < 0.05$). Therefore, parametric tests were performed for all three types of exercises—using either the independent samples t-test or Welch's test, depending on whether the assumption of homogeneity of variance was met (Table 9). Additionally, the non-parametric Mann–Whitney test was performed specifically for the cushion exercise.

Table 9. Homogeneity of variance assessment (Levene's test)

	F	Sig. (p)
Cushion jump	1.261	0.267
Medicine ball throw against the wall	0.073	0.788
Shuttle run	0.960	0.332

Source: The table was created by the author.

For all exercise types, the variance between the two groups in the post-test is not significantly different ($p > 0.05$); therefore, the equality of means can be assessed using the independent samples t-test.

Table 10. Comparison of group mean scores in the post-test (independent samples t-test)

	t	df	Sig. (p) 2-site
Cushion jump	-1.775	46	0.083
Medicine ball throw against the wall	-0.091	46	0.928
Shuttle run	-3.420	46	0.001

Source: The table was created by the author.

The t-test was significant only for the shuttle run (Table 10), where participants in the experimental group performed significantly better than those in the control group after using the Verum or placebo device. For the other two exercises, no significant difference was found between the mean scores of the two groups. Because the assumption of normality was partially violated for the cushion exercise, a non-parametric test was also performed (Table 11).

Table 11. Examination of the difference between group mean scores for the cushion exercise (Mann-Whitney test)

Mann-Whitney U	228.500
Z	-1.240
Asymp. Sig. (p) 2-site	0.215

Source: The table was created by the author.

Based on the non-parametric test, no significant difference ($p > 0.05$) was found between the mean scores of the two groups in the cushion post-test. It can be concluded that the post-test showed a significant difference between the experimental and control groups in the shuttle run, with the experimental group performing significantly better. No significant difference was observed between the groups in the pre-test. For the other two exercises, the post-test also revealed no significant differences between the groups.

Discussion

The main objective of this article was to verify the potential for improving the physical condition of professional staff through the use of BEMER physical vascular therapy. Building on previous research, we have confirmed the importance of physical fitness in law enforcement. The literature review outlined the physiological effects that changes in physical condition have on the human body. Notably, the study highlights that improved physical performance leads to better blood supply to muscles, an expanded vascular network in the muscles, an increased number of capillaries, and greater vasodilation capacity of blood vessels. A key factor contributing to the onset of fatigue is oxygen deficiency; that is, the capacity of the cardiovascular system limits endurance performance (Pavlik, 2019). The study specifically focused on improving endurance through BEMER by improving the body's ability to absorb oxygen, thereby increasing muscle endurance under load. We have placed physical vascular therapy within the framework of physiotherapy and briefly outlined the principle of magnetotherapy, highlighting the developmental direction of BEMER. Its beneficial effects on the human body have been validated by numerous medical studies, demonstrating its widespread acceptance in the medical community. Additionally, relevant sports-related research was reviewed, accompanied by a concise summary of the physical fitness improvements achievable through this therapy. In sports science and elite athletics, numerous institutions, organizations, and top athletes use physical vascular therapy to improve performance, as well as for regeneration and rehabilitation.

Our study was performed over a 4-week basic training period involving 60 male volunteer student police officers. In line with our methodology and hypotheses, we first analyzed descriptive data to verify the success of the randomization process. Randomization was used to form two groups that showed no significant differences in mean scores for any type of exercise during the pre-test. Data from both the pre- and post-tests indicate that the mean scores for each exercise type increased significantly in both the experimental and control groups. This confirms that the basic training led to significant positive changes in both groups, demonstrating that all exercises produced measurable improvements. Finally, the effect of the intervention (Verum) was assessed by comparing the post-test results of the experimental and control groups. Because there was no significant difference in the pre-test but a significant difference was observed in the post-test, it is reasonable to attribute this change to the use of the Verum device. The t-test revealed a significant difference only in the shuttle run exercise, where participants in the experimental group outperformed those in the control group after the use of either Verum or a placebo. Thus, the post-test demonstrated a significant difference between the experimental and control groups, specifically in the shuttle run.

Conclusions

The study's results confirm that BEMER, as a form of physical vascular therapy, is effective and leads to significant improvements in the shuttle run. Based on previous research, it can be inferred that not only conditioning abilities be improved, but regular use of the device may also positively affect the quality of life for professional staff. Owing to their age-related characteristics, the recruited students tolerate basic training and daily stress more effectively, allowing their bodies to recover more quickly from exertion. Further research could involve older generations currently in service, analyzing them by age groups and evaluating the impact of BEMER (as a physical vascular therapy) on their work performance and quality of life, while taking into account musculoskeletal or other health issues. It is worth noting that performing the study with a larger sample size would be beneficial because this would eliminate the need for non-parametric tests. Additionally, the study could be expanded to include other professional staff members.

Limitations

The research was limited to healthy professional men aged 18–22. Thus, the results for women of the same age group or professionals of different ages and genders remain unknown. Considering the various physical assessment standards from different countries discussed in the introduction, it can also be noted that no assessment specifically targeted the relative strength of the upper body and lower limbs. Instead, the focus was on maximum strength and endurance, and the effect of BEMER on these aspects was not investigated. The sample size could be increased to account for dropouts owing to injuries and illnesses. Additionally, valuable insights might have been gained through a questionnaire addressing lifestyle and sports habits. Future research could gather further information by performing interviews with participants, allowing them to share their personal experiences with the treatment.

Conflicts of interest

The author declares no potential conflicts of interest.

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