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Effects of Electromyostimulation (EMS) on Athlete Performance: Systematic Review

Abstract

Electromyostimulation (EMS) helps to improve muscle performance by generating different modes of muscle activation leading to physiological effects on the neuromuscular system. This review aims to examine the effects of EMS alone or in combination with traditional training on athletes' performance outcomes compared to the muscle adaptations induced by traditional training. As a method in the study, the PubMed database, where the world's leading studies in health and sports sciences are indexed, was analysed between 2016 and 2023, and studies on the effects of EMS on athletes training in different branches were examined. When the findings of the studies are examined, it is seen that the use of different training techniques together leads to more muscle adaptation compared to the use of EMS technique alone, which contributes to the earlier development of basic biomotor skills and increased performance. In conclusion, it can be said that the use of EMS technique provides some advantages for individuals; however, it may have a much greater effect when combined with dynamic or resistance exercises.
Keywords: Electromyostimulation Training, Strength, Speed, Athlete,

Elektromiyostimülasyon (EMS) Antrenmanının Sporcu Performansı Üzerindeki Etkileri: Sistematik Derleme

Özet

Elektromiyostimülasyon (EMS), nöromüsküler sistem üzerinde fizyolojik etkilere yol açan farklı kas aktivasyon modları oluşturarak kas performansını artırmaya yardımcı olur. Bu derleme, geleneksel antrenmanın yarattığı kas adaptasyonlarına kıyasla, EMS'nin tek başına ya da geleneksel antrenmanla birlikte kullanılmasının sporcuların performans sonuçları üzerindeki etkilerini incelemeyi amaçlamaktadır. Çalışmada yöntem olarak, sağlık ve spor bilimlerinde dünyanın önde gelen çalışmalarının indekslendiği PubMed veri tabanında, 2016-2023 yılları arasında, farklı branşlarda antrenman yapan sporcular üzerindeki etkilerini çalışan araştırmalar incelenmiştir. Çalışmaların bulguları incelendiğinde, farklı antrenman tekniklerinin bir arada kullanılmasının EMS tekniğinin tek başına kullanılmasına kıyasla daha fazla kas adaptasyonuna yol açtığı, bunun da temel biyomotor becerilerin daha erken gelişmesine ve performansın artmasına katkı sağladığı görülmektedir. Sonuç olarak, EMS tekniğinin kullanımının bireyler için bazı avantajlar sağladığı söylenebilir; ancak dinamik veya direnç egzersizleriyle birleştirildiğinde çok daha büyük bir etkiye sahip olabilir.

Anahtar Kelimeler: Elektromisimilasyon, Kuvvet, Hız, Sporcu

Introduction

Nowadays, new technology is being used alongside different training methods to enhance athletic performance. Therefore, it is essential to implement techniques that provide a similar external response in order to effectively incorporate new and innovative methods into training. This approach can produce a positive influence on sport performance in a short period (Jee, 2018). One technique used for practical approaches to preserving and improving strength is the use of electrical stimulation on muscles through artificial electrical muscle stimulation applied over the skin. The main objective is to train muscles through repeated contractions to improve their basic properties (Filipovic et al., 2016). It can be adapted to the field of sports that Yakov Kots states that electrical currents producing contractions generate a very high isometric force between 10% and 30% depending on the maximum desired contractions. It may even lead to greater increases in strength in professional athletes (Filipovic et al., 2019). Electrical Muscle Stimulation (EMS) is an innovative, practical, and time-saving training method that activates muscles by delivering currents to muscles and has drawn people's interest (Panda et al., 2022). It is said that the use of EMS in sports speeds up the removal of muscle metabolites by increasing blood flow to the muscles, which ultimately aids in the recovery of performance during or after exercise (Wietz, 2016). Today, EMS is widely used by sports scientists to ensure the safety of individuals during exercise. Ensuring maximum efficiency in training, accomplishing more tasks in less time, minimizing fatigue, and achieving optimal output is crucial (Kemmler et al., 2016).

1. The Incorporation of EMS Training for Strength Development

In order to enhance performance to its maximum level during strength training, EMS training has been added to merely reduce the duration of training and produce faster results.

During EMS exercises, the muscles receive significantly more intense stimuli to contract and move than in traditional exercises, and the extra stimuli added to signals sent by the central nervous system result in muscle contractions. Stimulation caused by electrical impulses can activate all main muscle groups as well as the most difficult-to-reach and deepest muscles. Using this method, muscles can be exercised much more intensively and in a shorter amount of time without the need for any weights or even the slightest load on the joints compared to traditional methods, resulting in increased performance without external strain (Kaçoğlu and Kale, 2019). Skeletal muscles are particularly responsive to stimulation caused by electrical current. Due to the influence on tissue and nerves, exercises performed using electrical muscle stimulation (EMS) are considered an additional method to traditional strength training and can

have a significant effect on achieving maximum muscle strength in a short of time during competitions (Rappelt et al, 2023). Studies have shown that healthy individuals gain more muscle strength through EMS alone compared to exercise alone (Table.1).

2. The Use and Literature of Electrical Muscle Stimulation (EMS) in Sports

EMS was originally a method used for treatment and has now become popular in sports. Sport scientists have drawn the attention of coaches and athletes to EMS (Kaçoğlu and Kale, 2019). Different training methods are applied to increase muscle strength in the body. The EMS training method is amongst the most commonly used techniques for improving muscle mass and strength. Furthermore, it simultaneously stimulates all body muscles and accelerates recovery time in elite athletes. This is achieved through repeated muscle contractions that increase blood flow within the muscle, maximum force output, strength endurance, and reducing symptomatology. These reasons contribute to the popularity of this training approach (Kaya and Erzeybek, 2016). The use of EMS technology in physical activity enables access to various muscle groups, resulting in maximum efficiency for the individual (Jee, 2018). Different EMS variables can be utilised in accordance with the set goals and training plan. During an EMS session, it is important to ensure the safety of the individual, achieve maximum results from the exercises, and make the most out of the given time. Minimising fatigue, understanding and optimizing electrical stimulation variables are of crucial significance in achieving the most suitable output force. Electrical current has various changing characteristics such as frequency, current intensity, and duration. In addition to the aforementioned factors, the characteristics of the electrodes used in terms of size, material, and positioning, the duration of the current supplied, the rest period, the waveform type of the 17 current, the scope and duration of the training are all variables of EMS training (Micke et al., 2018). Studies examining the impact of EMS on physical performance have typically involved training athletes for 4-8 weeks. Significant increases in maximal strength, dynamic strength, and isokinetic strength were observed among athletes following the training process. The language used is objective and formal, avoiding biased or ornamental language and follows grammar and spelling conventions of British English. In addition, it has been suggested that these exercises also enhance athletes' speed, vertical jump and other skills (Filipovic et al., 2016; Ludwig et al., 2020). In another study, the effect of EMS training with the traditional was examined and significant increases were found. Additionally, it has been suggested that EMS training should be supported by strength training, according to the results obtained (Wirtz, 2016).

Method

In this review, we searched the PubMed database, which includes international studies, published articles and the latest developments in the field of sports science, for studies on the effects of the methods used in athletes on performance parameters using the keywords "electromyostimulation training" "strength" and "athlete" between 2016 and 2023. To be included in this review, each article had to meet certain criteria. These criteria were that the participants in the studies had to be experienced athletes doing strength training and the experimental studies had to be combined with strength training or compared by measuring the muscle strength of the two groups using different methods. Eight studies were reviewed and analysed that met all these criteria. This study includes quantitative studies on the effects of whole body EMS technique use on sports performance and athletes' muscle strength, jump and sprint performance parameter outcomes.

Results

Table.1. Current research information on the application of EMS training on athletes.

Study	Aim	Subject	Time	Test Protocol	Result
Micke et al., 2018	EMS to compare its application with the traditional method	18 male athletes	8 weeks dynamic EMS	Leg Press 1 RM, Sprint , Vertical Jump And Horizantal Jump	Only Leg press 1 RM showed great improvement ↑
Panda et al., 2022	EMS effects of application on plyometric training	90 badminton players	4 week dynamic combined EMS	Agility, 30 M Sprint Vertical Jump	Only in vertical jump ↑ % 3.95
Filipovic et al., 2016	EMS effects of practice on training in the competitive season	22 elite football playersf	14 week combined EMS	Leg Strength 1 RM, Sprint, Vertical Jump, Kick Speed	Leg press 1 RM ↑, Sprint and ↓ vertical jump ↑
Wirtz, 2016	EMS to compare its application with the traditional method	20 athlete in training	6 week combined strength training (EMS)	Strength, Sprint,Vertical Jump	Vertical jump and strength↑

Rappelt et al., 2023	EMS to compare the application of static and dynamic exercise methods	26 athlete in training (13 Women- 13 Men)	4 week combined static and dynamic body weight (EMS)	Vertical Jump and Sprint	Test parameters in the use of dynamic exercises ↑
Schuhbeck et al., 2019	EMS training in addition standard ice hockey training	30 male ice hockey players	14 week dynamic EMS	İsokinetic Maximum Force , CounterMovement-Jump Height And Power, Sprint,	10 m skating time %5 ↓ Strength increase % 7 ↑ Vertical Jump %15.1 ↑
Ludwig et al., 2020	EMS training in addition to standard football traning	30 male football players	10 week combined football training	leg, hip and trunk muscles power	All parametres increased
Filipovic et al., 2019	EMS training in addition to standard football traning	28 male elite football players	7 week combined dynamic body weight (EMS in football traning	Strength, power	Leg press ↑ Leg curl ↑ 1RM maximal strength ↑

Discussion

Over the past 20 years, EMS has gained an increasing presence in strength training for various sports. Studies on professional athletes have demonstrated that complementary EMS training can lead to effective strength gains. Malatesta et al. (2003) found this to be true for volleyball, Maffiuletti et al. (2000) for basketball and tennis players, Babault et al. (2007) for rugby players. These studies conducted by Billot et al. (2010) revealed that soccer players demonstrated an increase in both jumping ability by 19.5% and maximum strength by 35.2%. The aim of this study was to determine the effects of incorporating electrical muscle stimulation (EMS) into athlete training on performance criteria. With the recent surge of interest in this training methodology, there is a need for an examination of its impact solely on athletes that objectively and consistently verifies the information previously gathered on this topic. When compared to traditional exercises, Whole-Body Electromyostimulation (WB-EMS) has been

shown to have a more positive effect on the improvement of power output in athletes when applied simultaneously to various muscle groups, such as muscle chains or agonist/antagonist, during dynamic movements, in contrast with the isolated application of EMS. A fundamental issue with EMS literature is the stimulation of muscles.

This is supported by evidence from studies such as those conducted by Rappelt et al. (2023) and Filipovic et al. (2016). The focus of EMS relates to changes in muscle performance through the application of both pure EMS and EMS in combination with other training methods, as demonstrated by Micke (2018). Studies that investigate the effects of combining EMS with other forms of training aim to identify the impact of EMS. Certain research findings clearly indicate that combining EMS with exercise programmes is much more effective than exercising alone without EMS (Table 1). The intention is to define the effects of EMS when combined with training techniques, with a view to establishing optimal performance enhancement.

Electrical muscle stimulation (EMS) and voluntary contractions can be considered as complementary stimulations with various acute physiological effects. Hence, in the context of a training program, EMS combination can theoretically lead to larger physiological adaptations than two techniques applied alone. This combination may also create complementary physiological adaptations.

The Effects of Training Programs Combining Resistance Exercise, or Electrical Muscle Stimulation on Athletes

Current research on combined technique, resistance training or sports training (plyometrics, etc.) combined with EMS was studied. Since performance tests should be specific to the movement modelling used in sports in order to be meaningful, the studies were limited to studies showing the effect of jump sprint, power output or maximal strength parameter on the athlete in the field.

Filipovic et al. (2016) examined the impact of the 14-week combined EMS training on the strength, sprint speed, jump height, and peak capacity of 22 football players. This entailed 28 EMS training sessions conducted twice a week and complemented by regular training conducted 6-7 times a week. While clear, notable improvements occurred in the sprinting ability (8.0%) of the subjects, their sprint time over a distance of 5 m also decreased by 2.9%. He also proposed that electrical muscle stimulation (EMS) could be a feasible substitute for customary resistance training to augment ultimate strength in top athletes. Nevertheless, Filipovic et al.'s (2019) subsequent analysis also affirmed momentous enhancements in robustness in top-class

football players, illustrating a 16.8% (7 weeks, 14 sessions) increase in leg press and a 22.4% (14 weeks, 28 sessions) increase in jumping among highly trained adult athletes.

In a similar positive finding, Micke et al. (2018) conducted a study comparing dynamic training, EMS and a similar traditional training approach among male athletes. They discovered that maximising leg press strength (+7.7%) was significantly greater in the group that employed EMS training alongside dynamic exercises. In the recommendation segment of their study, they proposed that combining dynamic exercises with EMS training, using similar movement designs, is an effective technique for elevating leg strength (Micke et al., 2018). Wirtz (2016) compared the traditional strength training group with 10 athletes from different disciplines and the other group with 10 athletes with EMS training combined with strength training. In the result of the study, it was stated that the group cobined with EMS provided significant improvements ($p<0.05$) in sprint, jump and leg strength (leg press) parameters (Wirtz, 2016).

Ludwig et al. (2023) investigated the effects of static and dynamic strength exercises performed with EMS for 4 weeks on jumping and power perfrons in a study of 26 athletes in total, and as a result, they reported that both static and dynamic exercises made a significant difference ($p<0.05$) in all parameters (Ludwig et al., 2023). Panda et al. (2022) aimed to compare the effects of EMS training application in badminton players compared to plyometric training in their study. 3 groups in which 90 athletes were randomly divided into 3 groups were planned and the effects of training on sprint and jump parameters were compared. As a result, although plyometric training improved explosive power, EMS application provided at least as much improvement ($p<0.05$) in the vertical jump parameter as the other training.

Schuhbeck (2019) investigated the effect of EMS training on shooting speed, jump height, power, sprint and maximal strength performance add to that standard ice hockey training. The results showed a positive contribution to the performance of ice hockey players with a 5.15% increase in jump, a 7% increase in power and a 5% decrease in sprint time in the 12-week EMS training group (Schuhbeck, 2019).

Conclusion

The use of combined EMS resulted in greater muscle adaptation in motor performance output than conventional training. The combined technique helped to further optimise strength qualities or muscle power in athletes. However, it resulted in larger improvement in the performance of complex dynamic movements compared to single use. This efficiency may be due to its ability to fully or partially facilitate the cumulative effects of training induced by the

EMS technique applied alone. Therefore, EMS should be combined with a more specific training in a sport to generate neuromuscular adaptations, while at the same time allowing the tuning of motor control during voluntary exercise.

Author Contribution

MC; (Conceptual framework, Data analysis, Data Collection, Reporting of the Article)

Conflict of Interest

Any personal and financial conflict of interest within the scope of the study

References

Babault, N., Cometti, G., Bernardin, M., Pousson, M., & Chatard, J. C. (2007). Effects of electromyostimulation training on muscle strength and power of elite rugby players. *The Journal of Strength and Conditioning Research, 21*(2), 431-437

Billot, M., Martin A., Paizis, C, Cometti C., & Babault, N. (2010) Effects of an electrostimulation training program on strength, jumping, and kicking capacities in soccer players. *The Journal of Strength and Conditioning Research, 24*, 1407-1413.

Filipovic, A., DeMarees, M., Grau, M., Hollinger, A., Seeger, B., Schiffer, T., Bloch, W., & Gehlert, S. (2019). Superimposed Whole-Body Electrostimulation Augments Strength Adaptations and Type II Myofiber Growth in Soccer Players During a Competitive Season. *Frontiers in Physiology*, *10*, 1187. https://doi.org/10.3389/fphys.2019.01187

Filipovic, A., Grau M., Kleinoder, H., Zimmer P., Hollmann, W., & Bloch, W. (2016) Effects of a Whole-Body Electrostimulation Program on Strength, Sprinting, Jumping, and Kicking Capacity in Elite Soccer Players. *Journal of Sports Science and Medicine, 15*, 639-648.

Jee,Y. S. (2018). The efficacy and safety of whole-body electromyostimulation in applying to human body: based from graded exercise test. *Journal of Exercise Rehabilitation, 14*(1), 49–57. https://doi.org/10.12965/jer.1836022.011

Kaçoğlu, C., & Kale, M. (2015). Elektromyostimülasyon ile ilgili elektriksel akım parametreleri ve metodolojisi. *CBÜ Beden Eğitimi ve Spor Bilimleri Dergisi, 10*(2) , 34-47 . Retrieved from https://dergipark.org.tr/tr/pub/cbubesbd/issue/32242/357841

Kaya, F., & Erzeybek, M. S. (2016). Electrical muscle stimulation and its use for sports training programs: A review. In A. Çamlı, B. Ak, R. Arabacı, R. Efe (eds.), *Recent Advances in Health Sciences,* (pp. 711-733), St. Kliment Ohridski University Press.

Kemmler, W., Teschler, M., Weißenfels, A., Bebenek, M., Fröhlich, M., Kohl, M., & Von Stengel, S. (2016) Effects of Whole-Body Electromyostimulation versus High-Intensity Resistance Exercise on Body Composition and Strength: A Randomized Controlled Study. *Evidence-based Complementary and Alternative Medicine*: eCAM 2016, 9236809-9236809.

Ludwig, O., Berger, J., Becker, S., Kemmler, W., Fröhlich, M. (2019) The Impact of Whole-Body Electromyostimulation on Body Posture and Trunk Muscle Strength in Untrained Persons. *Frontiers in Physiology* 10, 1020.

Ludwig, O., Berger, J., Schuh, T., Backfisch, M., Becker, S., & Fröhlich, M. (2020). Can a superimposed whole-body electromyostimulation intervention enhance the effects of a

10-week athletic strength training in youth elite soccer players? *Journal of Sports Science and Medicine, 19(3), 535–546.*

Maffiuletti, N.A., Cometti, G., Amiridis, I.G., Martin, A., Pousson, M., & Chatard, J.C. (2000). The effects of electromyostimulation training and basketball practice on muscle strength and jumping ability. *International Journal of Sports Medicine, 21*(6), 437-443.

Maffiuletti, N.A., Bramanti J, Jubeau M, Bizzini M, Deley G., & Cometti, G. (2009). Feasibility and efficacy of progressive electrostimulation strength training for competitive tennis players. *The Journal of Strength and Conditioning Research, 23*(2), 677-682.

Malatesta, D., Cattaneo, F., Dugnani, S., Maffiuletti, N.A. (2003). Effects of electromyostimulation training and volleyball practice on jumping ability. *Journal of Strength and Conditioning Research, 17*(3), 573–579

Micke, F., Kleinöder, H., Dörmann, U., Wirtz, N., Donath, L. (2018) Effects of an eight-week superimposed submaximal dynamic whole-body electromyostimulation training on strength and power parameters of the leg muscles: A randomized controlled intervention study. *Frontiers in Physiology, 9*, 1719.

Panda, M., Rizvi, M. R., Sharma, A., Sethi, P., Ahmad, I., & Kumari, S. (2022). Effect of electromyostimulation and plyometrics training on sports-specific parameters in badminton players. *Sports Medicine and Health Science, 4*(4), 280–286. https://doi.org/10.1016/j.smhs.2022.08.002

Rappelt, L., Micke, F., Held, S., Dörmann, U., Kleinöder, H., & Donath, L. (2023). Effects of four weeks of static vs. dynamic bodyweight exercises with whole-body electromyostimulation on jump and strength performance: A two-armed, randomized, controlled trial. *Journal of Sports Science and Medicine*, *22*(2), 226–234. https://doi.org/10.52082/jssm.2023.226

Schuhbeck, E., Birkenmaier, C., Schulte-Göcking, H., Pronnet, A., Jansson, V., & Wegener, B. (2019). The Influence of WB-EMS-training on the performance of ice hockey players of different competitive status. *Frontiers in Physiology*, *10*, 1136. https://doi.org/10.3389/fphys.2019.01136

Wirtz, N., Zinner, C., Doermann, U., Kleinoeder, H., & Mester, J. (2016) Effects of loaded squat exercise with and without application of superimposed EMS on physical performance. *Journal of Sports Science and Medicine, 15*, 26-33. https://pubmed.ncbi.nlm.nih.gov/26957923/

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1. The Incorporation of EMS Training for Strength Development

In order to enhance performance to its maximum level during strength training, EMS training has been added to merely reduce the duration of training and produce faster results.

During EMS exercises, the muscles receive significantly more intense stimuli to contract and move than in traditional exercises, and the extra stimuli added to signals sent by the central nervous system result in muscle contractions. Stimulation caused by electrical impulses can activate all main muscle groups as well as the most difficult-to-reach and deepest muscles. Using this method, muscles can be exercised much more intensively and in a shorter amount of time without the need for any weights or even the slightest load on the joints compared to traditional methods, resulting in increased performance without external strain (Kaçoğlu and Kale, 2019). Skeletal muscles are particularly responsive to stimulation caused by electrical current. Due to the influence on tissue and nerves, exercises performed using electrical muscle stimulation (EMS) are considered an additional method to traditional strength training and can

have a significant effect on achieving maximum muscle strength in a short of time during competitions (Rappelt et al, 2023). Studies have shown that healthy individuals gain more muscle strength through EMS alone compared to exercise alone (Table.1).

2. The Use and Literature of Electrical Muscle Stimulation (EMS) in Sports

EMS was originally a method used for treatment and has now become popular in sports. Sport scientists have drawn the attention of coaches and athletes to EMS (Kaçoğlu and Kale, 2019). Different training methods are applied to increase muscle strength in the body. The EMS training method is amongst the most commonly used techniques for improving muscle mass and strength. Furthermore, it simultaneously stimulates all body muscles and accelerates recovery time in elite athletes. This is achieved through repeated muscle contractions that increase blood flow within the muscle, maximum force output, strength endurance, and reducing symptomatology. These reasons contribute to the popularity of this training approach (Kaya and Erzeybek, 2016). The use of EMS technology in physical activity enables access to various muscle groups, resulting in maximum efficiency for the individual (Jee, 2018). Different EMS variables can be utilised in accordance with the set goals and training plan. During an EMS session, it is important to ensure the safety of the individual, achieve maximum results from the exercises, and make the most out of the given time. Minimising fatigue, understanding and optimizing electrical stimulation variables are of crucial significance in achieving the most suitable output force. Electrical current has various changing characteristics such as frequency, current intensity, and duration. In addition to the aforementioned factors, the characteristics of the electrodes used in terms of size, material, and positioning, the duration of the current supplied, the rest period, the waveform type of the 17 current, the scope and duration of the training are all variables of EMS training (Micke et al., 2018). Studies examining the impact of EMS on physical performance have typically involved training athletes for 4-8 weeks. Significant increases in maximal strength, dynamic strength, and isokinetic strength were observed among athletes following the training process. The language used is objective and formal, avoiding biased or ornamental language and follows grammar and spelling conventions of British English. In addition, it has been suggested that these exercises also enhance athletes' speed, vertical jump and other skills (Filipovic et al., 2016; Ludwig et al., 2020). In another study, the effect of EMS training with the traditional was examined and significant increases were found. Additionally, it has been suggested that EMS training should be supported by strength training, according to the results obtained (Wirtz, 2016).

Method

In this review, we searched the PubMed database, which includes international studies, published articles and the latest developments in the field of sports science, for studies on the effects of the methods used in athletes on performance parameters using the keywords "electromyostimulation training" "strength" and "athlete" between 2016 and 2023. To be included in this review, each article had to meet certain criteria. These criteria were that the participants in the studies had to be experienced athletes doing strength training and the experimental studies had to be combined with strength training or compared by measuring the muscle strength of the two groups using different methods. Eight studies were reviewed and analysed that met all these criteria. This study includes quantitative studies on the effects of whole body EMS technique use on sports performance and athletes' muscle strength, jump and sprint performance parameter outcomes.

Results

Table.1. Current research information on the application of EMS training on athletes.

Study	Aim	Subject	Time	Test Protocol	Result
Micke et al., 2018	EMS to compare its application with the traditional method	18 male athletes	8 weeks dynamic EMS	Leg Press 1 RM, Sprint , Vertical Jump And Horizantal Jump	Only Leg press 1 RM showed great improvement ↑
Panda et al., 2022	EMS effects of application on plyometric training	90 badminton players	4 week dynamic combined EMS	Agility, 30 M Sprint Vertical Jump	Only in vertical jump ↑ % 3.95
Filipovic et al., 2016	EMS effects of practice on training in the competitive season	22 elite football playersf	14 week combined EMS	Leg Strength 1 RM, Sprint, Vertical Jump, Kick Speed	Leg press 1 RM ↑, Sprint and ↓ vertical jump ↑
Wirtz, 2016	EMS to compare its application with the traditional method	20 athlete in training	6 week combined strength training (EMS)	Strength, Sprint,Vertical Jump	Vertical jump and strength↑

Rappelt et al., 2023	EMS to compare the application of static and dynamic exercise methods	26 athlete in training (13 Women- 13 Men)	4 week combined static and dynamic body weight (EMS)	Vertical Jump and Sprint	Test parameters in the use of dynamic exercises ↑
Schuhbeck et al., 2019	EMS training in addition standard ice hockey training	30 male ice hockey players	14 week dynamic EMS	İsokinetic Maximum Force , CounterMovement-Jump Height And Power, Sprint,	10 m skating time %5 ↓ Strength increase % 7 ↑ Vertical Jump %15.1 ↑
Ludwig et al., 2020	EMS training in addition to standard football traning	30 male football players	10 week combined football training	leg, hip and trunk muscles power	All parametres increased
Filipovic et al., 2019	EMS training in addition to standard football traning	28 male elite football players	7 week combined dynamic body weight (EMS in football traning	Strength, power	Leg press ↑ Leg curl ↑ 1RM maximal strength ↑

Discussion

Over the past 20 years, EMS has gained an increasing presence in strength training for various sports. Studies on professional athletes have demonstrated that complementary EMS training can lead to effective strength gains. Malatesta et al. (2003) found this to be true for volleyball, Maffiuletti et al. (2000) for basketball and tennis players, Babault et al. (2007) for rugby players. These studies conducted by Billot et al. (2010) revealed that soccer players demonstrated an increase in both jumping ability by 19.5% and maximum strength by 35.2%. The aim of this study was to determine the effects of incorporating electrical muscle stimulation (EMS) into athlete training on performance criteria. With the recent surge of interest in this training methodology, there is a need for an examination of its impact solely on athletes that objectively and consistently verifies the information previously gathered on this topic. When compared to traditional exercises, Whole-Body Electromyostimulation (WB-EMS) has been

shown to have a more positive effect on the improvement of power output in athletes when applied simultaneously to various muscle groups, such as muscle chains or agonist/antagonist, during dynamic movements, in contrast with the isolated application of EMS. A fundamental issue with EMS literature is the stimulation of muscles.

This is supported by evidence from studies such as those conducted by Rappelt et al. (2023) and Filipovic et al. (2016). The focus of EMS relates to changes in muscle performance through the application of both pure EMS and EMS in combination with other training methods, as demonstrated by Micke (2018). Studies that investigate the effects of combining EMS with other forms of training aim to identify the impact of EMS. Certain research findings clearly indicate that combining EMS with exercise programmes is much more effective than exercising alone without EMS (Table 1). The intention is to define the effects of EMS when combined with training techniques, with a view to establishing optimal performance enhancement.

Electrical muscle stimulation (EMS) and voluntary contractions can be considered as complementary stimulations with various acute physiological effects. Hence, in the context of a training program, EMS combination can theoretically lead to larger physiological adaptations than two techniques applied alone. This combination may also create complementary physiological adaptations.

The Effects of Training Programs Combining Resistance Exercise, or Electrical Muscle Stimulation on Athletes

Current research on combined technique, resistance training or sports training (plyometrics, etc.) combined with EMS was studied. Since performance tests should be specific to the movement modelling used in sports in order to be meaningful, the studies were limited to studies showing the effect of jump sprint, power output or maximal strength parameter on the athlete in the field.

Filipovic et al. (2016) examined the impact of the 14-week combined EMS training on the strength, sprint speed, jump height, and peak capacity of 22 football players. This entailed 28 EMS training sessions conducted twice a week and complemented by regular training conducted 6-7 times a week. While clear, notable improvements occurred in the sprinting ability (8.0%) of the subjects, their sprint time over a distance of 5 m also decreased by 2.9%. He also proposed that electrical muscle stimulation (EMS) could be a feasible substitute for customary resistance training to augment ultimate strength in top athletes. Nevertheless, Filipovic et al.'s (2019) subsequent analysis also affirmed momentous enhancements in robustness in top-class

football players, illustrating a 16.8% (7 weeks, 14 sessions) increase in leg press and a 22.4% (14 weeks, 28 sessions) increase in jumping among highly trained adult athletes.

In a similar positive finding, Micke et al. (2018) conducted a study comparing dynamic training, EMS and a similar traditional training approach among male athletes. They discovered that maximising leg press strength (+7.7%) was significantly greater in the group that employed EMS training alongside dynamic exercises. In the recommendation segment of their study, they proposed that combining dynamic exercises with EMS training, using similar movement designs, is an effective technique for elevating leg strength (Micke et al., 2018). Wirtz (2016) compared the traditional strength training group with 10 athletes from different disciplines and the other group with 10 athletes with EMS training combined with strength training. In the result of the study, it was stated that the group cobined with EMS provided significant improvements ($p<0.05$) in sprint, jump and leg strength (leg press) parameters (Wirtz, 2016).

Ludwig et al. (2023) investigated the effects of static and dynamic strength exercises performed with EMS for 4 weeks on jumping and power perfrons in a study of 26 athletes in total, and as a result, they reported that both static and dynamic exercises made a significant difference ($p<0.05$) in all parameters (Ludwig et al., 2023). Panda et al. (2022) aimed to compare the effects of EMS training application in badminton players compared to plyometric training in their study. 3 groups in which 90 athletes were randomly divided into 3 groups were planned and the effects of training on sprint and jump parameters were compared. As a result, although plyometric training improved explosive power, EMS application provided at least as much improvement ($p<0.05$) in the vertical jump parameter as the other training.

Schuhbeck (2019) investigated the effect of EMS training on shooting speed, jump height, power, sprint and maximal strength performance add to that standard ice hockey training. The results showed a positive contribution to the performance of ice hockey players with a 5.15% increase in jump, a 7% increase in power and a 5% decrease in sprint time in the 12-week EMS training group (Schuhbeck, 2019).

Conclusion

The use of combined EMS resulted in greater muscle adaptation in motor performance output than conventional training. The combined technique helped to further optimise strength qualities or muscle power in athletes. However, it resulted in larger improvement in the performance of complex dynamic movements compared to single use. This efficiency may be due to its ability to fully or partially facilitate the cumulative effects of training induced by the

EMS technique applied alone. Therefore, EMS should be combined with a more specific training in a sport to generate neuromuscular adaptations, while at the same time allowing the tuning of motor control during voluntary exercise.

Author Contribution

MC; (Conceptual framework, Data analysis, Data Collection, Reporting of the Article)

Conflict of Interest

Any personal and financial conflict of interest within the scope of the study

References

Babault, N., Cometti, G., Bernardin, M., Pousson, M., & Chatard, J. C. (2007). Effects of electromyostimulation training on muscle strength and power of elite rugby players. *The Journal of Strength and Conditioning Research, 21*(2), 431-437

Billot, M., Martin A., Paizis, C, Cometti C., & Babault, N. (2010) Effects of an electrostimulation training program on strength, jumping, and kicking capacities in soccer players. *The Journal of Strength and Conditioning Research, 24*, 1407-1413.

Filipovic, A., DeMarees, M., Grau, M., Hollinger, A., Seeger, B., Schiffer, T., Bloch, W., & Gehlert, S. (2019). Superimposed Whole-Body Electrostimulation Augments Strength Adaptations and Type II Myofiber Growth in Soccer Players During a Competitive Season. *Frontiers in Physiology*, *10*, 1187. https://doi.org/10.3389/fphys.2019.01187

Filipovic, A., Grau M., Kleinoder, H., Zimmer P., Hollmann, W., & Bloch, W. (2016) Effects of a Whole-Body Electrostimulation Program on Strength, Sprinting, Jumping, and Kicking Capacity in Elite Soccer Players. *Journal of Sports Science and Medicine, 15*, 639-648.

Jee,Y. S. (2018). The efficacy and safety of whole-body electromyostimulation in applying to human body: based from graded exercise test. *Journal of Exercise Rehabilitation, 14*(1), 49–57. https://doi.org/10.12965/jer.1836022.011

Kaçoğlu, C., & Kale, M. (2015). Elektromyostimülasyon ile ilgili elektriksel akım parametreleri ve metodolojisi. *CBÜ Beden Eğitimi ve Spor Bilimleri Dergisi, 10*(2) , 34-47 . Retrieved from https://dergipark.org.tr/tr/pub/cbubesbd/issue/32242/357841

Kaya, F., & Erzeybek, M. S. (2016). Electrical muscle stimulation and its use for sports training programs: A review. In A. Çamlı, B. Ak, R. Arabacı, R. Efe (eds.), *Recent Advances in Health Sciences,* (pp. 711-733), St. Kliment Ohridski University Press.

Kemmler, W., Teschler, M., Weißenfels, A., Bebenek, M., Fröhlich, M., Kohl, M., & Von Stengel, S. (2016) Effects of Whole-Body Electromyostimulation versus High-Intensity Resistance Exercise on Body Composition and Strength: A Randomized Controlled Study. *Evidence-based Complementary and Alternative Medicine*: eCAM 2016, 9236809-9236809.

Ludwig, O., Berger, J., Becker, S., Kemmler, W., Fröhlich, M. (2019) The Impact of Whole-Body Electromyostimulation on Body Posture and Trunk Muscle Strength in Untrained Persons. *Frontiers in Physiology* 10, 1020.

Ludwig, O., Berger, J., Schuh, T., Backfisch, M., Becker, S., & Fröhlich, M. (2020). Can a superimposed whole-body electromyostimulation intervention enhance the effects of a

10-week athletic strength training in youth elite soccer players? *Journal of Sports Science and Medicine, 19(3), 535–546.*

Maffiuletti, N.A., Cometti, G., Amiridis, I.G., Martin, A., Pousson, M., & Chatard, J.C. (2000). The effects of electromyostimulation training and basketball practice on muscle strength and jumping ability. *International Journal of Sports Medicine, 21*(6), 437-443.

Maffiuletti, N.A., Bramanti J, Jubeau M, Bizzini M, Deley G., & Cometti, G. (2009). Feasibility and efficacy of progressive electrostimulation strength training for competitive tennis players. *The Journal of Strength and Conditioning Research, 23*(2), 677-682.

Malatesta, D., Cattaneo, F., Dugnani, S., Maffiuletti, N.A. (2003). Effects of electromyostimulation training and volleyball practice on jumping ability. *Journal of Strength and Conditioning Research, 17*(3), 573–579

Micke, F., Kleinöder, H., Dörmann, U., Wirtz, N., Donath, L. (2018) Effects of an eight-week superimposed submaximal dynamic whole-body electromyostimulation training on strength and power parameters of the leg muscles: A randomized controlled intervention study. *Frontiers in Physiology, 9*, 1719.

Panda, M., Rizvi, M. R., Sharma, A., Sethi, P., Ahmad, I., & Kumari, S. (2022). Effect of electromyostimulation and plyometrics training on sports-specific parameters in badminton players. *Sports Medicine and Health Science, 4*(4), 280–286. https://doi.org/10.1016/j.smhs.2022.08.002

Rappelt, L., Micke, F., Held, S., Dörmann, U., Kleinöder, H., & Donath, L. (2023). Effects of four weeks of static vs. dynamic bodyweight exercises with whole-body electromyostimulation on jump and strength performance: A two-armed, randomized, controlled trial. *Journal of Sports Science and Medicine*, *22*(2), 226–234. https://doi.org/10.52082/jssm.2023.226

Schuhbeck, E., Birkenmaier, C., Schulte-Göcking, H., Pronnet, A., Jansson, V., & Wegener, B. (2019). The Influence of WB-EMS-training on the performance of ice hockey players of different competitive status. *Frontiers in Physiology*, *10*, 1136. https://doi.org/10.3389/fphys.2019.01136

Wirtz, N., Zinner, C., Doermann, U., Kleinoeder, H., & Mester, J. (2016) Effects of loaded squat exercise with and without application of superimposed EMS on physical performance. *Journal of Sports Science and Medicine, 15*, 26-33. https://pubmed.ncbi.nlm.nih.gov/26957923/