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Benefits of Field Tennis for Upper Limb Burn Therapy in Children

[Beneficios del tenis de campo como alternativa terapéutica para niños quemados en miembros superiores]

[Benefícios do tênis de campo como alternativa terapêutica para crianças com queimaduras nos membros superiores]

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ABSTRACT

Introduction: Children are vulnerable to burns. The utilization of sports as therapy increases the physiological indicators and rehabilitation effectiveness.

Aim: To examine the effect of motor actions in field tennis as a therapeutic alternative for the recovery of motor functions in burned children's upper limbs.

Materials and methods: A pre-experimental design study with minimum control was done for twelve weeks between January and April 2023. The sample was selected according to a non-probabilistic stratified intentional sampling. From a total population of 8 children with burns, 5 met the inclusion criteria and performed adapted motor actions used in field tennis. The data were processed through SPSS 28.

Results: The results showed statistically significant changes in the sample about the motor functionality of the upper limbs, pain when moving, muscle strength issues, and movement limitations. All the subjects achieved higher indicator values.

Conclusions: The motor actions in field tennis can be used effectively for therapy in the recovery of motor functionality of the upper limbs of burned children.

Keywords: Therapeutic physical culture, adapted sport, motor functionality, burned patient, field tennis.

RESUMEN

Introducción: Los niños constituyen un grupo de población vulnerable a la producción de quemaduras. El uso de deportes como alternativa terapéutica incrementa indicadores fisiológicos y la efectividad de los tratamientos rehabilitadores.

Objetivo: examinar el efecto de acciones motrices del tenis de campo como alternativa terapéutica en la recuperación de la funcionalidad motriz de miembros superiores en niños quemados.

Materiales y métodos: Se realizó un estudio de diseño pre experimental de control mínimo, con doce semanas de duración entre el mes de enero a abril de 2023. La muestra seleccionada se realizó a partir de un muestreo intencional estratificado no probabilístico, se seleccionaron cinco niños con quemaduras de una muestra de 8 pacientes, los cuales cumplieron con los criterios de inclusión y realizaron acciones motrices adaptadas que realiza el tenis de campo. Los datos obtenidos fueron procesados con el software estadístico SPSS 28.



Resultados: Los resultados obtenidos mostraron cambios estadísticamente significativos en la muestra analizada en relación con la funcionabilidad motriz de los miembros superiores, dolor al movimiento, problemas de fuerza muscular y limitaciones en los rangos de movimiento. El 100 % logró registros superiores en los elementos sometidos a evaluación.

Conclusiones: Las acciones motrices del tenis de campo como alternativa terapéutica fueron efectivas en la recuperación de la funcionabilidad motriz de miembros superiores en niños quemados.

Palabras clave: Cultura Física Terapéutica, deporte adaptado, funcionabilidad motriz, paciente quemado, tenis de campo.

RESUMO

Introdução: As crianças constituem um grupo populacional vulnerável a queimaduras. A utilização do esporte como alternativa terapêutica aumenta os indicadores fisiológicos e a eficácia dos tratamentos reabilitativos.

Objetivo: Determinar o efeito das ações motoras do tênis de campo como alternativa terapêutica na recuperação da funcionalidade motora de membros superiores em crianças queimadas.

Materiais e métodos: Foi realizado um estudo de desenho pré-experimental de controle mínimo, com duração de doze semanas entre o mês de janeiro a abril de 2023. A amostra selecionada foi realizada a partir de uma amostragem intencional estratificada não probabilística, cinco crianças com queimaduras de uma amostra de 8 pacientes, que atenderam aos critérios de inclusão e realizaram ações motoras adaptadas realizadas no tênis de campo. Os dados obtidos foram processados com o software estatístico SPSS 28.

Resultados: Os resultados obtidos demonstraram alterações estatisticamente significativas na amostra analisada em relação à funcionalidade motora dos membros superiores, dores ao movimentar-se, problemas de força muscular e limitações na amplitude de movimento. 100% obtiveram pontuações mais elevadas nos elementos em avaliação.

Conclusões: As ações motoras do tênis de campo como alternativa terapêutica foram eficazes na recuperação da funcionalidade motora de membros superiores em crianças queimadas.

Palavras-chave: Cultura Física Terapéutica, desportos adaptados, funcionalidade motora, paciente queimado, campo de tênis.



INTRODUCTION

Burns are injuries caused on the skin or other tissue by physical, chemical, or biological agents (Eid, 2021). The skin's most important function is to protect the interior of the body from harmful radiation, and chemical and physical agents, and also to block the loss of water and extracellular liquid (Mohamed, 2019).

The clinical presentation of the burns is diverse, so it is important to know their classification using several criteria. One of them has to do with the histological name of the tissue damage by the lesion, based on its depth. Téot (2018) classified them into epidermal or first grade; surface dermal (A); dermal deep or second grade (AB); and hypodermic (B). Another criterion to classify burns is based on the way they spread, according to the Kirschbaum scheme or Rule of 9 in adults (Mairal *et al.*, 2021). In contrast, in children, the most reliable method to estimate the surface area of the burn is the LundBrowder scale, which calculates the body surface depending on age and the affected area in each person (Jaramillo *et.al.*, 2019).

The epidemiology of burns regarding the incidence and prevalence is particularly manifested in every population, etiological variety, forms of intervention, and methodologies according to a nation's development. No significant changes have been observed in the consulted literature in the last ten years, except for countries that have undergone wars or extensive disasters generating drastic changes in the statistics. Most epidemiological studies are retrospective and descriptive, and the main results have been reported in developed countries, considering the utilization of advanced technology in the application of rehabilitation therapies (Rannia *et.al.*, 2021).

Physio-therapeutic treatment in burned children prevents, maintains, and restores adequate functions through motor function improvements so that children can have more independence and autonomy in their activities, and permits full integration and adaptation to their environments (Dos Santos *et.al.*, 2021). In other words, using physical exercise to improve the biological, and therefore, the spiritual potential may be the main way of treating the aftereffects as an essential part of therapies for burned patients that



determines the success of not only healing but also rehabilitation and reinsertion of the injured person in the social life after suffering the consequences of a burn (Soriano and Macías, 2022).

Today, physical culture is highly recognized as a part of society, which has demonstrated that movement is a line that binds people to society and their environments. Hence, it is tightly linked to humans as social beings. Physical activity is then assumed as a cornerstone of the healing scheme of burned patients in their treatments. The association healing schemes-sports used for therapies has various significant factors within this process, such as preventing, maintaining, and restoring a particular function by enhancing motor functions.

Therefore, the insertion of sports practice in physical culture with therapeutic purposes in burned children is not only a therapeutic process but also a pedagogic one. That is why it embraces medicine, biology, and education, such as Physical Medicine, Caumatology, Psychology, and Physiology. It also includes Physical Education Theory, Sports Training, and Pedagogy as the main pillars. Accordingly, early intervention in the form of a program of overall rehabilitation is a necessary method that improves the patient's life quality, and the functional result. It also reduces burn-related complications through an increase in movements and the elimination of contractions following the burns or skin grafting (Rania *et. al.*, 2021).

The utilization of sports like field tennis to treat burned children is a valuable and simple method; it contributes to the stability of vital signs, reduces the mean intensity of pain, and increases strength and the extension of joint movements, particularly during the chronic rehabilitation of the disease.

López *et al.* (2022); Campanario, Franco, and Zorrilla (2022); Palencia and Gallón (2022), Soriano, Macías, and Martínez (2023), and Nápoles (2023) coincided with the existing association between physiotherapists and physical-sports educators in terms of physical exercise and therapeutic exercise, with healing effects in alternative sport in treating motors disabilities.



Research about interventions in sports adapted for the restoration of motor capacities started after the Second World War, as a form of rehabilitating disabled people. In that sense, neurologist Ludwig Guttmann (1899-1980) developed adapted sports programs that served not only as recreation for individuals but also as physical and psychological rehabilitation (Torralba *et al.*, 2014). Then, the utilization of sports as an intervention for burn treatments may be an invaluable resource due to the non-invasive, non-pharmacological, and easy access and implementation aspects for burned patients.

Field tennis has recently become more popular thanks to international commercial sponsors and the empathy created by the figures represented by the media. Its practice generates properties at the neuro-muscular level, such as strength, explosiveness, motivation, and the creation of favorable movement patterns for physio-therapeutic treatment of burns, particularly in children. These features are rarely used, perhaps due to the lack of knowledge to apply them, and consequently, fears of harming the children, or because of the belief that training through sports should be following physical recovery and only to socialize and seek social reinsertion.

The previous is a social need that permits physical culture specialists as social objects to work comprehensively and solve the social reinsertion issues of burned patients, have a say in the family and society through practical and transforming activity, as the base and core of human activity supported by the advances of science and technology associated with physical and therapeutic activity currently. They demand highly qualified reflexive professionals, capable of using their knowledge for the benefit of the social and economic development of the nation. It has been given thanks to contributions to skill improvements according to the healing scheme for the burned patient, which promotes higher professional pertinence in any community. It also contributes to a more philosophical and systemic way of managing the health/disease process that offers greater integrity to the transforming capacity of humans in physical and therapeutic activity and participatory sports.



Accordingly, this paper aims to examine the effect of motor actions performed in field tennis as a therapeutic alternative for the recovery of motor functions in the upper limbs of burned children.

MATERIALS AND METHODS

The study was based on a pre-experimental design with minimum control. Initial and final tests (pre-test and post-test) were made with an independent variable, the application of the general and special exercises, then it was evaluated in the final confirmation, and its effectiveness was checked. This research took place at the field tennis facility belonging to the Orestes Gutiérrez Escalona Sports Complex No. 2, Manzanillo, Granma, which lasted two weeks, between January and April 2023. The population was selected according to an intentional, non-probabilistic stratified sampling. It consisted of burned children with deep skin burns (AB), and hypodermic burns (B) on the shoulders and elbows. The average age was 10 years, and all of them were male. The inclusion and exclusion criteria for the research were determined as follows:

Inclusion criterion: Patients below 15, with deep skin burns (AB) and hypodermic burns (B) on the dominating upper limbs, based on the assessment of the physical therapist and rehabilitation specialist for physical-sports activities to continue the rehabilitating practice.

Exclusion criterion: adult patients, injuries in other parts of the body, or normal movement range.

Rejection criterion: the parents' or guardians' will to continue to practice physical-sports activities, or loss of follow-up, or both.



A written consent document was presented to the parent or guardian before starting physical sports activities and planned exercises. All of them received information on the object of study, the evaluation procedures, and the character of voluntary participation. Consequently, identity protection and confidentiality were duly safeguarded, along with data protection and the researcher's commitment not to publish the data without previous official notice.

Also, part of the population consisted of five specialists from other branches of the research. The determination of the necessity was based on information collection about topics related to the causes, current treatments, relevant figures, and current trends in physical rehabilitation of burned patients and sports training that permitted the determination of its impact on the physical-therapeutic side, using theoretical, empirical, and research techniques, such as analysis and synthesis, inductive-deductive, systemic-structural-functional, documentary analysis, methodological triangulation, and source classification, structured observation, interview and survey, review of medical records from every patient to assess their evolution, previous treatments, evolution of the physical and psychological state since their admission to the hospital, and the recommendations and indications described by the specialists involved in the treatment.

The visual analog scale (VAS) for self-assessment of pain before and right after the treatment session, was used. VAS is a 10 cm long horizontal line anchored on each end by word descriptors, with 0 (absence of pain) and 10 (maximum pain). VAS's validity and liability were recorded and evaluated at two different levels: Mild (0-2 cm), Moderate (3-7 cm), and Severe (8-10 cm), from the left end to the mark pointed by the patient. Each participant was asked to mark the line where they felt pain at that time. VAS's score was measured (cm) from the left end to the mark pointed by the patient. The strength and movement range values were evaluated by adapting to distances and markers on a Romero Test wall. Articular arc measurements using a universal goniometer were evaluated according to the assessment of the numerical progression of these indicators.



The final assessment of the treatment relied on motor functionality evaluations, considering the regression of the disability scale of the upper limb (DASH) into, Excellent (<20 points), Good (20-30 points), Average (40-59 points), and Bad (60-100 points).

Indicators: pain intensity, DASH scale, strength, and movement range improvements.

Exercises chosen for improving motor functionality through actions adapted from field tennis in burned children

- The students stay in a row facing a wall. The first student drops the ball and hits it with the racket against the wall, then the next student catches the ball with the racket and hand and does the same.
- The students make a circle. They all together throw the ball upward without losing the ball's direction.
- The students make pairs, and each has a target painted on the wall, then each student hits the ball to the target alternatively.
- The students stand from a basket and will try to enter the basket after hitting it with the racket.
- The students stand in front of a wall, hitting the ball against the wall, increasing the distance progressively as they hit the ball more times.
- Two teams of three players each are made; the students on one team must pass the ball to one another before sending it to the other side.
- The students make trios and throw the ball, combining depth, direction, and height.
- Pairs are set and each of them throws and picks the ball increasing their distance. The ball should not fall onto the floor.
- Variants: Every exercise can be done resembling a game, with special rules, competitively or cooperatively, as determined by the teacher.



Aspects assumed by the work with the burned child in the sports complex:

- To promote the interest in sports practice as a healthy activity.
- To improve the general health state and raise motor functionality of the affected limb so that the children have a favorable influence to accomplish rehabilitation and curricular activities.
- To guide students progressively into the complexity of sports actions related to motor functionality.
- To develop a capacity for adjustment to different types of balls that let them acquire abilities, strength and more complex movement ranges.
- To improve the flexibility of every joint, intra- and inter-muscular coordination, general strength, and isometric contraction as a stabilizer of damaged upper limbs.
- Risk factors that may hurt the desired results.
- To stimulate joy and performance rather than competition, along with constant effort.
- To give the participants a chance to assess and express their favorite tasks, thus encouraging confidence in the execution of recommended exercises.

RESULTS AND DISCUSSION

To determine the after-intervention effects on the motor functionality of the upper limbs of burned children, the sample was analyzed depending on the pain mentioned when moving, using strength, and joint movements resulting from the functionality scale of the upper limb affected, according to the nullity statistics to determine if field tennis as an adapted sport that could make significant changes in the motor functionality of the upper limbs of burned children.



Hypothesis

- H_0 = No changes observed in motor functionality in the upper limb at the beginning and end of the treatment.
- H_1 = Changes observed in motor functionality in the upper limb at the beginning and end of the treatment.

Significance level

The Wilcoxon signed-rank test had a significant level (alpha) $\alpha = 5 \% = 0.05 \%$.

Table 1. - Wilcoxon^a signed-rank test in terms of pain when moving

-	Z	Asymptotic Sig. (two-sided)
Reports of pain (initially and finally)	-1.633 ^b	.102

a. Wilcoxon signed-rank test in terms of pain when moving

b. Based on positive ranks

Table 1 shows the results of the Wilcoxon signed-rank test of the sample, in which the patients had significant results after using the pain scale before and after the treatment.

Table 2. - Wilcoxon signed-rank test in terms of pain strength of the affected limb

	Z	Asymptotic Sig. (two-sided)
Strength (final and initial)	-2.032 ^b	.042

a. Wilcoxon signed-rank test

b. Based on negative ranks

Table 2 shows the results of the Wilcoxon signed-rank test of the sample, in which the patients responded favorably after using the pain scale before and after the treatment, with significant results (Table 2).



Table 3 - Wilcoxon^a signed-rank test for the evolution of joint mobility of the shoulder (affected limb)

	Z	Asymptotic Sig. (two-sided)
Ante-version (final and initial)	-2.032 ^b	.042
Retro-version (final and initial)	-2.032 ^b	.042
Abduction (final and initial)	-2.023 ^b	.043
Abduction (final and initial)	-2.041 ^b	.041
Internal rotation (final and initial)	-2.041 ^b	.041
External rotation (final and initial)	-2.070 ^b	.038

a. Wilcoxon signed-rank test

b. Based on negative ranks

Table 4 - Wilcoxon^a signed-rank test for the evolution of joint mobility of the elbow (affected limb)

-	Z	Asymptotic Sig. (two-sided)
Flexion (final and initial)	-2.121 ^b	.034
Extension (final and initial)	-2.121 ^b	.034
Supine (final and initial)	-2.121 ^b	.034
Pronation (final and initial)	-2.041 ^b	.041

a. Wilcoxon signed-rank test

b. Based on negative ranks

Tables 3 and 4 show the results of the Wilcoxon signed-rank test of the sample, in which the patients had significant results in joint mobility of the shoulder and elbow, respectively, in which the patients underwent favorable changes (Table 3 and Table 4).

Table 5. - Final treatment assessment Wilcoxon^a signed-rank test in the DASH scale (motor functionality)

-	Z	Asymptotic Sig. (two-sided)
Motor functionality (DASH scale) (final and initial)	-2.032 ^b	.042

a. Wilcoxon signed-rank test

b. Based on positive ranks



Table 5 shows statistically significant results in the Wilcoxon signed-rank test as the final assessment of the treatment upon the application of the DASH scale. It can be said that p (two-sided asymptotic sig.) was lower than 0.05. So, the null hypothesis was rejected. The study demonstrated the existence of sufficient evidence to say that the motor actions in field tennis used as a therapeutic strategy were effective for the recovery of motor functionality of the upper limbs of burned children, with 5% significance (Table 5).

The analysis of the data collected revealed that the results were significant in every aspect, which means that during the rehabilitation of burned children, the inclusion of field tennis as an alternative to the regular treatment, widens the focus on this pathology with a physical culture perspective based on an understanding of the potentialities of adapted sport. However, these results cannot lead to general deductions without building a context based on scientific evidence.

The main limitations of the study are associated with the participants' ages, the small size of the sample, the burned part of the body, and the customization of tests and exercises not only for the upper limbs.

In recent years, there has been a major transformation in the way pathologies are treated with physical exercise, with interventions based on multidisciplinary approaches. In that sense, progress made in understanding the bioethical aspects of physical activity and the respect for the Helsinki Standards that refer to research with humans (Barrios Osuna, I., Anido Escobar, V., and Morera Pérez, M. 2016), as well as the physiology of exercise, the influence of treated pathologies, and their mark as part of clinical and surgical treatments, targeted to the different areas of the complex set of integrated patient therapies (Dantes *et. al.*, 2017 and Carmona, 2022). The effect of physical exercise has been explored in fact research, phenomena, deeds, and processes with disciplinary and multidisciplinary settings of therapeutic physical activity, medical sciences, physical education, and sports (Vidal *et. al.*, 2022, Rannia *et. al.*, 2021, and Schouten *et.al.*, 2019).



Therapeutic exercise combined with sports practice, like tennis, adapting some of its tests to assess the evolution of elements like strength (Romero, 2005) is a simple, affordable, accessible element for improving people's life quality, especially those with burns (children), since these sports add a ludic component to therapy, seeking a purpose that permits higher results.

Consequently, the introduction of sports as a therapeutic means has shown that promoting sports practice for the disabled also promotes social inclusion, engagement, and changes in the ways of thinking and establishing a perspective on this population. External motivation will be a strong motivation for self-encouragement and a useful approach to improving lifestyles and social interactions. Espinosa (2019) said that sport is one of the noblest human activities, the cause of many personal and social benefits, as the saying goes: a healthy mind in a healthy body. In terms of people whose physical capacities have been diminished due to many circumstances, there is more greatness in the spirit when humans practice sports (Castro, 2021).

As to alternative therapies included in rehab schemes for improving joint mobility and pain treatment, the results coincide with a study that analyzes the effect of combined use of music with physical therapy in children whose lower limbs are burned (Eid *et al.*, 2020), and concludes with evidence of statistically significant reduction of pain and movement ranges. Likewise, there are reports of exercises for joint movements in children with deep dermal burns (AB) and hypodermic burns (B), using virtual reality as a way to divert pain during the physical rehabilitation of children. It shows a significant reduction of pain intensity and a broader movement range following its application, though it is a non-viable method in physical-therapeutic settings today, considering the concordance in the recurrence of distracters and tennis (Rania *et al.*, 2021).

Moreover, there are coincidences in relation to muscle strength effort, since the results achieved have points in common with the findings of Mohamed, H. Mohamed A., and Gamal, G. (2019), who studied the efficacy of a protocol for strength exercises to determine its effect on scars through muscle strength and movement range. They



concluded that structured protocol exercises improve these indicators significantly under these indicators. Furthermore, strength exercises lead to significant improvements in motor functionality, according to everyday scales validated depending on the type of experimental control groups.

Analyzing the prescription of physical activity and its implications in burned patients shows that these studies have similar reports to this study in that the particular traits of each patient are important. This analysis contributes to proper orientation and dosage of exercises, which have a special meaning for the recovery of the affected organ or area's structure and function (Soriano and Macías, 2022).

The results of this research study match those of Soriano, Macías, and Banqueris (2023), who concluded that the main problems of physical rehabilitation in burned patients are caused by contractions caused by scars and loss of muscle elasticity, which are very hard to detect, and cause constant pain. Scars cause contractions that often occur due to the lack of joint mobility during the recovery.

This study reveals a favorable link between the different surgical and clinical treatments for analgesia and anxiety regulation, the reduction of cardiac frequency and physical activity, which improves the rate of muscle control improvements, and gait patterns in children and adults with motor disorders during the rehabilitation treatment (Betancourt-Cárdenas *et.al*, 2019).

It matches other studies saying that burned patients undergo a loss of muscle mass resulting from an increase in catabolism following this type of injury. Hence, it causes a drop in muscle functional capacity, weakening the muscles. Patients are unable to perform daily activities normally, thus delaying their integration into society.

Most current studies on burns deal with the utilization of alternative therapies combined with the standard treatment schemes, assuming physical exercise with a high technological base. (Ruíz and Rodríguez, 2022; Mohamed, H. Mohamed A., and Gamal, 2019; Jiang, 2017, and Zhang *et al.*, 2017). Despite physical activity being a low-cost



resource, significant improvements can be achieved in patients because they are easy to perform and highly effective, only by doing simple things through practical training and adaptative and innovative use of the few resources of poor and developing countries.

CONCLUSIONS

The results achieved using the motor actions of field tennis for therapy permitted the recovery of motor functionality in the upper limbs of burned children, with a satisfactory evolution of pain, muscle strength, and the movement ranks of the affected limb.

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