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ORIGINAL ARTICLE

The impact of physical exercise on the mental health of the elderly

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ABSTRACT

Objective. To study the impact of physical exercise on the mental health of the elderly, and to formulate corresponding management strategies for physical exercise. Methods. From February 2018 to February 2019, 180 elderly people were selected from the community as research subjects. The elderly people included in the group were randomly divided into a physical exercise group and a control group, and the symptom self-rating scales of the two groups were compared. (SCL-90) score. Results. The scores of somatizations, obsessive-compulsive symptoms, interpersonal sensitivity, depression, anxiety, and terror of the elderly in the physical exercise group were significantly lower than those in the control group ($p < .05$); there was no significant difference in the scores of hostilities, paranoia, and psychosis between the two groups ($p > .05$). Conclusion. The mental health of the elderly is an important factor affecting their quality of life, and strengthening the way and content of physical exercise for the elderly can effectively regulate the mental health of the elderly, thereby promoting the improvement of their quality of life and, to a certain extent, alleviating the social and social problems brought about by population aging. Economic pressure is of great significance to the long-term and stable development of society.

Keywords: Physical exercise, Mental health, Exercise.

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INTRODUCTION

In recent years, the trend of my country's population aging has intensified, and the number of elderly people has increased sharply, which has caused greater pressure on society and families. The physical and mental health of the elderly has an important impact on their daily lives. In addition to paying attention to and managing the physical health of the elderly, comprehensively analyze the factors that affect their mental health and formulate effective measures to improve their psychological health. Regulating the health status of the elderly can effectively regulate the physical and mental state of the elderly, improve their quality of life, and moderately reduce the pressure on family and society (Edwards, 2006). The formation and development of psychological problems in the elderly generally have hidden characteristics, and their existing psychological changes are sometimes difficult to notice by family members and the outside world. It is not until the psychological problems have a serious impact on normal life that they are paid attention to. The alleviation and prevention of psychological problems in the elderly have relatively large limitations (Castelli et al., 2007). Physical exercise occupies an important position in people's daily lives. A comparative analysis of the impact of physical exercise on the mental health of the elderly and, based on this, the formulation and implementation of effective physical exercise policies and countermeasures will help improve the physical and mental health of the elderly and promote social development. It is of great significance (Desheng, 2019). In this study, the Symptom Checklist (SCL-90) was used to study the impact of physical exercise on the mental health of the elderly and to formulate corresponding physical activity management strategies.

MATERIALS AND METHODS

General Information from February 2018 to February 2019, 180 elderly people were selected from the community as research objects, and the selected elderly people were divided into groups by computer random selection, and the participants were divided into those who did physical exercise group and control group. There were 90 physical exercise groups, including 49 males and 41 females, aged 66 to 82 averages (73. 46 ± 4. 71)] years old. The control group consisted of 90 subjects, including 46 males and 44 females, aged 67-82 [average (73. 85 ± 4. 84)] years old. Inclusion criteria: ① Sign the informed consent approved by the hospital ethics committee; ② Age over 60 years old; ③ No language barriers. Exclusion criteria: ① those with severe diseases requiring long-term bed rest; ② those with mental system diseases and cognitive impairment; ③ those with senile dementia. There was no statistically significant difference in age and gender between the two groups ($p > .05$), and they were comparable.

The control group did not carry out physical exercise regularly

Under the guidance of hospitals and community service agencies, the physical exercise group carried out targeted physical exercise in daily life and comprehensive exercise for body functions. Questionnaires were used to investigate the basic information of the two groups, such as age, gender, health status, education level, and hobbies, and the SCL-90 scale was used to evaluate the mental health status of the two groups. Questionnaire surveys and evaluations are conducted on the elderly by experienced, professional medical staff. All medical staff have received professional mental health test training and are able to master assessment knowledge and skills proficiently. Targeting age in research for elderly people who are unable to write the questionnaire due to factors such as size, the medical staff will fill in the records through the method of regular inquiry.

Observation indicators SCL-90 was used to improve the mental health of the two groups

The scale includes 9 aspects of somatization, obsessive-compulsive symptoms, interpersonal sensitivity, depression, anxiety, hostility, terror, paranoia, and psychosis. The somatization score ranges from 12 to 60,

and the higher the score, the more somatic the stronger the discomfort, the lower the score, the less obvious the symptom experience; the score of obsessive-compulsive symptoms ranges from 10 to 50, and the higher the score, the more unable to get rid of some meaningless behaviors, thoughts and impulses, and there may be some cognitive symptoms. Behavioral signs of cognitive impairment; Interpersonal relationship sensitivity score ranges from 9 to 45 points, the higher the score, the more problems in interpersonal communication, the more prominent problems such as low self-esteem and self-centeredness, and negative expectations may appear; Depression score 13 to 65 points, the higher the score, the more obvious the depression; the anxiety score is 10 to 50 points; the higher the score, the more severe the anxiety; the hostility part is 6 to 30 points, the higher the score, the more hostile the individual and the worse the temper control ; Horror score 7-35 points, the higher the score, the more severe the fear of places and objects, and obvious physical symptoms may appear at the same time; the paranoia score is 6-30 points, the higher the score, the more prone to paranoia; psychotic Scores range from 10 to 50, with higher scores indicating more psychotic symptoms and behaviors.

Statistical analysis

SPSS26.0 statistical software was used for t test.

RESULTS

There was no significant difference in hostility, paranoid and psychotic scores between the two groups Significance (p > .05); the scores of somatizations, obsessive-compulsive symptoms, interpersonal sensitivity, depression, anxiety, and terror in the physical exercise group were significantly lower than those in the control group, and the difference was statistically significant (p < . 05). See Table 1.

Table 1. Comparison of SCL-90 scores between the two groups (x ± s, points, n = 90).

Group	Somatic	Obsessive compulsive symptoms	Interpersonal sensitivity	Depression	
Exercise group	12. 23 ± 3. 66	11. 26 ± 2. 35	9. 46 ± 1. 64	13. 26 ± 3. 21	
Control group	22. 23 ± 4. 66	18. 23 ± 3. 26	16. 22 ± 2. 64	22. 23 ± 3. 64	
T value	6. 264	5. 624	5. 468	6. 554	
p-value	.012	.018	.019	.010	
Group	**Anxiety**	**Hostility**	**Fear**	**Paranoid**	**Psychotic**
Exercise group	12. 46 ± 3. 89	7. 64 ± 2. 64	8. 25 ± 2. 34	8. 68 ± 2. 65	12. 22 ± 2. 65
Control group	19. 64 ± 4. 23	9. 46 ± 3. 12	16. 46 ± 3. 89	10. 46 ± 3. 22	13. 46 ± 3. 56
T value	5. 348	3. 014	6. 234	3. 289	3. 664
p-value	.021	.083	.013	.070	.056

DISCUSSION

The status quo and influencing factors for the mental health of the elderly

Common types of psychological problems in the elderly the occurrence of psychological problems in the elderly will have obvious adverse effects on their physical health and quality of life. Diseases caused by mental health factors have become one of the most important factors that threaten the health of the elderly. At present, there is insufficient awareness and attention given to the mental health of the elderly in society, and the elderly do not have a strong awareness of their own mental health, which has led to the emergence of different types of mental and mental diseases in the elderly. The research and analysis found that the types of mental illness in the elderly mainly include twilight psychology, inferiority complex, worthlessness, restlessness, mental disorders, and psychosis. The reason for the formation of twilight psychology is the influence of factors such as the children of the elderly leaving home, infirmity, and other factors, which lead

to the loss of the joy of life in the elderly, negative and pessimistic emotions about the future, and a negative and negative gray psychology (Van den Berghe et al., 2014). Inferiority psychology will lead to complaints and acute responsibilities for children in the elderly. The inferiority complex is mainly due to the reduction of economic income, social status, and role changes in the elderly after retirement from their original jobs, followed by the formation of psychological problems. Disappointment and an inferiority complex. The sense of worthlessness means that the elderly cannot adapt to a leisurely life, cannot reasonably arrange their own time, and gradually think that they have become a burden on the family and society, unable to find the value of their own existence, and then have a negative and low evaluation of themselves. Uneasiness is caused by the elderly due to self-enclosed, Unable to communicate with society and others, they gradually develop a feeling of loneliness and helplessness and a fear of the outside world. Senile mental disorders are caused by the lack of regular life and group activities in the elderly, resulting in neurasthenia, depression, anxiety, hypochondria, phobias, Mental disorders such as obsessive-compulsive disorder and hysteria affect the elderly, who have a slightly higher incidence than other age groups (Wood et al., 2002).

Current status of the mental health of the elderly as a country with a large population in the world, under the influence of the aging trend of the population, the number of elderly people continues to rise. In 2010, the number of elderly people over 60 in my country reached 1. 3.7 billion, accounting for 10% of the country's total population 10%. Due to changes in work, family, and health, the elderly is prone to mental health problems. On the one hand, the elderly is prone to loneliness and loss. On the other hand, the lack of knowledge and concepts related to life and health leads to older people being more susceptible to disease and the degeneration of their own body functions, resulting in fear and anxiety. Relevant survey data show that 50% to 80% of geriatric diseases in my country are caused by the mental illness of the elderly, and about 70% of the mental illness of the elderly is caused by a lack of spiritual care (Newton et al., 1997). At present, about 85% of the elderly in my country have different degrees of psychological problems, and more than 20% have significant psychological disorders such as depression and anxiety. The number of patients with Alzheimer's disease has reached 0.75%. Factors such as children leaving home as adults and forming new families have led to an increasing number of empty-nest elderly in my country. More and more elderly people are unaccompanied in their lives, and their lives are very lonely and monotonous (Kissane, 2012). The gradual transfer of the young rural population to the city has seriously affected the medical care, entertainment, and quality of life of the rural elderly population, and their physical and mental health will have varying degrees of problems (Dyson, 2014).

Diseases in various aspects, especially the onset of various chronic diseases, will have obvious adverse effects on the daily life and mental health of the elderly because of the inability to obtain quality quickly and effectively (Wei et al., 2021). At the same time, the social relationship of the elderly is also an important factor affecting mental health. Relevant studies have shown that the mental health of the elderly with close friends and good social relationships is significantly better than that of the elderly with poor social relationships. Good social relations and close friends can enable the elderly to have a way to communicate and express their emotions (Rittweger, 2010). For psychological pressure and bad emotions Able to express and relieve to a certain extent.

The scientific impact of physical exercise on the mental health of the elderly

Physical exercise is a systematic exercise process that can improve the physical and psychological conditions of the elderly through different types and frequencies of physical exercise activities. Under the guidance of a personalized scientific physical exercise program, organizing and guiding the elderly to carry out physical exercise can make them the body gets targeted exercises to improve the discomfort of the elderly's gastrointestinal tract, cardiovascular and cerebrovascular systems, and respiratory systems and

slow down their physical discomfort. The elderly is in a state of leisure and idleness for a long time, and their cognitive function will decline, which will increase their occurrence of obsessive-compulsive, etc. Possibility of mental disorders (Khwajamir, 2016). The development of targeted physical exercise can target the physical and psychological characteristics of the elderly, exercise their different functions, and promote the maintenance and improvement of their cognitive functions. Physical exercise has certain group characteristics. Based on a comprehensive analysis of the physical functions and hobbies of the elderly, it can provide a space for activities and exchanges for the elderly with the same hobbies and characteristics. Communication can play an important role in expressing emotions and alleviating negative emotions and can effectively prevent the elderly from feeling uncomfortable and inferior in interpersonal communication due to long-term solitude and a sense of loss. In addition, regular physical exercise can make the elderly feel confident in their own lives and willing to find activities that suit them. At the same time, through communication with others during exercise, it can effectively reduce the possibility of anxiety and depression symptoms. Sex to cope with old age with a more peaceful and positive mental state in addition, The development of physical exercise can promote the adaptation of the elderly to the external environment, such as outdoor space and crowds, through gradual activities and avoid the occurrence of symptoms such as crowds and social phobia in the elderly (Santonja Medina et al., 2007).

Strategies to optimize the physical exercise of the elderly based on scientific sports exercise

They plays an important role in the mental health of the elderly. Relevant government departments, medical and health institutions, and family members of the elderly should strengthen their awareness and attention to the mental health and physical exercise of the elderly and provide good health care for the elderly from different perspectives. Physical exercise environment, encouragement and guidance the elderly actively participate in physical exercise, which promotes the improvement of their physical and mental condition and quality of life and, at the same time, provides assistance in alleviating family and social pressure.

The government and related departments strengthen the physical exercise of the elderly. Guide the relevant government departments to fully realize the importance of physical exercise for the elderly, strengthen the publicity and guidance of physical exercise, enable all social forces to pay attention to the mental health and physical exercise of the elderly through publicity and education, and provide for the elderly. Contribute to the development of human physical exercise. At the same time, relevant government departments should intensify efforts to build and improve the hardware foundation of physical exercise for the elderly, invest manpower and material resources to improve the equipment foundation for the elderly's physical exercise, improve the venues and equipment for the elderly's physical exercise, and provide the elderly with Scientific and safe physical exercise venues that can promote the enthusiasm and effectiveness of physical exercise for the elderly (Castelli et al., 2007). In addition, it is necessary to give full play to the role of the community, create volunteer services and activity centers for the elderly in the community, strengthen contact and communication with the elderly, and encourage the elderly. The cultivation of hobbies and enthusiasm for physical exercise lays the foundation for promoting the physical and mental health of the elderly (Pantović et al., 2015).

Medical institutions strengthen the research and development of physical exercise for the elderly. Guide medical institutions to give full play to their expertise in the treatment of diseases of the elderly and mental health interventions, strengthen exchanges and communication with community medical service centers, and provide professional and scientific guidance for physical exercise for the elderly. First of all, medical institutions should improve their own medical equipment and supporting facilities, strengthen the professionalism and effectiveness of diagnosis and treatment of geriatric diseases, and ensure that the elderly can receive timely and effective treatment after seeking medical treatment. At the same time, increase

research and nursing management of chronic diseases in the elderly, optimize disease prevention and control measures, and lay a medical and health foundation for the physical and mental health of the elderly (12). Secondly, medical institutions should intensify their guidance and training for community medical institutions and give full play to the medical institutions play a closer role in the diagnosis and treatment of diseases of the elderly and physical exercise and regularly train community medical personnel to improve their professionalism in the prevention and treatment of diseases of the elderly and the guidance of physical exercise. Finally, medical institutions should regularly carry out activities such as entering the community and entering the family to publicize the importance of physical exercise and the way that scientific physical exercise can promote the improvement of the scale and efficiency of physical exercise for the elderly This study shows that the mental health of the elderly is an important factor affecting their quality of life and the prevention and treatment of related diseases. Strengthening the way and content of physical exercise for the elderly can effectively regulate the mental health of the elderly, thereby promoting the improvement of their quality of life and, to a certain extent, alleviating the social and economic pressure brought by population aging, which is of great significance to the long-term and stable development of society.

AUTHOR CONTRIBUTIONS

Mohammad Younus Ajmiri: the primary data was collected. Hizbullah Bahir:completed the literature review, method and design, analysis data and all parts of the article.

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No potential conflict of interest were reported by the authors.

REFERENCES

Castelli, D. M., Hillman, C. H., Buck, S. M., & Erwin, H. E. (2007). <Castelli et al._2007.pdf>. 239-252. https://doi.org/10.1123/jsep.29.2.239

Desheng, L. (2019). Analysis on Different Strength Characteristics of Track and Field Athletes Based on Physical Health Consciousness. Iwedss, 1213-1217. https://doi.org/10.25236/iwedss.2019.268

Dyson, B. (2014). Quality physical education: A commentary on effective physical education teaching. Research Quarterly for Exercise and Sport, 85(2), 144-152. https://doi.org/10.1080/02701367.2014.904155

Edwards, N. C. (2006). School Facılıtıes And Student Achıevement: Student Perspectıves On The Connectıon Between The Urban Learnıng Envıronment And Student Motıvatıon And Performance. In Global Shadows: Africa in the Neoliberal World Order (Vol. 44, Issue 1959).

Khwajamir, M. (2016). History and Problems of Education in Afghanistan. SHS Web of Conferences, 26, 01124. https://doi.org/10.1051/shsconf/20162601124

Kissane, C. (2012). The way forward for girls' education in Afghanistan. Journal of International Women's Studies, 13(4), 10-28.

Newton, R. U., Murphy, A. J., Humphries, B. J., Wilson, G. J., Kraemer, W. J., & Häkkinen, K. (1997). Influence of load and stretch shortening cycle on the kinematics, kinetics and muscle activation that

occurs during explosive upper-body movements. European Journal of Applied Physiology and Occupational Physiology, 75(4), 333-342. https://doi.org/10.1007/s004210050169

Pantović, M., Madić, D., Popović, B., Batez, M., & Obradović, J. (2015). Efekti primene vibracionog treninga i treninga sa dodatnim spoljašnjim opterećenjem na razvoj snage kod 13-godišnjeg dečaka nakon lezije m. biceps femoris i posttraumatske kalcifikacije. Vojnosanitetski Pregled, 72(7), 646-650. https://doi.org/10.2298/VSP140228040P

Rittweger, J. (2010). Vibration as an exercise modality: How it may work, and what its potential might be. European Journal of Applied Physiology, 108(5), 877-904. https://doi.org/10.1007/s00421-009-1303-3

Santonja Medina, F. M., Sainz De Baranda Andújar, P., Rodríguez García, P. L., López Miñarro, P. A., & Canteras Jordana, M. (2007). Effects of frequency of static stretching on straight-leg raise in elementary school children. Journal of Sports Medicine and Physical Fitness, 47(3), 304-308.

Van den Berghe, L., Vansteenkiste, M., Cardon, G., Kirk, D., & Haerens, L. (2014). Research on self-determination in physical education: Key findings and proposals for future research. Physical Education and Sport Pedagogy, 19(1), 97-121. https://doi.org/10.1080/17408989.2012.732563

Wei, W., Wei, J., & Fang, W. (2021). Application Analysis of Flipped Classroom Based on Wechat Public Platform in Basketball Physical Education Teaching. Journal of Physics: Conference Series, 1744(4). https://doi.org/10.1088/1742-6596/1744/4/042228

Wood, T. M., Maddalozzo, G. F., & Harter, R. A. (2002). Accuracy of seven equations for predicting 1-RM performance of apparently healthy, sedentary older adults. Measurement in Physical Education and Exercise Science, 6(2), 67-94. https://doi.org/10.1207/S15327841MPEE0602_1

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ORIGINAL ARTICLE

The effectiveness of a college athletic department's pro-environmental initiatives: Examining the tri-component attitude model

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ABSTRACT

The current study seeks to determine whether sport consumers' beliefs, feelings, and behavioural intentions differ when the consumers perceive and are presented with a college athletic department's high pro-environmental performance compared to its ordinary PE performance. This study employed an online-based experiment and relied on data from 613 sport consumers in the U.S. Two PE performance scenarios were developed, and one of the scenarios was randomly assigned to a sample of the consumers. A multivariate analysis of covariance was performed to test the research hypotheses. The findings suggested that sport consumers who were exposed to a college athletic department's high PE performance had significantly higher levels of feelings of gratitude and intentions to donate toward the PE initiatives than those who were presented with the ordinary PE performance. In contrast, there were no significantly differential impacts between high PE performance and ordinary PE performance on sport consumers' beliefs and general feelings. Both high-quality and quantity PE initiatives can function as strong motivational and learning processes that formulate sport consumers' perceptual and emotional engagement. This study contributes to the sport management literature by investigating the differential impacts of PE performance on the tri-component attitude model to fill the research gap.

Keywords: Sport management, Pro-environmental performance, Beliefs, Attitude, Gratitude, Donation intentions.

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INTRODUCTION

As a result of urgent environmental challenges, environmental sustainability has become a high priority for institutions of higher education in North America. In many instances, colleges and universities expand the environmental sustainability commitment and strategic plans for the causes of climate change (Casper et al., 2020). To fulfil this institutional priority, college athletic departments, regardless of size across the United States act as a social platform to promote environmental citizenship and adopt various pro-environmental (PE) initiatives (Kim et al., 2023; Pelcher & McCullough, 2019). A PE initiative involves environmentally responsible actions to minimize or offset the adverse environmental impacts caused by conventional business practices. College athletics departments' PE initiatives encourage a broad spectrum of stakeholder groups (e.g., fans, employees, public administrations, and business partners) to change their environmental attitudes and behaviours. Furthermore, their PE performance in conjunction with communication efforts and messaging strategies enhance emotional engagement and personal obligation to conduct environmentally responsible behaviours (McCullough et al., 2020). In short, anticipating higher expectations from society on environmental responsibilities, college athletic departments have accelerated support of the environmental sustainability efforts led by their Universities and Colleges.

College athletics departments' PE initiatives serve as an effective communication platform to educate their stakeholders about the threat of global climate change. Previous research has demonstrated the essence of PE initiatives which inculcates pro-environmental mindsets and actions to shape a sustainable society (Casper et al., 2014). Casper and his colleagues (2020) found that season ticket holders of a collegiate basketball program reporting higher norms associated with environmentally responsible behaviours at the sporting events have the positive perceptions of the sport organizations' PE efforts. Notably, the PE initiatives at the sporting events and through communication platforms have been an effective means for enhancing positive consumer attitudes, thereby fostering fans and other stakeholders to engage in environmentally responsible behaviours (Cayolla et al., 2023; Jin et al., 2011; McCullough & Cunningham, 2011; Trail & McCullough, 2020). In general, the PE efforts up to this point have indicated a positive association with consumer perceptions and behavioural responses.

A plethora of research has been devoted to understanding the causal relationships between consumers' perceptions of PE initiatives and environmentally responsible behaviours. However, the effectiveness of PE initiatives in the context of collegiate sport is missing in the literature (Casper et al., 2020). There is still a need for empirical research in assessing the impact of different levels of PE performance (high vs. ordinary) by the college athletics departments on consumers' attitudes. In conjunction with the research problem, this study attempts to offer empirical evidence to answer the following research questions: How likely the different levels of PE performance are to have differential impacts on consumers' attitudes? Further, how consumers' attitudes differ when they are exposed to a college athletic department's high PE performance information compared to its ordinary PE performance information?

To fill the aforementioned research gap, the purpose of this study is to examine the impacts of a college athletic department's PE performance on the tri-component model of attitude consisting of cognition (beliefs), affect (feelings), and conation (behavioural intentions). In particular, this current study seeks to determine whether sport consumers' beliefs, feelings, and behavioural intentions differ when the consumers perceive and are presented with a college athletic department's high PE performance compared to its ordinary PE performance. Measuring sport consumers' psychological responses influenced by college athletic departments' PE performance enhance our understanding of the effectiveness of PE initiatives as well as the essential function and role of college athletic departments regarding environmental sustainability for the

institutional commitment and responsibility (Cayolla et al., 2023). Thus, this research will contribute to the environmental sustainability literature in the context of collegiate sport by providing the first empirical evidence of the differential impacts of PE performance on sport consumer attitudes. It is intended to determine whether a college athletic department's high PE performance leads to greater degrees of sport consumers' attitudes than its ordinary PE performance. Those three components of attitude play a crucial role in predicting consumers' overall evaluation of the PE performance as well as determining the return on investment of the PE performance in the form of sport consumers' comprehensive psychological responses.

Literature review

The objective of PE initiatives

Sport organizations at the collegiate and professional levels across North America have adopted various PE initiatives to tackle the ever-increasing environmental threats (Trail & McCullough, 2020). More specific objective of sport organizations' PE initiatives is largely threefold: (a) to minimize or offset carbon emissions; (b) raise awareness of environmental challenges; and (c) inspire and educate various stakeholders to engage in sustainable practices. The implementation of PE initiatives becomes standard and a part of the modern sport landscape (McCullough & Cunningham, 2011). According to Trendafilova and colleagues (2013), the motives of sport organizations' PE initiatives involve fulfilling societal norms on environmental stewardship, increasing expectations from external stakeholders (e.g., governmental agencies and the media) on environmental standards and policies, and growing market pressures to emulate what other competitors are doing to maintain reputation. Additionally, enhancing goodwill perceptions and institutional strategic plan stimulate sport organizations to invest in PE initiatives.

Guided by an institutional strategic plan, college athletic departments have implemented a variety of PE initiatives to offset their carbon footprints. In recent years, despite the financial challenges of building or renovating eco-friendly sports venues, athletic departments at numerous universities regardless of size adopt the Leadership in Energy and Environmental Design (LEED) building standards (Jin et al., 2011; Kim et al., 2023). The LEED certification program developed by the U.S. Green Building Council (USGBC) provides a framework for low-carbon emitting, high-waste diversion rate, healthy indoor air quality, and energy- and water-efficient green buildings (USGBC, n.d.). Building to LEED standards can help a college athletic department benefit from lower operational costs and market pressures, image enhancement, and business partnership opportunities. The LEED-certified athletic facilities reflect college athletic departments' greening efforts and continue to gain ground in the U.S. (Broughton, 2022).

Sport organizations function as a public communication platform not only to promote their commitments to environmental sustainability but also to induce a pro-environmental mindset among stakeholders through environmental messages, reports, and communications (McCullough et al., 2020). In partnerships with environmentally focused companies, professional sport teams in the United States harness naming rights as a message to raise awareness of the urgent need for collective climate action. In June 2020, Amazon decided to purchase naming rights from the Oak View Group and name Climate Pledge Arena for the home of the WNBA's Seattle Storm and NHL's Seattle Kraken. The Climate Pledge is a coalition of companies, organizations, and individuals to address the climate crisis and "*a commitment to reach net-zero carbon emissions by 2040*" (The Climate Pledge, n.d.). Following this environmentally focused naming right agreement, the Kroenke Sports and Entertainment (KSE) partnered with Ball Corporation to produce sustainable aluminium cans, cups, and bottles to educate and showcase in-venue green practices at sporting events including naming rights for Ball Arena (formerly known as Pepsi Center). Most recently, the NBA's Phoenix Suns venue is called Footprint Center. Footprint develops and manufactures food containers and packaging solutions made from plant-based fibres (Young, 2021). Their unique partnership helps introduce

fans to biodegradable, compostable, and recyclable food bowls, plates, and utensils as the most sustainable and healthy choice while providing a more environmentally friendly fan experience at the venue. When fans are informed and exposed to the PE initiatives at sporting events, they are willing to engage in those environmentally responsible practices in their everyday lives (Casper et al., 2020). McCullough and his colleagues (2020) support the notion that "*predominantly, communications from sport organizations serve as a fan engagement effort to increase fan awareness and participation in the initiative*" (p. 4).

Tri-component model of attitude

According to Eagly and Chaiken (1998), "*an attitude is a psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour*" (p. 269). Kotler and Armstrong (2021) define attitude as "*a person's relatively consistent evaluations, feelings, and tendencies toward an object or idea*" (p. 145). A consumer's evaluative responses drive the formation of positive and/or negative views of an object or activity through perceptual, motivational, and learning processes (Neal et al., 2006). Consumer attitudes are developed and influenced by a consumer's personality, lifestyle, past experiences, and environmental situations. Indeed, these are essential sources of behaviour that guide their choice of actions (Wells & Prensky, 1996). Consumers gather information through perceptual, motivational, and learning processes (e.g., early experiences) to form attitudes and then use their attitudes to determine behavioural decisions whether they move toward or away from a given object or activity (Wells & Prensky, 1996): consumers' decisions to buy or refuse to buy. To sum up, consumer attitudes are evaluative responses expressing favour or disfavour and approval or disapproval (Eagly & Chaiken, 1993, 1998) and therefore play an important role in understanding consumers' behavioural and buying decisions (Ajzen, 2008; Schiffman & Kanuk, 1997).

Malhotra (2005) stated that "*attitude can be conceptualized as a summary evaluation of an object*" (p. 477). A prevalent framework of attitude consists of three major components: cognition (beliefs); affect (feelings); and conation (behavioural intentions) (Albarracin et al., 2005; Blythe, 2013; Breckler, 1984; Maio et al., 2004; Neal et al., 2006; Rosenberg & Hovland, 1960). This tri-component attitude model contributes to a global measure of attitude. The premise of this model is that all three components explicate the formation of an individual's attitude (Breckler, 1984) and best represent psychological responses and evaluative tendencies that reflect an evaluation of an object or activity (Albarracin et al., 2005). "*In general, people who have positive attitudes toward an attitude object should often possess beliefs, feelings, and behaviours that are favourable toward the object*" (Maio et al., 2004, p. 10). In contrast, people often form unfavourable beliefs, feelings, and behaviours toward an object if they have already had a negative attitude toward that object (Maio et al., 2004). Thus, this study adopts the tri-component attitude model to capture the comprehensive psychological responses of college athletic departments' PE initiatives.

Cognition (Beliefs)

The cognitive component of attitude consists of the knowledge and perceptions which take the form of a consumer's beliefs about an object or activity (Eagly & Chaiken, 1993, 1998; Verplanken et al., 1998). Beliefs are a consumers' thoughts and expectations that an object or activity possesses specific attributes that lead to acceptable/beneficial or unacceptable/detrimental outcomes. For example, consumers believe Patagonia's eco-friendly products not only preserve the natural environment but are also innovative and high quality. On the other hand, they believe that its eco-centric production (e.g., materials, recycling, packaging, and shipping) makes Patagonia's products more expensive. Consumers' beliefs are typically formed through an individual's early experiences and knowledge (Schiffman & Kanuk, 1997) and play a prominent role in the formation of action (Duncan & Olshavsky, 1982).

Sport organizations adopting PE initiatives can engender positive cognitive perceptions of those organizations. Consumers tend to believe the consequences (i.e., benefits) of the PE initiatives when they are exposed to or informed by the impact of the actions through strategic marketing communications (McCullough et al., 2020). For example, sport fans are growing accustomed to seeing environmental education programs and campaigns at sporting events. These educational opportunities both increase awareness and change personal worldviews or beliefs about environmental issues (Casper et al., 2014). Ottman (2017) supports the notion that fact-based visual evidence (e.g., data and results) of PE performance strengthens individuals' beliefs about the benefits of the business organizations' environmental commitment.

Perceived beliefs are important precursors and psychological tendencies that motivate desired actions. Previous consumer behaviour studies in sustainability affirm that consumers who believe in benefits of PE initiatives are willing to be more active on green consumption (Channa et al., 2021; Lee et al., 2012), recycling (Inoue & Kent, 2012a, 2012b), donation to sustainability efforts (Walker, 2013), and environmentally friendly practices (Casper et al., 2014; Trail & McCullough, 2020). Therefore, it is essential for college athletics managers to combine a variety of PE initiatives with effective communication strategies so that they can elicit consumers' beliefs about the PE performance contributing to sustainable progress for society. However, no attempt has been made to provide empirical evidence about the effectiveness of different levels of college athletic department's PE performance. Specifically, it is important to determine whether sport consumers' beliefs about the benefits of the PE performance can be strengthened when they perceive and are presented with high PE performance information. Overall, the effectiveness of associating PE performance with consumers' positive attitudes has been in question. To this end, the following hypothesis is proposed:

Hypothesis 1: A college athletic department's high PE performance is more effective than its ordinary PE performance in enhancing sport consumers' perceived beliefs about the benefits of PE initiatives.

Affect (Feelings)

The affective component of attitude denotes an individual's positive and negative feelings about or emotional reactions to an object or activity (Agyeiwaah et al., 2021). A consumer expresses inner feelings based on his or her affective evaluations toward a product, brand, and service. Consumers' emotional reactions such as happiness, anger, and appreciation can result from their evaluations of positive or negative experiences and recollections of past experiences (i.e., learned predispositions) (Schiffman & Kanuk, 1997). Conversely, emotional reactions can be instant and require no previous experience. For example, a spectator will immediately feel disappointed upon realizing that he or she is not among the first 100 people to receive a special giveaway at the sporting event. These feelings can be accessed more quickly than a cognitive (i.e., belief-based) component of attitudes (Verplanken et al., 1998), and are thus a crucial driver of consumption behaviours (Schiffman & Kanuk, 1997).

A growing body of literature has supported a positive link between PE initiatives and consumers' affective component of attitude. Consumers form emotional responses through the process of evaluation when exposed to publicity about the benefits and efforts of an organization's PE initiatives. Nam and colleagues (2017) posit that the more information a consumer has about sportswear brands' eco-centric production efforts, the more favourable emotional reactions the consumer has toward those brands. Similarly, findings from previous research imply that consumers tend to feel grateful when they recognize companies' prosocial actions for public benefits (Hwang & Kandampully, 2015; Kwak & Kwon, 2016; Romani et al., 2013), including their PE initiatives (Blankenbuehler & Kunz, 2014; Jung & La, 2021; Septianto et al., 2021). In general, consumers' recognition of the benefits and efforts of PE initiatives is an important antecedent of the affective component of attitudes including individuals' perceived attitude and gratitude. Consumers' feelings are

evaluative responses, tendencies, and appreciation of products, brands, and services, in turn, influencing their choice of consumption behaviours.

Affective attitude-behaviour relations have been supported in the consumer behaviour literature on sustainability. Consumers who have favourable feelings toward college athletic departments' green stadium initiatives are more likely to donate to their PE initiatives in the future (Jin et al., 2011). Trail and McCullough (2020) found evidence that consumers' attitude toward a sport organization's sustainability campaign is a significant predictor of intentions to practice sustainable behaviours. In line with these findings, feelings of gratitude engendered by Patagonia's perceived PE efforts (i.e., corporate self-sacrifice) enhance intentions to sustainable consumption (Jung & La, 2021). Overall, researchers postulated that strengthening consumers' positive feelings/emotional responses through PE initiatives is an essential strategy to promote environmentally responsible behaviours among stakeholders. In turn, it could bring environmental, social, and economic benefits to sport organizations (Greenhalgh & Drayer, 2020).

Even though previous research supports that positive feelings can drive consumers' willingness to engage in environmentally responsible behaviours, whether a college athletic department's high PE performance is more effective in enhancing consumers' feelings remains unclear. In this study, general feelings and gratitude are conceptualized as promoting prosocial behaviours. Therefore, the following hypotheses were developed:

Hypothesis 2: A college athletic department's high PE performance is more effective than the ordinary PE performance in heightening sport consumers' general feelings toward the PE initiatives.

Hypothesis 3: A college athletic department's high PE performance is more effective than the ordinary PE performance in enhancing sport consumers' feelings of gratitude for the PE initiatives.

Conation (Behavioural Intentions)

The conative component of attitude encompasses a consumer's tendency to engage in a specific action toward an object or activity (Assael, 2004). A series of predispositions to try out a product or react negatively toward the product would be the conative component of attitude (Neal et al., 2006). In marketing and consumer behaviour research, the conative component of attitude is considered and measured as behavioural intention. Ajzen (1991) explicates that the behavioural intention is an indication of "*how much of an effort individuals are planning to exert in order to perform the behaviour*" (p.181). In this sense, behavioural intention refers to the individual's willingness to perform a given behaviour. Consumers' intentions to perform a particular behaviour can be influenced by perceptual processes and motivational factors (e.g., social influences and information) that consumers recall from past experiences and anticipate desired future outcomes. Hence, the stronger the intention one has to engage in a particular action, the more likely one is to execute that action (Ajzen, 1991).

The literature on environmental consumer behaviour has suggested a strong link between motivational factors and behavioural intentions. Stern (1999) noted that consumers' environmentally responsible behaviours (e.g., residential energy conservation, recycling, carpools) can be motivated by a combination of credible information, incentives, and social influences. In line with this premise, Freeling and colleagues' (2022) experimental study found that a green message underscoring fact-based evidence of a charity's climate solutions convinced donors to contribute more money to the charity. Similarly, sport fans' willingness to pay a sustainability fee was strengthened by the information cue illuminating that the sustainability fee can help upgrade their favourite team's green stadium rating (e.g., from LEED silver to LEED gold) (Greenhalgh & Drayer, 2020). Hence, the information conveying the desired future outcomes greatly increased the

likelihood of donors/fans' behaviour. Furthermore, the findings of sustainable marketing research suggest that consumers are likely to purchase eco-friendly products in response to the green marketing messages about the business' commitment to sustainability (Casadesus-Masanell et al., 2009; Kim & Oh, 2020; Kong & Zhang, 2013).

Consequently, the conative component of attitude, behavioural intention, is an evaluative response influenced by motivational factors and assumed to drive consumer behaviour (Ajzen, 2002). Measuring and monitoring the conative component of attitude are considered as the closest proxies that enable marketers to predict consumer behaviour/engagement, thereby assessing the effectiveness of marketing efforts. Casper and colleagues (2020) support the notion that the effects of PE initiatives on consumers' behavioural intentions can be measured to assess the effectiveness of given PE initiatives. To shed light on the effectiveness of PE initiatives, this study attempts to determine whether or not a college athletic department's high PE performance can be more effective in motivating consumers' intentions. Therefore, the following hypothesis was established:

Hypothesis 4: A college athletic department's high PE performance is more effective than the ordinary PE performance in reinforcing intentions to donate to the PE initiatives.

METHOD

Procedures

To evaluate the impacts of different levels of PE performance on sport consumers' psychological responses (i.e., the tri-component attitude model) including perceived beliefs, general feelings, feelings of gratitude, and donation intentions, the present study employed an experimental design with two fictitious scenarios of PE performance (see Appendix A): High PE performance and ordinary PE performance. In general, PE initiatives are activities, processes, and operations (Lee et al., 2010) that include a wide range of eco-friendly programs (e.g., water and waste management, use of sustainable energy, PE campaigns, etc.). Thus, various PE initiatives and descriptions were used as stimuli in this study. Moreover, as different levels of communication strategies influence consumer behaviour toward consideration of environmental concerns (McCullough et al., 2020), this study stimulated participants by displaying different numbers of messages pertaining to PE initiatives. In the high PE performance condition, participants were presented with eight descriptions: Volunteers' PE efforts, monetary donation to non-profit environmental organizations, in-venue waste management, team uniforms made from recycled materials, use of renewable energy, retrofitting campaign, food donation, and planting trees. In the ordinary PE performance condition, participants were presented with five descriptions: Installation of recycling infrastructure, volunteers' PE efforts, promotion of recycling, planting trees, and team uniforms made from recycled materials. The top of the PE performance for both conditions included a statement indicating that a college athletic department is actively involved in comprehensive sports greening programs.

Participants were randomly assigned to view one of the two PE performance scenarios to ensure better external validity (Winer, 1999) as well as the reliability and validity of the measured factors while controlling for the effect of elements of the individual characteristics (Kuehl, 2000). After participants completed the consent form, they were randomly given one of the conditions. Following exposure to the PE performance scenario, the participants were asked to answer a series of questions regarding their perceived beliefs, general feelings, feelings of gratitude, and donation intentions.

Participants

An online survey was developed by Qualtrics, and participants were recruited via Amazon's Mechanical Turk (MTurk), which Buhrmester and colleagues (2011) found to be a reliable, high-quality method of data collection. In addition, MTurk allows researchers to collect data in a reasonable amount of time while avoiding the interaction between the researchers and survey participants (Buhrmester et al., 2011). Since the study's target sample was general consumers of college sports, participants were limited to individuals who self-identified as being active fans of college sports by using a filtering question (i.e., participant's favourite sport). As an incentive to participate in the study, participants received 75 cents (USD) upon completing the survey. Of the 757 participants completed survey, the 144 surveys with the same answer for all questions or with extremely inconsistent answer combinations were eliminated (Hospers et al., 2005). Of the remaining 613 usable surveys, 57.4% were male and 58.4% were Caucasian. The average age of participants was 33.93 years old. The largest household income segment was between $25,000 and $45,000 (21.6%). A total of 309 participants were provided the high PE performance and 304 the ordinary PE performance. Table 1 presents the demographic information of the sample and participants in each experimental condition—that is, high PE performance and ordinary PE performance.

Table 1. Demographic information.

Variables	**Categories**	**Overall (*n* = 613)**		**High PE Performance (*n* = 309)**		**Ordinary PE Performance (*n* = 304)**	
		n	%	*n*	%	*n*	%
Gender	Male	352	57.4	194	62.8	158	52.0
	Female	256	41.8	112	36.2	144	47.4
	Other	5	0.8	3	0.9	2	0.9
Income	Under $25,000	143	23.3	71	23.0	72	23.7
	$25,000 - $45,000	160	26.1	71	23.0	89	29.3
	$45,000 - $65,000	149	24.3	88	28.5	61	20.1
	$65,000 - $85,000	77	12.6	45	14.6	32	10.5
	$85,000 - $105,000	48	7.8	22	7.1	26	8.6
	Over $105,000	36	5.9	12	3.9	24	7.9
Education	High School	102	16.6	39	12.6	63	20.7
	Professional School	28	4.6	9	2.9	19	6.3
	Associate Degree	65	10.6	23	7.4	42	13.8
	Bachelor's Degree	334	54.5	194	62.8	140	46.1
	Master's Degree	73	11.9	39	12.6	34	11.2
	Doctorate	11	1.8	4	1.3	6	2.0
Season Ticket	Yes	173	28.2	137	44.3	36	11.8
	No	440	71.8	172	55.7	268	88.2
Race	Caucasian	358	58.4	144	46.6	214	70.4
	African-American	38	6.2	17	5.5	21	6.9
	Hispanic	31	5.1	9	2.9	22	7.2
	Native American	10	1.6	6	1.9	4	1.3
	Asian	165	26.9	130	42.1	35	11.5
	Other	11	1.8	3	1.0	8	2.6

Measures

The measurement items used in this study were adapted and modified from previous research. Three items were adapted from Du and colleagues (2007) and Madrigal (2001) to measure perceptions of beliefs. A sample item includes "*I believe (the College Athletic Department A)'s environmental initiatives make a*

positive impact on the environmental protection." Next, three items were adapted and modified from Jin and colleagues (2011) to measure donation intentions. One of the three items is measured by "*it is likely that I will donate to (the College Athletics Department A)'s sports greening movement*." In terms of the affective component of attitude, the feelings of gratitude scale consisting of three items was adopted from Palmatier et al. (2009). An example of item is "*I feel grateful for (the College Athletics Department A)*". Participants responded to all items measuring beliefs, gratitude, and intentions to donate on a 7-point Likert scale from 1 (*strongly disagree*) to 7 (*strongly agree*). Lastly, three items measuring general feelings toward PE initiatives were adapted from Mitchell and Olson (1981) and measured on a 7-point semantic differential scale (unfavourable/favourable, dislike very much/like very much, and despairing/hopeful).

Data analysis

The collected data were analysed using SPSS 26.0 and Mplus version 8.0. Descriptive and frequency analyses were conducted first, followed by confirmatory factor analysis (CFA) to test the psychometric properties. Goodness-of-fit of the model was assessed based on the following fit indices: chi-square per degrees of freedom (χ^2/df), comparative fit index (CFI), Tucker–Lewis index (TLI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR; Hu & Bentler, 1999). Because both groups of participants, despite receiving different levels of PE performance, completed the same questionnaires regarding their perceptions, it was inevitable to carry out a sequence of measurement invariance tests (i.e., configural, metric, and scalar measurement invariance tests) to gauge whether the participants in both groups had interpreted the questionnaires in an equivalent way.

In addition, because the level of individuals' team identification could influence the overall results, team identification, measured on Robinson and Trail's (2005) team identification scale, was controlled as a covariate. Moreover, two other demographic variables were controlled (i.e., gender and age) in that they possibly influence overall results (see Lee, 2009). Thus, a multivariate analysis of covariance (MANCOVA) was performed to determine the overall differences in two groups in perceived beliefs, general feelings, feelings of gratitude, and donation intentions. Between-subject conditions were two groups: the high performance and ordinary PE performance conditions, while within-subject variables were beliefs, general feelings, feelings of gratitude, and donation intentions. A Bonferroni adjustment was carried out to interpret significance of differences (i.e., .05).

RESULTS

Common method variance

Common method variance (CMV) could impact the study's results because data were collected from a single source (e.g., sport consumers). To reduce the potential issue of CMV, different survey scales (i.e., 7-point Likert scale and semantic differential scale) were employed in the survey design stage. After collecting the data, further efforts were made by testing Harman's single factor analysis to see if CMV was an issue in this study. Results of principal component analysis demonstrated that the single factor accounted for 18.6% of the variance, which is less than the threshold of 50% (Podsakoff et al., 2003). Hence, the impact of CMV on the current study was limited.

Manipulation check

For the purpose of testing manipulation check, participants' perceptions of the college athletic department's investment in the PE initiatives were measured to confirm the correctness of manipulation. To do that, a one-way ANOVA was performed as a manipulation check to determine whether the two conditions (i.e., high PE performance vs. ordinary PE performance) had been properly controlled. Participants' perceptions of the

athletic department's investment in the initiatives served as a dependent variable. The results of ANOVA revealed a significant difference in the perceptions between the groups, $F(1, 611) = 10.50$, $p = .001$. According to Tuckey's *post hoc* test, participants in the high PE performance indicated a significantly higher perceived investment ($M = 5.71$, SD = .83) than ones in the ordinary PE performance ($M = 5.45$, SD = 1.12). In other words, participants in the high PE performance felt that the college athletic department had exerted more effort in the high PE performance than participants in the ordinary PE performance. Overall, the results indicated that the manipulation was successful.

Descriptive analysis

In the group of high PE performance, values of skewness ranged from -1.26 to -.80, while values of kurtosis ranged from .22 to 2.15. In the group of ordinary PE performance, values of skewness ranged from -1.12 to -.18, while values of kurtosis ranged from -.91 to 1.34. In both groups, those values were within the cutoff criteria (Hair et al., 2010). In addition, a multicollinearity was not an issue because all values of the inter-factor correlations were less than .85 (Kline, 2015).

Construct validation

Cronbach's alpha scores were greater than .70, and composite reliability ranged from .78 to 93, thereby indicating the scale's internal consistency in both groups. All groups' factor loadings in both groups were significant and greater than the cutoff point of .50, except for three items. Factor loadings for the three items were deleted from the further analysis following Hair *et al*.'s (2010) suggestion (i.e., < .40). Construct's average variance extracted (AVE) in both groups exceeded the threshold of .50 (Fornell & Larcker, 1981). Those results indicated convergent validity was confirmed. Discriminant validity was also established since the square root of the structured AVE was greater than the correlation of constructs (see Table 2). In terms of the model fit. the results of the CFA for the high PE performance group showed a good fit, $\chi^2(48) = 125.092$, RMSEA = .072 (CI: 0.057, 0.088), CFI = .965, TLI = .953, and SRMR = .036, as did the results of CFA for the ordinary PE performance group, $\chi^2(48) = 98.844$, RMSEA = .059 (CI: 0.042, 0.076), CFI = .984, TLI = .978, and SRMR = .028. Table 3 presents the results of measurement scales.

Table 2. Descriptive statistics, Cronbach's alpha (α), and correlations of variables.

	1	2	3	4
High PE Initiatives				
1. Perceived Beliefs	**.74**			
2. Feelings	.724 [0.666, 0.774]	**.76**		
3. Gratitude	.590 [0.511, 0.659]	.567 [0.486, 0.639]	**.79**	
4. Donation Intentions	.313 [0.208, 0.411]	.512 [0.424, 0.590]	.271 [0.164, 0.372]	**.90**
Ordinary PE Initiatives				
1. Perceived Beliefs	**.83**			
2. Feelings	.767 [0.717, 0.810]	**.87**		
3. Gratitude	.722 [0.663, 0.772]	.717 [0.657, 0.767]	**87**	
4. Donation Intentions	.445 [0.349, 0.530]	.582 [0.502, 0.652]	.394 [0.295, 0.485]	**.92**

Note. Square root of AVE is presented on the diagonal of the matrix; 95% percentile confidence intervals are provided.

Measurement invariance

Prior to conducting the main analysis, a series of measurement invariance tests (i.e., configural, metric and scalar) was performed to determine whether the groups had similarly interpreted the questionnaires. To that purpose, configural invariance test was carried out by constraining factor structure, but all parameters are freely estimated. The configural model revealed a good model fit ($\chi^2/df = 2.23$, RMSEA = .063, CFI = .975,

TLI = .970, SRMR = .050). Next, metric invariance model was developed by constraining all factor loadings to be the same across the two groups. The metric invariance model also showed a good model fit (χ^2/df = 2.30, RMSEA = .065, CFI = .975, TLI = .968, SRMR = .049).

Table 3. Measurement scales.

Factor and Items	λ A/B	α A/B	C.R. A/B	AVE A/B
Perceived Beliefs		.79/.89	.79/.87	.56/.69
1. I believe [the College Athletic Department A] makes a real difference through its environmental initiatives	.705/.839			
2. I believe [the College Athletic Department A]'s environmental initiatives make a positive impact on the environmental protection	.744/.840			
3. I believe [the College Athletic Department A]'s environmental initiatives help protect our environment	.801/.825			
General Feelings		.82/.88	.81/.90	.59/.76
1. Unfavourable/Favourable	.789/.896			
2. Dislike very much/Like very much	.725/.876			
3. Despairing/Hopeful	.790/.860			
Feelings of Gratitude		.83/.90	.83/.90	.63/.76
1. I feel thankful for [the College Athletic Department A]	.838/.854			
2. I feel grateful for [the College Athletic Department A]	.792/.869			
3. I feel appreciative for [the College Athletic Department A]	.757/.904			
Donation Intentions		.95/.96	.93/94	.81/.85
1. It is likely that I will donate to [the College Athletic Department A]'s sports greening movement	.888/.874			
2. I intend to make an effort to donate to [the College Athletic Department A] for its environmental efforts	.917/.942			
3. It is likely that I will donate to [the College Athletic Department A] for its environmentally responsible initiatives	.909/.953			

Note. Factor Loadings (λ), Cronbach's alpha (α), Composite Reliability (C.R.), and Average Variance Extracted (AVE); A = high PE performance, B = ordinary PE performance.

Although both the configural and metric models revealed a good fit to the data (Table 4), χ^2 statistics indicated a significant difference between the two models, $\Delta\chi^2$ = 25.46, Δdf = 8, $p < .05$. It indicates that some of the factor loadings are not invariant across the two groups. To locate the non-invariance factor loadings, modification indices were inspected and revealed that two items in gratitude and attitude were considered non-invariance. Thus, partial metric invariance model was developed with the two items that were freely estimated in each group. The results showed that the partial metric model revealed a good model fit (χ^2/df = 2.19, RMSEA = .062, CFI = .977, TLI = .971, SRMR = .045). χ^2 statistics indicated a non-significant difference between the two models, $\Delta\chi^2$ = 6.32, Δdf = 3, $p > .05$. Additionally, metric measurement invariance was supported since changes in CFI, RMSEA, and SRMR were less than 0.010, 0.015, and 0.030, respectively (Chen, 2007). For the test of scalar invariance, the scalar invariance model was developed in which the intercepts were constrained to be equal across the two groups and was compared to the partial metric invariance model. χ^2 statistics was not statistically significant ($\Delta\chi^2$ = 7.88, Δdf = 5, $p > .05$), thereby indicating that scalar invariance was established. Also, changes in CFI, RMSEA, and SRMR that are less than 0.010, 0.015, and 0.010 would indicate scalar measurement invariance across groups (Chen, 2007). Hence, the

series of measurement invariance tests demonstrated that participants in both groups similarly interpreted the questionnaires in an equivalent way.

Table 4. Measurement invariance tests across two groups: high and ordinary PE performance.

Model	*df*	χ^2	RMSEA	CFI	TLI	SRMR
Configural model	100	223.989	.063	.975	.970	.050
Metric model	108	249.383	.065	.975	.968	.049
Partial metric model	105	230.246	.062	.977	.971	.045
Scalar model	110	238.127	.062	.976	.972	.037

Between-group differences in sport consumers' perceptions

MANCOVA was performed with sport consumers' level of team identification, gender, and age controlled as a covariate. The results indicated a statistically significant difference between the groups, $F(4, 594) = 8.82$, $p < .001$; Wilk's $\Lambda = .944$, partial $\eta^2 = .056$. In the assessment of pairwise comparisons, participants who were presented with the high PE performance had significantly higher feelings of gratitude ($M = 5.49$, $p < .05$, power > .80) and intentions to donate ($M = 4.75$, $p < .001$, power > .80) than those who were shown the ordinary PE performance ($M = 5.25$, $M = 4.03$, respectively), after controlling for sport consumers' levels of team identification, gender, and age (Table 5). Therefore, Hypothesis 3 and Hypothesis 4 were supported. No significant differences were found between those in perceived beliefs and general feelings toward the PE initiatives, refuting Hypothesis 1 and Hypothesis 2. Considering the power values that were greater than .80, findings regarding significant differences in gratitude and intentions to donate to PE initiatives were meaningful. In addition, the results showed significant covariate effects on sport consumers' perceived beliefs, general feelings, feelings of gratitude, and donation intentions. Specifically, team identification accounted for 15% of the variance in sport consumers' perceptions of PE initiatives ($F[4, 594] = 27.14$, $p < .001$; Wilk's $\Lambda = .845$). Gender accounted for 3.7% of the variance in sport consumers' perceptions of PE initiatives ($F[4, 594] = 5.62$, $p < .001$; Wilk's $\Lambda = .963$). Age accounted for 4% of the variance in sport consumers' perceptions of PE initiatives ($F[4, 594] = 6.12$, $p < .001$; Wilk's $\Lambda = .960$).

Table 5. Results of MANCOVA: comparison between high and ordinary PE performance.

Hypotheses	Variable	Total Sample (SD)	High PE Performance (SE)	Ordinary PE Performance (SE)	F Statistic	Sig.	η2	Supported
H1	Perceived Beliefs	5.63 (0.95)	5.66 (0.05)	5.60 (0.05)	0.48	.488	.001	No
H2	General Feelings	5.94 (0.95)	5.99 (0.05)	5.90 (0.05)	1.62	.203	.003	No
H3	Gratitude	5.37 (1.14)	5.49 (0.06)	5.25 (0.06)	7.34	.007	.012	Yes
H4	Donation Intentions	4.38 (1.71)	4.75 (0.08)	4.03 (0.08)	33.05	.000	.052	Yes

DISCUSSION

Despite the rapid advancements in collegiate sport research with respect to environmental sustainability, there is a surprising absence of experimental examinations of the effectiveness of PE initiatives in the literature. As a result, the effectiveness of sport organizations' PE investment remains in question. Therefore,

this study empirically examines whether sport consumers' beliefs, feelings, and behavioural intentions (i.e., tri-component attitude model) are affected differently when they are presented with high or ordinary PE performance by a college athletics department. The online-based experimental design applied two scenarios of PE performance. With the data from a sample of sport consumers in the U.S., a MANCOVA was conducted to test four research hypotheses.

Hypothesis testing results

The results indicated no significant differences between two groups in terms of beliefs about the benefits of PE initiatives (Hypothesis 1) or general feelings about PE initiatives (Hypothesis 2). Despite the lack of statistical significances in Hypotheses 1 and 2, it is worth noting that the overall mean scores of both perceived beliefs (M = 5.63) and general feelings (M = 5.94) toward the PE initiatives are relatively higher than gratitude (M = 5.37) and donation intentions (M = 4.38). These results indicate that sport consumers express fairly positive beliefs and feelings regardless of the high or ordinary PE performance presented by a college athletic department. That is, a college athletic department's ordinary PE performance still signals the value of such effort reflecting the positive perceptions of sport consumers.

In terms of Hypothesis 3, the results empirically demonstrate that the participants presented with the high PE performance scenario showed stronger feelings of gratitude than the participants presented with the ordinary PE performance scenario. This finding affirms that a college athletic department's high PE performance is more effective than its ordinary PE performance in fortifying sport consumers' feelings of gratitude. This finding is parallel with the previous research in that the sport fans' feelings of gratitude were greater for the PE effort when the sponsor of their favourite team helped the team save more operating (energy) costs (US$800,000/year versus US$12,000/year) by installing on-site solar panels (Kim et al., 2018). Similarly, Romani and colleagues (2013) provided evidence that higher levels of socially responsible investments engendered a stronger sense of gratitude. Therefore, high PE performance proves an effective and worthwhile investment because of its significant role in enhancing sport consumers' emotional engagement.

The results of this study also offer empirical evidence that the greater a sport consumer's perception of a college athletic department's PE investment, the stronger his or her intentions to donate to the PE effort. This finding supports Hypothesis 4 that a college athletic department's high PE performance is more effective than the ordinary PE performance in reinforcing sport consumers' willingness to donate to PE initiatives. Freeling and colleagues' (2022) work supports the results of Hypothesis 4, as they found that a non-profit organization's high effectiveness of climate solutions increased actual donations. Compared to donors who were exposed to mid-impact evidence, the average donation amount increased by 17% when donors were exposed to a message with high-impact evidence. According to the theory of planned behaviour (Ajzen, 2002), intention is an immediate precursor of action. In this case, measuring a consumer's behavioural intention can assist practitioners in gauging the effectiveness of their PE investments. Thus, this finding implies that the high PE performance enables practitioners to convince themselves of the return on investment in PE initiatives in the form of enhanced donation intentions and to achieve a major objective of those initiatives: To inspire and motivate stakeholders to engage in environmentally responsible behaviours.

Practical implications

The results of this study point to the differential impacts of PE performance on the tri-component model of attitude in collegiate sport. In addition, the study presents practical insights in the realm of strategic communication. A college athletic department's PE initiatives not only minimize adverse environmental impacts, but also reinforce sport consumers' affective and conative components of attitudes toward its higher levels of PE performance. To maximize the effectiveness of these initiatives, college athletics managers must

implement a variety of essential PE initiatives in conjunction with disclosures of information on PE performance.

College athletic departments that implement PE initiatives are encouraged to communicate their efforts. Sport consumers' positive attitudes can be enhanced when they are informed about and exposed to the impact of PE performance. College athletics managers can harness their easily available communication platforms such as official websites, social media, video boards, prominent alumni, mascots, and green team volunteers to share their genuine commitment to environmental sustainability. For instance, the University of California-Berkeley athletics department issued a press release about its PAC-12 Basketball Zero Waste Challenge. According to the release, "*The Golden Bears have won five of the last six basketball challenges, posting a diversion rate of 92% or higher in each of the victories*" (Cal Athletics, 2023). Ohio State University's athletic department tweeted, "*the overall zero waste diversion rate for all 13 zero waste events in fiscal year 2023 is 90.81 percent*" (Ohio State Athletics, 2023). The tweet included graphs of persuasive diversion rates. Taken together, it is crucial for managers to leverage the high PE performance by communicating its positive consequences (e.g., triple bottom line) of the PE efforts to bolster sport consumers' affective and behavioural responses.

Another practical implication based on these findings is that presenting evidence (e.g., assessment data) of a college athletic department's PE performance could elicit sport consumers' gratitude and willingness to make donations. Displaying PE performance numerically or with scientific evidence can make environmental impacts more tangible and compelling to stakeholders (Ottman, 2017). Food donations made by the University of Notre Dame's athletic department were featured in a news story that underlined its PE performance: "*The University of Notre Dame donated more than 8 tons of food to Cultivate Food Rescue during the recently completed home football season, or about 2,300 pounds per game, helping to battle hunger and reduce food waste in the local community*" (Blasko, 2022). The emphasis on the amount of philanthropic giving to environmental causes could foster emotional and behavioural engagement. Kwak and Kwon (2016) supported our managerial insight that sport fans showed more gratitude when their favourite team made larger charitable donations. Therefore, college athletics managers should measure the PE performance and communicate the social and environmental impact validated by evidence to strengthen the emotional and behavioural engagement of their stakeholders.

From a corporate partner's perspective, the findings from this study imply that corporate partners of college athletic departments who provide valued resources to enhance capabilities of PE initiatives may benefit from the affiliation with high PE performance. Xavier University athletics partnered with the Formica Corporation, a manufacturer of surfacing materials, to organize and execute a Threes for Trees campaign. As a part of its PE campaign, the Formica Corporation pledges to plant ten trees for every three-point made by the men's basketball team. This corporate-sponsored PE initiative has resulted in the planting of 18,860 trees since 2015 (Xavier University Athletics, 2022). Through such communication efforts, favourable attitudes could be shared with or transferred to a corporate partner when sport consumers are informed about the sponsor's genuine interest in and dedication to high PE performance (Kim et al., 2018). In this sense, the partners should take advantage of college athletic departments' communication platforms to publicize the value of cause-linked alliance enacting advanced and beneficial PE initiatives. At the same time, college athletics managers must be strategic in creating mutual benefits to advance higher levels of the partnering PE initiatives.

Limitations and future research

The findings of this study help undergird the literature on environmental sustainability in collegiate sport and extend the knowledge of the effectiveness of PE initiatives. However, the following limitations should be noted.

First, this study adopted the tri-component attitude model—sport consumers' psychological responses—to measure the effectiveness of a college athletic department's PE initiatives. Future research could include additional outcome measures such as actual donation amounts, frequency of participation in green events, and engagement metrics (e.g., message recall, event satisfaction, and social media impressions) to predict the return on investment of the PE initiatives more precisely.

Second, the authors used comprehensive PE initiatives in the performance-based scenarios (high vs. ordinary) to examine the effects of PE performance on sport consumer attitudes. Even though high PE performance was shown to be more effective in increasing affective and conative components of attitudes, it would be worthwhile to identify which PE initiative is more influential in improving consumer attitudes. As an extension of this study, researchers could use benefit-based scenarios to test the effectiveness of PE initiatives. That is, three scenarios can be framed based on environmental benefits (e.g., zero waste events), social benefits (e.g., installation of energy-efficient products to low-income families), and economic benefits (e.g., cost saving). This experimental design using benefit-based scenarios could provide empirical evidence of the differential impacts of PE initiative types on sport consumer attitudes, thereby determining whether a certain type of PE initiative is more influential in the outcome measures.

Third, the sample sizes in this study were sufficient to run a MANCOVA to determine the overall differences in the high and ordinary PE initiative groups; however, the composition of the respondent population was lopsided in terms of gender (62.8% males vs. 36.2% females) and race (70.4% Caucasian, 11.5 % Asian, 7.2% Hispanic compared to ordinary PE performance institutions). Future studies should aim for equal sample sizes to obtain more generalizable outcomes.

Lastly, for an emerging trend in corporate-sponsored PE initiatives in the sport sector (McCullough et al., 2022), follow-up studies should examine and provide evidence of the effectiveness of corporate-sponsored PE initiatives. Practitioners and academics must understand how to achieve sponsorship objectives, assess effectiveness/outcomes, and develop communication strategies of the corporate-sponsored PE initiatives. Findings and insights from such research could shed light on the benefits of corporate sponsors' PE investments, and therefore could attract more corporate partners to advance the partnering PE initiatives.

CONCLUSIONS

This experimental study adopted two scenarios to test the differential impacts of a college athletic department's PE performance on the tri-component attitude model. Empirical evidence found in this study indicates that college athletic departments' high PE performance can capture a wider range of sport consumer attitudes, especially feelings of gratitude and donation intentions. Further, sport consumers' attitudes improve when they receive information about the high PE performance. Therefore, it is crucial for the college athletic managers to design and disseminate impactful PE information in order to capitalize on the benefits being generated by their stakeholders (McCullough et al., 2020). To this end, the greater availability of PE information in public can be seen as an industry standard and benchmarking practices for peer institutions' environmental commitments.

To date, experimental evaluations of the effectiveness of sport organizations' PE initiatives is in a nascent stage of development. More research using robust methodologies is required to identify factors of a cause-effect relationship to assess the effectiveness of the PE initiatives. In turn, providing sufficient evidence of effectiveness enables sport practitioners to optimize the process and implementation of their PE initiatives. For this reason, the findings of this study serve as foundational evidence for future research in sport management around the effectiveness of sport organizations' PE initiatives.

AUTHOR CONTRIBUTIONS

Yu analyzed the data and wrote the Method and Results sections. Dabbs, Kim, and Nam designed the study, collected the data, and wrote other sections of the manuscript. All authors contributed to a review, revision, and final proofreading of the manuscript.

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REFERENCES

Agyeiwaah, E., Dayour, F., Otoo, F. E., & Goh, B. (2021). Understanding backpacker sustainable behavior using the tri-component attitude model. Journal of Sustainable Tourism, 29(7), 1193-1214. https://doi.org/10.1080/09669582.2021.1875476

Ajzen, I. (1991). The theory of planned behavior. Organization Behavior and Human Decision Processes, 50(2), 179-211. https://doi.org/10.1016/0749-5978(91)90020-T

Ajzen, I. (2008). Handbook of consumer psychology. In C. P. Haugtvedt, P. M. Herr, & F. R. Cardes (Eds.), Consumer attitudes and behavior (pp. 525-548). Routledge. https://doi.org/10.4324/9780203809570

Ajzen, I. (2002). Perceived behavioral control, self-efficacy, locus of control, and the theory of planned behavior. Journal of Applied Social Psychology, 32(4), 665-683. https://doi.org/10.1111/j.1559-1816.2002.tb00236.x

Albarracín, D., Johnson, B. T., & Zanna, M. P. (2005). The handbook of attitudes. Psychology Press. https://doi.org/10.4324/9781410612823

Assael, H. (2004). Consumer behaviour: A strategic approach. Houghton Mifflin Company.

Blankenbuehler, M., & Kunz, M. B. (2014). Professional sports compete to go green. American Journal of Management, 14(4), 75-81.

Blasko, E. (2022, December 15). Eight tons of surplus food saved, repurposed from Notre Dame Stadium during 2022 football season. Notre Dame News. Retrieved from: https://news.nd.edu/news/eight-tons-of-surplus-food-saved-repurposed-from-notre-dame-stadium-during-2022-football-season/ [Accesed 09/19/2023].

Blythe, J. (2013). Consumer behaviour. SAGE Publications.

Breckler, S. J. (1984). Empirical validation of affect, behavior, and cognition as distinct components of attitude. Journal of Personality and Social Psychology, 47(6), 1191-1205. https://doi.org/10.1037/0022-3514.47.6.1191

Broughton, D. (2022, April 4). LEED program grows with recertifications, benchmarks. Retrieved from: https://www.sportsbusinessjournal.com/Journal/Issues/2022/04/04/In-Depth/LEED-certification.aspx [Accesed 09/19/2023].

Buhrmester, M., Kwang, T., & Gosling, S. D. (2011). Amazon's Mechanical Turk: A new source of inexpensive, yet high-quality data?. Perspectives on Psychological Science, 6(1), 3-5. https://doi.org/10.1177/1745691610393980

Cal Athletics (2023, June 6). Cal wins PAC-12 basketball Zero Waste Challenge. Cal Athletics News. Retrieved from: https://calbears.com/news/2023/6/6/athletics-news-cal-wins-pac-12-basketball-zero-waste-challenge.aspx [Accesed 09/19/2023].

Casadesus-Masanell, R., Crooke, M., Reinhardt, F., & Vasishth, V. (2009). Households' willingness to pay for "green" goods: Evidence from Patagonia's introduction of organic cotton sportswear. Journal of Economics and Management Strategy, 18(1), 203-233. https://doi.org/10.1111/j.1530-9134.2009.00212.x

Casper, J. M., McCullough, B. P., & Pfahl, M. E. (2020). Examining environmental fan engagement initiatives through values and norms with intercollegiate sport fans. Sport Management Review, 23(2), 348-360. https://doi.org/10.1016/j.smr.2019.03.005

Casper, J. M., Pfahl, M. E., & McCullough, B. (2014). Intercollegiate sport and the environment: Examining fan engagement based on athletics department sustainability efforts. Journal of Issues in Intercollegiate Athletics, 7, 65-91.

Cayolla, R. R., Escadas, M., Biscaia, R., Kellison, T., Quintela, J. A., & Santos, T. (2023). Fans' perceptions of pro-environmental sustainability initiatives in sport and triple bottom line benefits. International Journal of Sports Marketing and Sponsorship, 24(2), 395-421. https://doi.org/10.1108/IJSMS-07-2022-0141

Channa, N. A., Tariq, B., Samo, A. H., Ghumro, N. H., & Qureshi, N. A. (2021). Predicting consumers' intentions to purchase eco-friendly athletic wear in a moderated model of individual green values and gender. International Journal of Sports Marketing and Sponsorship, 23(2), 410-436. https://doi.org/10.1108/IJSMS-12-2020-0215

Chen, F. F. (2007). Sensitivity of goodness of fit indexes to lack of measurement invariance. Structural Equation Modeling: A Multidisciplinary Journal, 14(3), 464-504. https://doi.org/10.1080/10705510701301834

Du, S., Bhattacharya, C. B., & Sen, S. (2007). Reaping relational rewards from corporate social responsibility: the role of competitive positioning. International Journal of Research in Marketing, 24(3), 224-241. https://doi.org/10.1016/j.ijresmar.2007.01.001

Duncan, C. P., & Olshavsky, R. W. (1982). External search: The role of consumer beliefs. Journal of Marketing Research, 19(1), 32-43. https://doi.org/10.1177/002224378201900103

Eagly, A. H., & Chaiken, S. (1993). The psychology of attitudes. Harcourt Brace Jovanovich College Publishers.

Eagly, A. H., & Chaiken, S. (1998). Attitude structure and function. In D. T. Gilbert, S. T. Fiske, & G. Lindzey (Eds.), The handbook of social psychology (pp. 269-322). McGraw-Hill.

Freeling, B. S., Dry, M. J., & Connell, S. D. (2022). Climate donations inspired by evidence-based fundraising. Frontiers in Psychology, 13, 1-8. https://doi.org/10.3389/fpsyg.2022.768823

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. Journal of Marketing Research, 18(1), 39-50. https://doi.org/10.1177/002224378101800104

Greenhalgh, G., & Drayer, J. (2020). An assessment of fans' willingness to pay for team's environmental sustainability initiatives. Sport Marketing Quarterly, 29(2), 121-133. http://doi.org/10.32731/SMQ.292.062020.04

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). Multivariate data analysis, Pearson Education.

Hospers, H. J., Kok, G., Harterink, P., & de Zwart, O. (2005). A new meeting place: Chatting on the Internet, e-dating and sexual risk behaviour among Dutch men who have sex with men. Aids, 19(10), 1097-1101. http://doi.org/10.1097/01.aids.0000174457.08992.62

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. Structural Equation Modeling: A Multidisciplinary Journal, 6(1), 1-55. https://doi.org/10.1080/10705519909540118

Hwang, J., & Kandampully, J. (2015). Embracing CSR in pro-social relationship marketing program: Understanding driving forces of positive consumer responses. Journal of Services Marketing, 29(5), 344-353. https://doi.org/10.1108/JSM-04-2014-0118

Inoue, Y., & Kent, A. (2012a). Investigating the role of corporate credibility in corporate social marketing: A case study of environmental initiatives by professional sport organizations. Sport Management Review, 15(3), 330-344. https://doi.org/10.1016/j.smr.2011.12.002

Inoue, Y., & Kent, A. (2012b). Sport teams as promoters of pro-environmental behavior: An empirical study. Journal of Sport Management, 26(5), 417-432. https://doi.org/10.1123/jsm.26.5.417

Jin, L., Mao, L. L., Zhang, J. J., & Walker, M. B. (2011). Impact of green stadium initiatives on donor intentions toward an intercollegiate athletic programme. International Journal of Sport Management and Marketing, 10(1-2), 121-141. https://doi.org/10.1504/IJSMM.2011.043620

Jung, E., & La, S. (2021). Consumer gratitude and reciprocation toward self-sacrificial environmental CSR in fashion markets: Understanding the moderation effects of incremental theorist and collectivist beliefs. Journal of Consumption Culture, 24(3), 35-58. https://doi.org/10.17053/jcc.2021.24.3.002

Kellison, T. B., & Kim, Y. K. (2014). Marketing pro-environmental venues in professional sport: Planting seeds of change among existing and prospective consumers. Journal of Sport Management, 28(1), 34-48. https://doi.org/10.1123/jsm.2011-0127

Kim, Y. D., Nam, C., & LaPlaca, A. M. (2023). Marketing and communicating sustainability through college athletics: The effects of pro-environmental initiatives on the belief-attitude-intention hierarchy. Journal of Marketing for Higher Education, 33(1), 58-78. https://doi.org/10.1080/08841241.2021.1892897

Kim, Y., & Oh, K. W. (2020). Effects of perceived sustainability level of sportswear product on purchase intention: Exploring the roles of perceived skepticism and perceived brand reputation. Sustainability, 12(20). https://doi.org/10.3390/su12208650

Kim, Y., Smith, R. D., & Kwak, D. H. (2018). Feelings of gratitude: A mechanism for consumer reciprocity. European Sport Management Quarterly, 18(3), 307-329. https://doi.org/10.1080/16184742.2017.1389973

Kline, R. B. (2015). Principles and practice of structural equation modeling. Guilford Press.

Kong, Y., & Zhang, A. (2013). Consumer response to green advertising: The influence of product involvement. Asian Journal of Communication, 23(4), 428-447. https://doi.org/10.1080/01292986.2013.774433

Kotler, P., & Armstrong, G. (2020). Principles of marketing (18th ed.). Pearson.

Kuehl, R. O. (2000). Design of experiments: Statistical principles of research design and analysis. Duxbury/Thomson Learning.

Kwak, D. H., & Kwon, Y. (2016). Can an organization's philanthropic donations encourage consumers to give? The roles of gratitude and boundary conditions. Journal of Consumer Behaviour, 15(4), 348-358. https://doi.org/10.1002/cb.1576

Lee, K. (2009). Gender differences in Hong Kong adolescent consumers' green purchasing behavior. Journal of Consumer Marketing, 26(2), 87-96. https://doi.org/10.1108/07363760910940456

Lee, N., Choi, Y. J., Youn, C., & Lee, Y. (2012). Does green fashion retailing make consumers more eco-friendly? The influence of green fashion products and campaigns on green consciousness and behavior. Clothing and Textiles Research Journal, 30(1), 67-82. https://doi.org/10.1177/0887302X12446065

Lee, J. S., Hsu, L. T., Han, H., & and Kim, Y. (2010). Understanding how consumers view green hotels: How a hotel's green image can influence behavioural intentions. Journal of Sustainable Tourism, 18(7), 901-914. https://doi.org/10.1080/09669581003777747

Madrigal, R. (2001). Social identity effects in a belief-attitude-intentions hierarchy: Implications for corporate sponsorship. Psychology and Marketing, 18(2), 145-165. https://doi.org/10.1002/1520-6793(200102)18:2<145::AID-MAR1003>3.0.CO;2-T

Maio, G. R., Esses, V. M., Arnold, K. H., & Olson, J. M. (2004). The function-structure model of attitudes: Incorporating the need for affect. In G. Handdock & G. R. Maio (Eds.), Contemporary perspectives on the psychology of attitudes, (pp. 27-52). Psychology Press.

Malhotra, N. K. (2005). Attitude and affect: New frontiers of research in the 21st century. Journal of Business Research, 58(4), 477-482. https://doi.org/10.1016/S0148-2963(03)00146-2

McCullough, B. P., Casper, J. C., & Kushner Smith, D. M. (2022). Fan responses of sponsored environmental sustainability initiatives. Sustainability, 14. https://doi.org/10.3390/su142114062

McCullough, B. P., & Cunningham, G. B. (2011). Recycling intentions among youth baseball spectators. International Journal of Sport Management and Marketing, 10(1-2), 104-120. https://doi.org/10.1504/IJSMM.2011.043618

McCullough, B. P., Pelcher, J., & Trendafilova, S. (2020). An exploratory analysis of the environmental sustainability performance signaling communications among North American sport organizations. Sustainability, 12. https://doi.org/10.3390/su12051950

Mitchell, A. A., & Olson, J. C. (1981). Are product attribute beliefs the only mediator of advertising effects on brand attitude?. Journal of Marketing Research, 18(3), 318-332. https://doi.org/10.1177/002224378101800306

Nam, C., Dong, H., & Lee, Y. A. (2017). Factors influencing consumers' purchase intention of green sportswear. Fashion and Textiles, 4(1), 1-17. https://doi.org/10.1186/s40691-017-0091-3

Neal, C. M., Quester, P. G., & Hawkins, D. I. (2006). Consumer behaviour: Implications for marketing strategy, McGraw-Hill Australia.

Ohio State Buckeyes [@OhioStAthletics]. (2023, April 22). The overall zero waste diversion rate [Tweet]. Twitter. Retrieved from: https://twitter.com/OhioStAthletics/status/1649827176081154050?s=20 [Accesed 09/19/2023].

Ottman, J. (2017). The new rules of green marketing: Strategies, tools, and inspiration for sustainable branding. Routledge. https://doi.org/10.4324/9781351278683

Palmatier, R. W., Jarvis, C. B., Bechkoff, J. R., & Kardes, F. R. (2009). The role of customer gratitude in relationship marketing. Journal of Marketing, 73(5), 1-18. https://doi.org/10.1509/jmkg.73.5.1

Pelcher, J. A., & McCullough, B. P. (2019). Greening our front porch: environmental sustainability in collegiate athletics. Case Studies in Sport Management, 8(1), 13-17. https://doi.org/10.1123/cssm.2018-0017

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. Journal of Applied Psychology, 88(5), 879-903. https://doi.org/10.1037/0021-9010.88.5.879

Robinson, M. J., & Trail, G. T. (2005). Relationships among spectator gender, motives, points of attachment, and sport preference. Journal of Sport Management, 19(1), 58-80. https://doi.org/10.1123/jsm.19.1.58

Romani, S., Grappi, S., & Bagozzi, R. P. (2013). Explaining consumer reactions to corporate social responsibility: The role of gratitude and altruistic values. Journal of Business Ethics, 114(2), 193-206. https://doi.org/10.1007/s10551-012-1337-z

Rosenberg, M. J., & Hovland, C. I. (1960). Cognitive, affective, and behavioral components of attitudes. In C. I. Hovland & M. J. Rosenberg (Eds.), Attitude organization and change: An analysis of consistency among attitude components (pp. 1-14). Yale University Press.

Schiffman, L. G., & Kanuk, L. L. (1997). Consumer behaviour. Prentice Hall.

Septianto, F., Seo, Y., & Errmann, A. C. (2021). Distinct effects of pride and gratitude appeals on sustainable luxury brands. Journal of Business Ethics, 169(2), 211-224. https://doi.org/10.1007/s10551-020-04484-7

Stern, P. C. (1999). Information, incentives, and proenvironmental consumer behavior. Journal of Consumer Policy, 22(4),461-478. https://doi.org/10.1023/A:1006211709570

The Climate Pledge (n.d.). About the climate pledge. The Climate Pledge. Retrieved October 7, 2022, from https://www.theclimatepledge.com/us/en/the-pledge/About [Accesed 09/19/2023].

Trail, G. T., & McCullough, B. P. (2020). Marketing sustainability through sport: Testing the sport sustainability campaign evaluation model. European Sport Management Quarterly, 20(2), 109-129. https://doi.org/10.1080/16184742.2019.1580301

Trendafilova, S., Babiak, K., & Heinze, K. (2013). Corporate social responsibility and environmental sustainability: Why professional sport is greening the playing field. Sport Management Review, 16(3), 298-313. https://doi.org/10.1016/j.smr.2012.12.006

USGBC (n.d.). Benefits of LEED. U.S. Green Building Council. Retrieved October 4, 2022, from https://www.usgbc.org/leed/benefits-leed [Accesed 09/19/2023].

Verplanken, B., Hofstee, G., & Janssen, H. J. (1998). Accessibility of affective versus cognitive components of attitudes. European Journal of Social Psychology, 28(1), 23-35. https://doi.org/10.1002/(SICI)1099-0992(199801/02)28:1<23::AID-EJSP843>3.0.CO;2-Z

Walker, M. (2013). Does green management matter for donation intentions? The influence of environmental consciousness and environmental importance. Management Decision, 51(8), 1716-1732. https://doi.org/10.1108/MD-10-2012-0732

Wells, W., & Prensky, D. (1996). Consumer behavior. Wiley & Sons.

Winer, R. S. (1999). Experimentation in the 21st century: The importance of external validity. Journal of the Academy of Marketing Science, 27(3), 349-358. https://doi.org/10.1177/0092070399273005

Young, J. (2021, July 16). Phoenix Suns arena will be named Footprint Center in one of the most unique partnerships in sports. CNBC. Retrieved from: https://www.cnbc.com/2021/07/16/phoenix-suns-arena-will-be-called-footprint-center.html [Accesed 09/19/2023].

SUSTAINABILITY & SPORTS SCIENCE JOURNAL

ORIGINAL ARTICLE

Flexibility and mobility parameters in climbers and non-climbers

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ABSTRACT

Purpose: In recent years, climbing has become increasingly popular and now has more enthusiasts and research interest than ever before. However, no study has yet considered the relationships between the functional mobility of the upper and lower limbs, climbing experience, climbing-specific hip mobility, and muscle strength. The purpose of this study was to determine whether functional mobility (measured using shoulder mobility and active straight leg raise tests) or climbing-specific hip mobility (measured using an adapted Grant foot raise test [hip flexion] and lateral foot reach test [hip abduction and external rotation determines climbing skills. Methods: A total of 59 volunteer climbers in 3 groups (elite climbers, intermediate climbers, and non-climbers) were assessed according to anthropometry, muscle strength, functional mobility, and hip mobility. Results: Elite climbers performed significantly better than intermediate climbers and non-climbers in tests of the external mobility of the left shoulder (p = .043; η^2 = 0.112) and in the adapted Grant foot raise test (p = .023; η^2 = 0.126). Conclusions: Elite climbers have greater hip mobility than intermediate climbers and non-climbers. Functional shoulder mobility, especially external rotation, may play a role in effective climbing.
Keywords: Technology, Innovation, Flexibility, Climbing, Hip mobility.

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INTRODUCTION

The body of research relating to indoor and outdoor climbing has increased dramatically in recent decades (Mermier et al., 2000) as the sport has gained popularity (Ozimek et al., 2016a). The number of indoor climbing gyms continues to increase, as does the number of people involved in climbing, both recreationally and competitively (Deyhle et al., 2015).

Despite improvements in traditional climbing, the increased number of climbers (Grant et al., 1996), and the growing research in this area (Mermier et al., 2000), scientific data on the subject remains scarce (Fryer et al., 2017; Giles et al., 2006). Much of the scientific literature focuses on injuries and their prevention (Hoge et al., 2010; Mermier et al., 2000). In addition, the literature offers some debate and some conflicting evidence regarding the impacts of physiological and anthropometric factors on climbing performance (Mermier et al., 2000; Watts, 2004).

To predict a climber's performance, researchers assess their physiological workload, how they respond to short-term fatigue and psychological demands (Magiera et al., 2019), their anthropometric characteristics, their muscular strength, their endurance, and the flexibility of their legs and arms (Saul et al., 2019; Watts, 2004). Many tests have been designed to assess climbers' muscle strength, the most commonly used being the handgrip and/or finger strength test (Grant et al., 1996, 2001; Mermier et al., 2000; Ozimek et al., 2016; Sheel, 2004; Watts, 2004). However, when handgrip strength is expressed relative to body mass ratio (SBMR), climbers' scores tend to be more accurate (Watts et al., 1993).

Handgrip strength is used not only to estimate overall muscle strength but also to predict health-related prognoses (Sasaki et al., 2007). In conjunction with finger grip strength, upper-limb power, and endurance, it accounts for 46% of the training components in climbing, while anthropometrics explains only 4% of all variance (Laffaye et al., 2016). With that being said, a recent systematic review suggests that, alongside handgrip strength, low skinfold thickness and body fat, as well as high forearm volume, are all anthropometric traits of a successful climber (Saul et al., 2019).

Among climbers, flexibility is often assessed through range of motion (ROM) (Magiera & Ryguła, 2007; Mermier et al., 2000; Wall et al., 2004) and indirect assessments such as the sit-and-reach test (Draper et al., 2009; Grant et al., 1996, 2001), the leg span test (Grant et al., 1996, 2001) and the foot raise (Draper et al., 2009; Grant et al., 1996, 2001). Mermier et al. (Mermier et al., 2000) show that in climbing performance, variations in the squared semi-partial correlations between the training components, anthropometry, and flexibility are 58.9%, 0.3%, and 1.8%, respectively. This suggests that training components are the only significant predictor of climbing performance, while anthropometry and flexibility contribute little to a climber's overall ability. Additional research (Sheel, 2004) concludes the same and seems to support previous findings (Mermier et al., 2000). Flexibility is not necessarily a determinant of climbing ability (Giles et al., 2006). Nonetheless, Draper et al. (Giles et al., 2006) determined that climbing-specific hip flexion—assessed by the Grant foot raise test—and hip abduction and external rotation—assessed by the lateral foot reach test—should be addressed in any training or rehabilitation program (Draper et al., 2009). On this basis, these authors (Draper et al., 2009) have developed an adapted Grant's foot raise test to address climbing-specific hip flexion. The importance of hip joint mobility—in particular, hip abduction—in rock climbing performance is confirmed by a recent review paper (Michail Lubomirov, 2014), which contrasts with findings related to the ROM of the hip and leg, which do not determine the contestant development performance of climbers (Magiera & Ryguła, 2007).

Rock climbing puts intense demands on the soft tissues surrounding the glenohumeral joint, causing climbers to demonstrate less mobility in scapular upward rotation and to have significantly less mobility in this plane than non-climbers (Roseborrough & Lebec, 2007). Asymmetry in reach skills can also be considered a negative determinant factor in climbing (Čular et al., 2018), with many sport asymmetries being a consequence of limb dominance (Maloney, 2019). Training interventions can reduce sport asymmetries and improve performance, though, further research is needed to fully understand and determine dependencies (Maloney, 2019).

Although previous studies have analysed many of these characteristics in climbers, (Draper et al., 2009; Grant et al., 1996, 2001; Mermier et al., 2000; Watts et al., 1993), to the best of our knowledge, no study has considered functional mobility tests of the upper and lower limbs. Functional mobility exists on the spectrum of functional movement—an indicator of movement proficiency (O'Brien et al., 2017). Mobility is the ability to integrate joint ROM without any restrictions on muscle length, strength, or motor control (Behm, 2019). Regarding ROM competence, the functional movement screen (FMS) is one of the most commonly used screening systems; it provides a clinically interpretable measure of movement quality (Kraus et al., 2014; Marques et al., 2017). The purpose of the FMS is to assess functional movement patterns, thereby creating a functional movement baseline against which subsequent movements can be rated and ranked (Cook, Burton, Hoogenboom, et al., 2014).

On this basis, our study considered the functional mobility of the upper and lower limbs, climbing experience, climbing-specific hip mobility, and muscle strength. Our goal was to compare the functional mobilities, climbing-specific hip mobilities (using the lateral foot reach and adapted Grant foot raise tests), handgrip strengths, and strength-to-body-mass ratios of climbers and non-climbers—with the former divided based on skill level, as either "*intermediate*" and "*elite*." We hypothesized that the elite climbers would perform better than the intermediate climbers and non-climbers in tests of hip mobility, handgrip strength, and strength-to-body-mass ratio.

METHODS

A cross-sectional design was used 1) to analyse the variance of functional mobility, ROM, climbing-specific hip mobility and handgrip strength between groups (elite climbers, intermediate climbers, and non-climbers); and 2) to analyse which test best characterized the elite climbers, intermediate climbers, and non-climbers.

Participants

A total of 59 volunteers (23.7% female and 76.3% male) were evaluated for anthropometry, muscle strength, functional mobility, and hip mobility. The volunteers were then divided into three groups: elite climbers (4 females; n = 17), intermediate climbers (6 females; n = 28), and non-climbers (3 women, n = 14). The proportion of female participants was similar for all groups (22.1%). Participants ranged from 12 to 46 years of age, with an average age of 25.

The tests were conducted in two phases. The first phase was carried out with students and teachers at the School of Sports and Leisure in Melgaço, while the second phase took place during the seniors' national boulder climbing competition in Soure, Coimbra. All subjects—and the parents of those under 18 years of age—received a clear explanation of the study that included information about the risks and benefits of participation. Prior to testing, each participant provided written informed consent according to the Declaration of Helsinki, including consent to be video-recorded for further analysis.

All participants were involved in regular physical activity. When performing the mobility tests, the participants were excluded if: in the presence of pain; unable to complete the movement pattern; or unable to assume the position to perform the movement. Those with no regular practice in climbing were categorized as non-climbers, while those with experience were classified as either elite or intermediate. It was not possible to categorize the climbers based on the International Rock Climbing Research Association's guidelines (Draper et al., 2015), as no universal scale are provided. Thus, the elite group consisted of finalists from all national competitions in the subsequent year, and all remaining climbers were considered intermediate.

Anthropometrics

Bodyweight was measured using a scale (SECA 760, Germany). Subjects were instructed to remove their shoes prior to stepping on the scale platform. The measurement was recorded in kilograms (to the nearest 0.5 kg). Height was measured using a portable stadiometer (SECA 217, Germany). Subjects once again removed their shoes and assumed an anthropometric position on the smooth surface of the stadiometer, with their heels together and their weight distributed evenly across both feet. The head was oriented according to the Frankfurt plain. Testers assisted subjects as needed by applying slight pressure to correct the curvature of the column and then encouraging subjects to take a deep breath. The stem of the stadiometer was compressed on the vertex, and the measurements were taken in centimeters (to the nearest 0.1 cm).

Mobility

The functional movement screen (FMS) (Frost et al., 2012)—a battery of seven qualitative tests that evaluate and classify functional mobility and postural stability without locomotion (Butler, 2010)—was selected. From the seven tests, and considering climbing abilities, we selected two (shoulder mobility and active straight leg raise) for analysis.

The shoulder mobility test requires scapular mobility and thoracic spine extension. It assesses the bilateral and reciprocal ROM in the shoulder, combining internal rotation with the abduction of one shoulder and external rotation with the abduction of the other shoulder (Cook, Burton, Hoogenboom, et al., 2014; Cook et al., 2006). Meanwhile, the active straight leg raise test requires the participant to disassociate the lower extremities from the trunk while maintaining stability in the torso. It assesses active hamstring and gastro-soleus flexibility with a stable pelvis and core, as well as the active extension of the opposite leg (Cook, Burton, Hoogenboom, et al., 2014; Cook et al., 2006).

Three repetitions of each screening test were completed and filmed with a video camera (GC-PX100, JVC, Kenwood Corporation, Japan) for further analysis. The best-performed repetition was scored. For each pattern, a score from 0 to 3 was assigned. A score of 0 indicated that the subject experienced pain somewhere in the body. A score of 1 indicated that the participant was unable to complete the movement pattern or assume the position needed to perform the movement. A score of 2 indicated that the participant was able to complete the movement but had to compensate in some way to do so. Finally, a score of 3 indicated that the participant performed the movement correctly without any compensation and in compliance with the standard movement expectations associated with the test (Cook, Burton, & Hoogenboom, 2014). Approximately 10 seconds of rest was provided between trials, and one minute was given between tests. Subjects always returned to the starting position between attempts. Each side of the body was assessed unilaterally so that asymmetries could be detected.

Shoulder mobility

According to Cook et al. (Cook, Burton, Hoogenboom, et al., 2014; Cook et al., 2006), the tester must first determine hand length by measuring the distance from the distal wrist crease to the tip of the third digit. The

subject is then instructed to make a fist with each hand, placing the thumb inside the fist. They are asked to stand and raise one arm above their head, then to bend their elbow, let the first rest on the back of the neck, and then slide it down the back and between the shoulder blades. With the other arm, they then reach towards the back, sliding the first hand down and the second hand up to try and touch both fists together. During the test, both hands should remain in fists, and the fists should be placed on the back in one smooth motion. Once the action is completed, the tester measures the distance between the two closest bony prominences. The test is performed as many as three times bilaterally.

Video of the testing was analysed using the freeware motion-analysis software Kinovea (version 0.8.15, available for download at http://www.kinovea.org). Angulation in internal and external rotation was analyzed while considering the olecranon as the vertex, the middle finger in on the extremities and the acromion in the other extremity.

Active straight leg raise

For this test, the subject assumes a relaxed supine position with the arms in anatomical position, the legs on a towel about 4 centimeters in height, and the head flat on the floor. The tester identifies the midpoint between the anterior superior iliac spine and the midpoint of the patella of the leg on the floor. Then, the subject is instructed to slowly lift the test leg with a dorsiflexed ankle and an extended knee. The knee of the lower leg must remain in contact with the ground, with the toes pointed upward. The head must also remain in contact with the floor. Once the end position is achieved, the tester notes the position of the upward ankle relative to the lower leg and verifies that the latter has maintained a neutral position (i.e., no hip external rotation has occurred). The malleolus helps to identify the score of the test leg. The test is performed three times bilaterally (Cook, Burton, Hoogenboom, et al., 2014; Cook et al., 2006).

Video of the testing was analysed using the freeware motion-analysis software Kinovea (version 0.8.15, available for download at http://www.kinovea.org). Angulation was analysed while considering the anterior superior spine as the vertex, the malleolus on one the extremities and a parallel line within the floor in the other extremity.

Climbing-specific hip mobility

Hip mobility was evaluated using an adapted Grant foot raise test (for hip flexion) and the lateral foot reach test (for hip abduction and external rotation).

Adapted grant foot raise

The adapted Grant foot raise test builds upon the methods described in previous research (Draper et al., 2009; Grant et al., 1996). The objective of this test is to place the foot at maximum hip flexion on the wall directly in front of the climber. In this study, lateral placement of the foot was permitted (Draper et al., 2009) in order to better simulate a climbing movement.

During testing, the subject stands facing a wall with their toes touching a line. The line, in this case, was placed 23 centimeters from the wall. Both of the subject's hands are placed flat on the wall with the fingers pointing upwards at shoulder height. The subject then raises their right foot directly underneath their right hand (guided by a tape measure and adhesive tape) to a maximum hip flexion position. A plantar flexion of the left ankle is permitted to vertically extend the body's position. In climbing, the hands and feet are used in alternation as the climber progresses vertically. During this test was allowed the placement of the right hand next to the meter tape and lifting it so that those who had more capability could reach. The test was performed three times, with the tester measuring the distance from the top of the participant's right foot to the floor for

each trial. A few subjects raised their feet as high as or higher than their hands, having been permitted to move their hands slightly to the side.

Lateral foot reach

Draper et al. (2009) developed the lateral foot reach as a climbing-specific measure of hip abduction and external rotation. When performing this test, both of the subject's hands are placed on the right side of a campus rung that is located centrally on a test apparatus and set at the subject's height above the left foothold. The left foot moves to the foothold. Then, the test is completed when the right foot (guided by a tape measure) reaches maximal hip abduction and external rotation horizontally. The left foot and both hands must remain in contact with their corresponding holds throughout the movement. The measurement is taken from the outside of the left foothold to the outside of the right foot.

In the absence of a campus rung and test apparatus, the test was performed on a conventional climbing wall. Because the set-up could not be adjusted for each subject, the rung was maintained at a height of 175 centimeters throughout. The test used the same two holds with the same distance between them on each of the two evaluation days—one wide hold for the hands and one narrow hold for the left foot. Both hands were placed on the right side of a large climbing hold, located centrally above the left foothold.

Handgrip strength

Handgrip strength was assessed using a hand dynamometer with an adjustable grip (SH5001, SAEHAN Corporation) and recorded in kilograms (kg). For each hand, the subject was seated with their shoulder adducted and neutrally rotated, their elbow flexed at 90°, their forearm in a neutral position, and their wrist between 0° and 30° dorsiflexion and between 0° and 15° ulnar deviation (Mullerpatan et al., 2013).

The subject was then instructed and verbally encouraged to squeeze the handgrip as hard as they could. Three trials were completed for each hand, and the highest score for each hand was recorded for further analysis. The strength-to-body-mass ratio (SBMR) was calculated by dividing grip strength by body mass.

Statistical analysis

Descriptive statistics (including an average and a 95% confidence interval for lower and upper limits) were calculated. Differences among the three groups (elite climbers, intermediate climbers, and non-climbers) were investigated for each of the tests in the battery using one-way ANOVA. Assumptions about the normality and homogeneity of the sample were also tested. Eta squared (η^2) tested the effect size (ES) of the inferential analysis, then Ferguson's classification was applied to the ES values (Ferguson, 2009), categorizing each as *no effect* (ES < 0.04), *minimum effect* (0.04 < ES < 0.25), *moderate effect* (0.25 < ES < 0.64), or *strong effect* (ES > 0.64). All statistical analyses were completed using SPSS (version 23.0.0.0 for MAC, IBM, USA) for a $p < .05$.

RESULTS

Significant differences were found between groups (elite climbers, intermediate climbers and non-climbers) in weight ($p = .004$; $\eta^2 = 0.187$, *minimum effect*). No significant differences were found in height ($p = .064$; $\eta^2 = 0.094$, *minimum effect*) [Table 1].

Significant differences were found between groups in shoulder mobility (SM) left external rotation ($p = .043$; $\eta^2 = 0.112$, *minimum effect*). No significant differences were found in SM right ($p = .452$; $\eta^2 = 0.029$, *no effect*), SM left ($p = .247$; $\eta^2 = 0.050$, *minimum effect*), SM asymmetry ($p = .223$; $\eta^2 = 0.054$, *minimum effect*), SM

right internal rotation (p = .794; η^2 = 0.008, *no effect*), SM right external rotation (p = .056; η^2 = 0.103, *minimum effect*), or SM left internal rotation (p = .313; η^2 = 0.042, *minimum effect*) [Table 2].

Table 1. Sample description (mean and 95%CI).

	Elite Climbers (N = 17)	Intermediate Climbers (N = 28)	Non-climbers (N = 14)
Age (years)	22.41 [18.48-26.35]	26.54 [23.47-29.60]	23.36 [19.02-27.69]
Weight (kg)	57.18[b] [51.62-62.73]	69.21[a] [64.89-73.54]	66.79[c] [60.67-72.91]
Height (cm)	166.18 [161.91-170.45]	172.33 [169.01-175.66]	172.06 [167.36-176.77]

Note. Significant different comparing to elite climbers[a]; intermediate climbers[b]; and non-climbers[c] at p < .05; kg – kilograms; cm centimetres.

Table 2. Shoulder mobility (mean and 95%CI) specifications.

	Elite Climbers (N = 17)	Intermediate Climbers (N = 28)	Non-climbers (N = 14)
SM right (AU)	2.25 [1.80-2.70]	1.96 [1.62-2.31]	1.86 [1.38-2.34]
SM left (AU)	2.06 [1.62-2.51]	1.59 [1.25-1.93]	1.71 [1.24-2.19]
SM asymmetry (AU)	1.38 [1.14-1.61]	1.41 [1.23-1.59]	1.14 [0.89-1.40]
SM right internal (º)	56.44 [49.68-63.20]	59.07 [53.87-64.28]	56.93 [49.70-64.16]
SM right external (º)	35.81 [31.30-40.33]	42.26 [38.79-45.73]	37.08 [32.07-42.08]
SM left internal (º)	56.38 [49.95-62.80]	58.85 [53.91-63.80]	52.36 [45.49-59.22]
SM left external (º)	35.94[b] [30.62-41.26]	44.33[a] [40.24-48.43]	39.15[c] [33.25-45.06]

Note. Significant different comparing to elite climbers[a]; intermediate climbers[b]; and non-climbers[c] at p < .05; SM - shoulder mobility; AU - arbitrary unit; º - degrees.

Table 3. Active straight leg raise (mean and 95%CI) specifications.

	Elite Climbers (N = 17)	Intermediate Climbers (N = 28)	Non-climbers (N = 14)
ASLR right (AU)	2.75 [2.51-3.00]	2.56 [2.37-2.74]	2.64 [2.38-2.91]
ASLR left (AU)	2.67 [2.39-2.99]	2.48 [2.25-2.71]	2.50 [2.18-2.82]
ASLR asymmetry (AU)	1.06 [0.88-1.25]	1.15 [1.01-1.29]	1.29 [1.09-1.48]
ASLR right (º)	83.06 [77.18-88.95]	77.07 [72.54-81.61]	81.64 [75.35-87.94]
ASLR left (º)	82.31 [75.29-89.34]	76.15 [70.74-81.56]	79.79 [72.28-87.30]
ASLR asymmetry (º)	2.13 [1.45-2.80]	1.59 [1.07-2.11]	1.50 [0.78-2.22]

Note. Significant different comparing to elite climbers[a]; intermediate climbers[b]; and non-climbers[c] at p < .05; ASLR - active straight leg raise; AU - arbitrary unit; º - degrees.

Table 4. Adapted grant foot raise, lateral foot reach, hand grip and strength to body mass ratio (mean and 95%CI) specifications.

	Elite Climbers (N = 17)	Intermediate Climbers (N = 28)	Non-climbers (N = 14)
AGFR (cm)	124.82[c] [118.21-131.44]	118.77[b] [113.61-123.92]	110.89[a] [103.60-118.18]
LFR (cm)	168.41 [160.59-176.23]	171.32 [165.23-177.42]	165.93 [157.31-174.55]
HG right (kg)	30.65 [27.84-33.46]	34.67 [32.44-36.90]	33.07 [29.98-36.17]
HG left (kg)	30.59 [27.80-33.38]	33.78 [31.56-35.99]	31.86 [28.78-34.93]
SBMR right	0.52 [0.48-0.57]	0.52 [0.48-0.55]	0.51 [0.46-0.56]
SBMR left	0.52 [0.47-0.56]	0.50 [0.47-0.53]	0.49 [0.44-0.54]

Note. Significant different comparing to elite climbers[a]; intermediate climbers[b]; and non-climbers[c] at p < .05; AGFR - adapted grant foot raise; LFR - lateral foot reach; HG - hand grip; SBMR - strength to body mass ratio (grip strength/weight); kg – kilograms; cm centimetres.

No significant differences were found between groups in active straight leg raise (ASLR) right (p = .454; η^2 = 0.029, *no effect*), ASLR left (p = .534; η^2 = 0.023, *no effect*), ASLR asymmetry (p = .252; η^2 = 0.050, *minimum*

effect), ASLR right (º) (p = .229; η^2 = 0.053, *minimum effect*), ASLR left (º) (p = .367; η^2 = 0.036, *no effect*), or ASLR asymmetry (º) (p = .363; η^2 = 0.037, *no effect*) [Table 3].

Significant differences were found between groups in the adapted Grant foot raise (AGFR) (p = .023; η^2 = 0.126, *minimum effect*). No significant differences were found in the lateral foot reach (LFR) (p = .579; η^2 = 0.019, *no effect*), handgrip (HG) right (p = .089; η^2 = 0.084, *minimum effect*), HG left (p = .195; η^2 = 0.058, *minimum effect*), strength-to-body-mass ratio (SBMR) right (p = .856; η^2 = 0.006, *no effect*), or SBMR left (p = .633; η^2 = 0.017, *no effect*) [Table 4].

DISCUSSION AND CONCLUSIONS

To the best of our knowledge, this study is the first to associate functional mobility testing of the limbs (without locomotion) with climbing experience, climbing-specific hip mobility (using adapted Grant foot raise and lateral foot reach tests), and muscle strength. In elite climbers, the adapted Grant foot raise test proved to be a key identifier of climbing ability (Draper et al., 2009). In our study, this climbing-specific test differed significantly between elite climber, intermediate climber, and non-climber groups, demonstrating that elite climbers have a higher level of hip flexion—on average, higher than the average height—than intermediate climbers and non-climbers do. Non-climbers, meanwhile, have an average hip abduction of less than the average height, hypotactically uncovering their lack of hip mobility and climbing-specific flexibility. In the lateral foot reach test, no statistically significant differences were observed. This might be related to unavoidable equipment adaptations, as it was not possible to adjust the rung according to standard specifications (Draper et al., 2009); it was instead maintained at a height of 175 centimeters.

The handgrip test also showed no significant differences between groups; though, the intermediate climber group displayed a level of force minimally superior to the other groups. This observation may indicate an attempt to compensate for a lack of hip mobility, or it may relate to overall higher body mass among the intermediate climber group. Along the same lines, the strength-to-body-mass ratio also showed no significant differences. Elite climbers presented a ratio similar to the other groups' in the right-hand measurement and minimally superior in the left-hand measurement. These results are consistent with other research (Watts et al., 1993), though at a different magnitude.

The functional mobility tests revealed only one significant difference—specifically, in the external rotation of the left shoulder. No other significant differences were identified in the SM or ASLR tests. This finding may be explained by the elite climbers' use of their upper limbs—combined with complex vertical and lateral movements and position changes—to support body mass (Morrison & Schoffl, 2007). In contrast, the intermediate climbers fall into a compensatory pattern that necessitates, on average, greater handgrip strength and reduced shoulder mobility (particularly, external rotation motion on the left side). The interdependencies of internal and external rotations during the SM test could be affected by sport asymmetries. Although many sport asymmetries are a consequence of limb dominance (Maloney, 2019), asymmetry in climbing reach skills can be considered a negative determinant factor (Čular et al., 2018). For a climber to achieve an efficient upward rotation of the scapula, their serratus anterior and lower trapezius must have an optimum length-tension relationship (Roseborrough & Lebec, 2007).

As discussed, there remains some debate and conflicting evidence in the climbing literature as to the impacts of physiological and anthropometric factors on climbing performance (Mermier et al., 2000; Watts, 2004), and few recent studies have been conducted on the subject. Further research is needed to assess functional mobility among climbers, as well as its implications for climbing performance. Nonetheless, the evidence

shows that it is essential for climbers to develop strength, adequate joint ROM, and functional mobility in order to sustain appropriate posture (Tozetto et al., 2012) and to carry out a variety of daily activities (Benetti et al., 2005).

This research has some limitations, including a lack of differentiation between genders, and the absence of a universal climbing scale on which to measure all subjects consistently. Despite this, efforts were made to ensure a consistent proportion of female subjects in each of the groups, and the criteria used to distinguish elite and intermediate athletes met the minimum standards of the International Rock Climbing Research Association (Draper et al., 2015) (ultimately, the elite group consisted of finalists from national competitions). In addition, the study's cross-sectional design made it impossible to generalize the results. Likewise, the use of a functional mobility test—simultaneously a strength and a limitation—made it challenging to compare the present study to previous studies with similar methodologies.

CONCLUSIONS

Elite climbers had better hip flexion and hip abduction (based on the adapted Grant foot raise test) than intermediate climbers and non-climbers. Functional shoulder mobility, especially external rotation, may play a role in climbing skills. The results of this study suggest that intermediate climbers could benefit from additional training to enhance hip mobility.

AUTHOR CONTRIBUTIONS

Conceptualization: BT, NC and BS; Methodology: BT and BS; Data Analysis: BT, NC and BS; Writing BT and BS; Writing - Review & Editing: BT, NC and BS; Project Supervision: BS.

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DISCLOSURE STATEMENT

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REFERENCES

Behm, D. G. (2019). The Science and Physiology of Flexibility and Stretching - Implications and Applications in Sport Performance and Health (1o Edition). Routledge. https://doi.org/10.4324/9781315110745-1

Benetti, G., Schneider, P., & Meyer, F. (2005). Sport benefits and the importance of muscle strength trainability in prepubertal volleyball athletes. Revista Brasileira de Cineantropometria e Desempenho Humano, September, 87-93.

Butler, K. I. M. K. B. K. L. B. Aron T. P. P. R. J. (2010). Interrater reliability of the FMS. Strength And Conditioning, 24(2), 479-486. https://doi.org/10.1519/JSC.0b013e3181c09c04

Cook, G., Burton, L., & Hoogenboom, B. (2006). Pre-participation screening: the use of fundamental movements as an assessment of function - part 2. N Am J Sports Phys Ther, 1(2), 62-72.

Cook, G., Burton, L., & Hoogenboom, B. (2014). Functional Movement Screening: The Use of Fundamental Movements as an Assessment of Function- Part 2. International Journal of Sports Physical Therapy, 9(4), 549-563. https://doi.org/10.1055/s-0034-1382055

Čular, D., Dhahbi, W., Kolak, I., Dello Iacono, A., Bešlija, T., Laffaye, G., & Padulo, J. (2018). Reliability, Sensitivity, and Minimal Detectable Change of a New Specific Climbing Test for Assessing Asymmetry in Reach Technique. Journal of Strength and Conditioning Research. https://doi.org/10.1519/JSC.0000000000002694

Deyhle, M. R., Hsu, H.-S., Fairfield, T. J., Cadez-Schmidt, T. L., Gurney, B. A., & Mermier, C. M. (2015). Relative Importance of Four Muscle Groups for Indoor Rock Climbing Performance. Journal of Strength and Conditioning Research / National Strength & Conditioning Association, 29(7), 2006-2014. https://doi.org/10.1519/JSC.0000000000000823

Draper, N., Brent, S., Hodgson, C., & Blackwell, G. (2009). Flexibility assessment and the role of flexibility as a determinant of performance in rock climbing. International Journal of Performance Analysis of Sport, 9(June 2014), 67-89. https://doi.org/10.1080/24748668.2009.11868465

Draper, N., Giles, D., Schöffl, V., Konstantin Fuss, F., Watts, P., Wolf, P., Baláš, J., Espana-Romero, V., Blunt Gonzalez, G., Fryer, S., Fanchini, M., Vigouroux, L., Seifert, L., Donath, L., Spoerri, M., Bonetti, K., Phillips, K., Stöcker, U., Bourassa-Moreau, F., … Abreu, E. (2015). Comparative grading scales, statistical analyses, climber descriptors and ability grouping: International Rock Climbing Research Association position statement. Sports Technology, 8(3-4), 88-94. https://doi.org/10.1080/19346182.2015.1107081

Ferguson, C. J. (2009). An Effect Size Primer: A Guide for Clinicians and Researchers. Professional Psychology: Research and Practice, 40(5), 532-538. https://doi.org/10.1037/a0015808

Frost, D. M., Beach, T. A. C., Callaghan, J. P., & McGill, S. M. (2012). Using the Functional Movement Screen to evaluate the effectiveness of training. J Strength Cond Res, 26(6), 1620-1630. https://doi.org/10.1519/JSC.0b013e318234ec59

Fryer, S., Stone, K. J., Sveen, J., Dickson, T., Giles, D., Baláš, J., Stoner, L., Draper, N., Stone, K. J., Sveen, J., Dickson, T., & Giles, D. (2017). Differences in forearm strength , endurance , and hemodynamic kinetics between male boulderers and lead rock climbers. European Journal of Sport Science ISSN:, 17(9), 1177-1183. https://doi.org/10.1080/17461391.2017.1353135

Giles, L. V., Rhodes, E. C., & Taunton, J. E. (2006). The physiology of rock climbing. Sports Medicine, 36(6), 529-545. https://doi.org/10.2165/00007256-200636060-00006

Grant, S., Hasler, T., Davies, C., Aitchison, T. C., & Wilson, J. (2001). A comparison of the anthropometric, strength, endurance and flexibility characteristics of female elite and recreational climbers and non-climbers. Journal of Sports Sciences, 19(7), 499-505. https://doi.org/10.1080/026404101750238953

Grant, S., Hynes, V., Whittaker, A., & Aitchison, T. (1996). Anthropometric , strength , endurance and flexibility characteristics of elite and recreational climbers. Journal of Sports Sciences, 14 (January 1996), 301-309. https://doi.org/10.1080/02640419608727715

Hoge, K. M., Ryan, E. D., Costa, P. B., Herda, T. J., Walter, A. A., Stout, J. R., & Cramer, J. T. (2010). Gender Differences in Musculotendinous Stiffness and Range of Motion After an Acute Bout of Stretching. Journal of Strength and Conditioning Research, 24(10), 2618-2626. https://doi.org/10.1519/JSC.0b013e3181e73974

Kraus, K., Schütz, E., Taylor, Wi. R. W. R., & Doyscher, R. (2014). Efficacy of the functional movement screen: A review. Journal of Strength and Conditioning Research, 28(12), 3571-3584. https://doi.org/10.1519/JSC.0000000000000556

Laffaye, G., Levernier, G., & Collin, J.-M. (2016). Determinant factors in climbing ability: Influence of strength, anthropometry, and neuromuscular fatigue. Scandinavian Journal of Medicine & Science in Sports, 26(10), 1151-1159. https://doi.org/10.1111/sms.12558

Magiera, A., Łukasik, I., Roczniok, R., & Placek, O. (2019). The effects of change in the safety rope protocol, hold size, and rest period on psychophysiological responses in sport rock climbers. Human Movement, 20(2), 34-43. https://doi.org/10.5114/hm.2019.79733

Magiera, A., & Ryguła, I. (2007). Biometric Model and Classification Functions in Sport Climbing. Journal of Human Kinetics, 18, 87-98.

Maloney, S. J. (2019). The Relationship Between Asymmetry and Athletic Performance: A Critical Review. Journal of Strength and Conditioning Research, 33(9), 2579-2593. https://doi.org/10.1519/JSC.0000000000002608

Marques, V. B., Medeiros, T. M., de Souza Stigger, F., Nakamura, F. Y., & Baroni, B. M. (2017). The Functional Movement Screen (FMS) in elite young soccer players between 14 and 20: composite score, individual test scores and asymmetries. International Journal of Sports Physical Therapy, 12(6), 977-985. https://doi.org/10.16603/ijspt20170977

Mermier, C. M., Janot, J. M., Parker, D. L., & Swan, J. G. (2000). Physiological and anthropometric determinants of sport climbing performance. British Journal of Sports Medicine, 34(5), 359-366. https://doi.org/10.1136/bjsm.34.5.359

Michail Lubomirov. (2014). Workload characteristic, performance limiting factors and methods for strength and endurance training in Rock Climbing. Medicina Sportiva, 3(18), 97-106. https://doi.org/10.5604/17342260.1120661

Morrison, A. B., & Schoffl, V. R. (2007). Physiological responses to rock climbing in young climbers. British Journal of Sports Medicine, 41(12), 852-861. https://doi.org/10.1136/bjsm.2007.034827

Mullerpatan, R. P., Karnik, G., & John, R. (2013). Grip and pinch strength: Normative data for healthy Indian adults. Hand Therapy, 18(1), 11-16. https://doi.org/10.1177/1758998313479874

O'Brien, W., Duncan, M., Farmer, O., & Lester, D. (2017). Do Irish Adolescents Have Adequate Functional Movement Skill and Confidence? Journal of Motor Learning and Development. https://doi.org/10.1123/jmld.2016-0067

Ozimek, M., Staszkiewicz, R., Rokowski, R., & Stanula, A. (2016). Analysis of Tests Evaluating Sport Climbers' Strength and Isometric Endurance. Journal of Human Kinetics, 53(1), 249-260. https://doi.org/10.1515/hukin-2016-0027

Roseborrough, A., & Lebec, M. (2007). Differences in static scapular position between rock climbers and a non-rock climber population. North American Journal of Sports Physical Therapy: NAJSPT, 2(1), 44-50.

Sasaki, H., Kasagi, F., Yamada, M., & Fujita, S. (2007). Grip Strength Predicts Cause-Specific Mortality in Middle-Aged and Elderly Persons. The American Journal of Medicine, 120(4), 337-342. https://doi.org/10.1016/j.amjmed.2006.04.018

Saul, D., Steinmetz, G., Lehmann, W., & Schilling, A. F. (2019). Determinants for success in climbing: A systematic review. Journal of Exercise Science and Fitness, 17(3), 91-100. https://doi.org/10.1016/j.jesf.2019.04.002

Sheel, A. W. (2004). Physiology of sport rock climbing. British Journal of Sports Medicine, 38(3), 355-359. https://doi.org/10.1136/bjsm.2003.008169

Tozetto, A. V. B., Milistetd, M., Medeiros, T. E., & Ignachewshi, W. L. (2012). Performance of young athletes on the physical abilities, flexibility, strength and agility. Cinergis, 13(6), 47-54.

Wall, C. B., Starek, J. E., Fleck, S. J., & Byrnes, W. C. (2004). Prediction of indoor climbing performance in women rock climbers. Journal of Strength and Conditioning Research, 18(1), 77-83. https://doi.org/10.1519/1533-4287(2004)018<0077:POICPI>2.0.CO;2

Watts, P. B. (2004). Physiology of difficult rock climbing. In European Journal of Applied Physiology (Vol. 91, Issue 4, pp. 361-372). https://doi.org/10.1007/s00421-003-1036-7

Watts, P. B., Martin, D. T., & Durtschi, S. (1993). Anthropometric profiles of elite male and female competitive sport rock climbers. Journal of Sports Sciences, 11(2), 113-117. https://doi.org/10.1080/02640419308729974

SUSTAINABILITY & SPORTS SCIENCE JOURNAL

ORIGINAL ARTICLE

Identification of the tourist profile and development of a sports tourism map in the town of Calpe

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ABSTRACT

The present work has a double objective, to identify the profile of the tourist and their habits regarding sports tourism in the town of Calpe (Alicante), and, secondly, based on the information acquired, to establish the development guides for the map of local sports tourism. For this, an ad hoc questionnaire was developed, which was passed to a random sample of 381 people, thus establishing significant results with a 0.8% error for samples greater than 1000000 individuals. After finding the profile of the local tourist, we proceeded to develop an application, in its alpha phase, of the sports tourism map of the locality under study. This work is the support point on which to develop a final application that houses all the information related to sports tourism in the Valencian Community, developing a complete sports tourism map of the Autonomous Community.

Keywords: Sports tourism, User profile, Application.

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INTRODUCTION

The connection between tourism and sport as an entity in itself arises from the evolution of tourism and sport, both matters being considered of great importance in the society of the moment (Latiesa and Paniza, 2006). Some authors determine that the idea of sports tourism appears from 1950 and the concept as such in 1970. It is observed how sports tourism, with its current definition (Pedote, 2023), it does not have a long history over time since it is included in the advanced societies of the 20th century (Simoes, Rebollo and Cabrera, 2008). Sports tourism as an industry is at a critical moment in its evolution. Thanks to the great growth shown by society in the practice of sports in recent years, sponsored by the increase in people who, whether for health, to escape from the daily routine and work or simply for enjoyment, begin to practise sport and with it to link this practice with their leisure time (García Ferrando, 2001). Sports tourism is framed within a product segmentation and diversification that serves as a complement to traditional tourism models, highlighting sun and beach tourism (Simoes, Rebollo and Cabrera, 2008). In recent years, it has become clear how sport is no longer only seen as a practice of entertainment activities, but is also a great business opportunity, since the practice of sport and its connection to tourism can be professional. or amateur, both factors both actively and passively (Leal, Travé, Medina, Abadia and Sánchez, 2021).

Taking into account the different types of sports tourism (Simoes, Rebollo and Cabrera, 2008), coastal tourism stands as the union between tourist practices and sports practices that occur on the coast. Distinguishing in this sense different elements that compose it from the orientation towards its practice, understood as a main activity or as a complementary activity. And segmenting the reason for your attraction to said practice (events, conferences, sports museums, etc.).

On the other hand, many city councils and other public institutions have a mobile application to inform visitors to their city about the sporting events and activities that are going to take place. Through technological applications, it is possible to show all the information that the visitor needs, and also help take care of the environment. All this in a practical, interactive and visually attractive way, despite this, the dissemination of these activities and services is not enough (Araujo, Fraiz and Araujo, 2020).

The province of Alicante has proven to be a potential in physical activity and sports, just by contemplating the large number of sporting events that take place throughout the year (Ministerio de Cultura y Deporte, 2022), and the number of teams and athletes that visit us shows us that this geographical location is unique for sports practice. Together with the above, sports tourism has represented one of the great values of visits to the province by both foreigners and visitors from other provinces (INECA, 2020). Despite this, we must continue to delve deeper into the digitalization process of the municipalities, in order to bring together and bring the visitor closer to all the information and services related to coastal tourism and specifically the sports tourism that is produced there.

The present work has two clearly defined objectives, firstly, to identify the profile of the tourist and their habits related to sports tourism, and, secondly, based on the information acquired, to establish the development guides for the sports tourism map. from the town of Calpe, one of the most diversified places for sports practice in the province of Alicante, where all the agents related to sports tourism come together.

METHOD

To fulfil these objectives, different milestones or tasks were established that mark the development of the research and the development of the future application.

The first action that was carried out was the preparation of a record of the most notable facilities and events in the target town -Calpe-, resulting in a total of 114 records (Table 1) and subsequently the centres of sports practice and its digitization process (Figure 1.)

Table 1. List of infrastructures of the locality under study.

Infrastructure and event	**N**
Public sports facilities	6
Sports centres and gyms	10
Hotels	48
Restaurants	21
Natural places for sports practice	15
Walking trails	9
Sports events	5

Figure 1. Example of sports centre identification and digitization.

After completing this first milestone, as a second task prior to the development of the application, we proceeded to analyse and evaluate the physical activity and sports habits of tourists who visit Calpe and relate it to the development of the digital map.

Sampling

To develop this second task, we started from the paradigm of the mixed qualitative and quantitative work methodology, which is based on the study, analysis and assessment of the sports practice habits of tourists who visit the city of Calpe, together with the social and economic impact of their period of stay in our land.

The type of sampling carried out is systematic and random within each stratum, establishing said strata based on nationality in the first stage and in a second stage based on age and gender. To do this, a two-stage type of sampling was carried out with stratification of units for each population community. The first sampling units were the census sports centres, and then they were stratified depending on the size of the sports centre. Ratio estimators were used to estimate proportions. The a priori sampling error considering the hypothesis P = Q = 0.5 is around 0.8% with a confidence level of 95% for populations greater than 1,000,000 individuals, resulting in a total of 381 surveys carried out.

Data collection instrument

For this purpose, an *ad hoc* survey on sports matters was developed based on the contributions of González (2008) and Araujo, Paul and Fraiz (2011) on the sports habits of tourists who visit Calpe.
The questions that make up the survey are presented in Table 2.

Table 2. Survey structure.

Number question	Question	Type of answer	Options
1	Age	Open	
2	Gender	Close	Male
			Female
3	What is the objective of your trip, in the sports section?	Close	Carry out sports activities
			Attend sporting event
			Others
4	What is your country of origin?	Open	
5	What type of sports activity do you do?	Close	Recreation
			Competitive
6	What sport or physical activity are you coming to do?	Close	Walk
			Run
			Swim/Diving
			Bicycle
			Others
			None
7	Are you coming to visit a sporting event?	Close	Yes
			No
8	Where do you do your physical activity during the tourist period?	Close	Beaches
			Rock
			Hiking routes
			Bicycle Routes
			Diving Routes
			Swimming Routes
9	How have you known this area in relation to your sports practice?	Close	Internet
			For my sports club
			Acquaintances
			Relatives
			Others
10	What expenses do you plan to make daily during your stay individually?	Close	Between 50-100€
			Between 100-200€

			More Than 200€
11	What is the frequency of physical activity you do?	Close	Every day
			Between 3-5 days a week
			At least once a week
12	Why do you do physical activity?	Close	Health reasons
			Entertainment and Socialization
			Competition
13	Regarding the province/city where you live, do you easily find the sport you want to practise?	Close	Yes
			Yes, but after a deep search
			No
14	Would you travel to a province/city in your autonomous community to practise a specific sport?	Close	Yes, at least once a month
			Yes, at least once a year
			No
15	How many days will you stay if you travel to another province/city to practise a specific sport?	Close	1 day, express trip
			Between 1-3 days
			Between 3-7 days

Information collection

The collection of individual information was carried out during the months of March, April, May, June and July 2022, in addition to the preparation of data collection through the creation and design of the website "*Digital Map Survey of Sports Tourism in the Province of Alicante – Study of physical activity and sports habits in the province of Alicante* (https://www.habitosdeportivosalicante.es/)". Information was collected with the questionnaire in a digital online version (27.3%) and in person using tablets (82.7%).

Statistical analysis

The statistical analysis carried out addresses the form of distribution of the study variables (survey items) through frequencies (absolute and relative), counting the times that each value in the sample was repeated. This analysis was carried out using SPSS 20.0.

RESULTS

After analysing the data collected in the 381 surveys carried out, the following results emerge. Below, the results are presented from the relative frequency parameter in order to simplify the results obtained and their understanding and presentation (Figure 2).

Taking into account the construct of age included by the people surveyed, 32.2% of the people surveyed are between 46 and 65 years old, followed in second place by people between 31 and 45 years old and in third place. place people over 65 years of age with 24.67%.

In reference to the gender of the sample, Figure 3 presents similar percentages in terms of the responses obtained, reaching 50.13% women and 49.87% men.

Figure 4 shows the results obtained regarding the item "*main objective of the trip*". It shows how 60.63% visit Calpe for reasons other than sports tourism, 39.11% visit the town to practise sports and 0.26% to attend a sporting event.

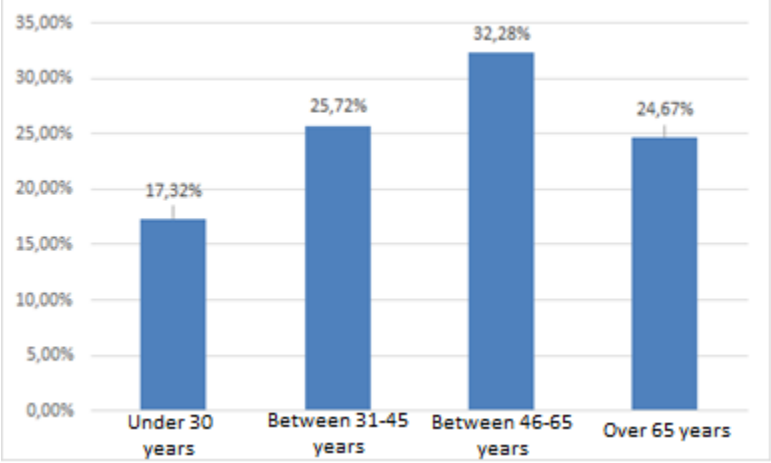


Figure 2. Relative frequency referring to the age of the participants in the sample.

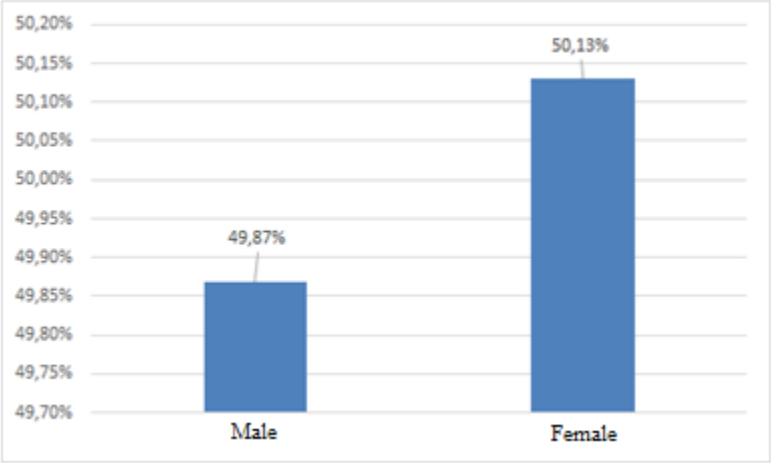


Figure 3. Relative frequency refers to the gender of the participants in the sample.

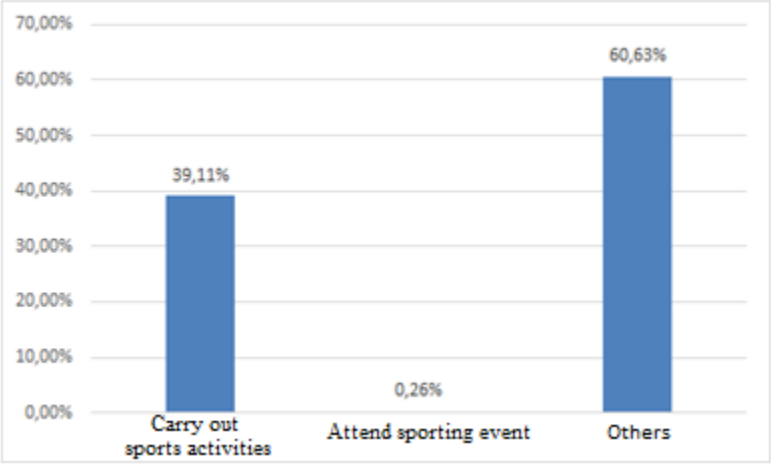


Figure 4. Relative frequency refers to the purpose of the visit of the participants in the sample.

In relation to the nationality of the people surveyed (Table 3), the results show the highest percentage in the United Kingdom with 21.78%, followed by Germany with 20.73%. It is worth highlighting the highest percentage presented in Table 3 with 29.13%, where the rest of the nationalities that differed from those presented in the model have been grouped together. This regrouping has been necessary, as indicated at the beginning. of this section for greater simplicity and better clarification of the presentation of results obtained.

Table 3. Relative frequency refers to the nationality of the participants in the sample.

Country	**Percentage of respondents**
Belarus	4.72%
United Kingdom	21.78%
France	9.19%
Spain	9.71%
Chile	4.72%
Germany	20.73%
Others	29.13%

Taking into account the component of sports practice that the people surveyed carry out when they carry it out, 91.60% orient their sports practice towards recreation while 8.40% orient it towards competition (Figure 5).

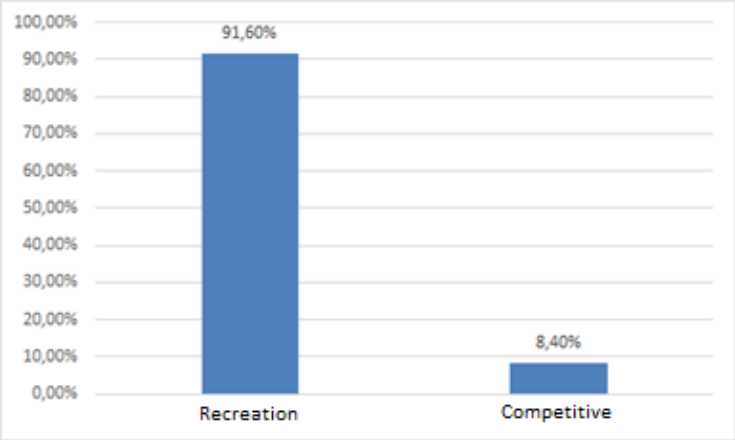


Figure 5. Relative frequency refers to the component of sports practice carried out by the participants in the sample.

In reference to the type of sports practice, Figure 6 presents the results obtained from the analysis of relative frequencies, where 32.02% corresponds to the physical activity "*walking*", followed by "*no sports practice*" with 30.18% and In third place is the practice of walks or bicycle routes with 15.75%.

As for the most requested place for said physical activity, the beaches are the first option, reaching 66.14%, followed by bicycle routes with 13.65% (Figure 7).

Figure 8 shows the results corresponding to the question regarding the source of primary information to know the location. 36.48% corresponds to the Family option, followed by Acquaintances with 34.12% and in third place the Internet option which reaches 12.60%.

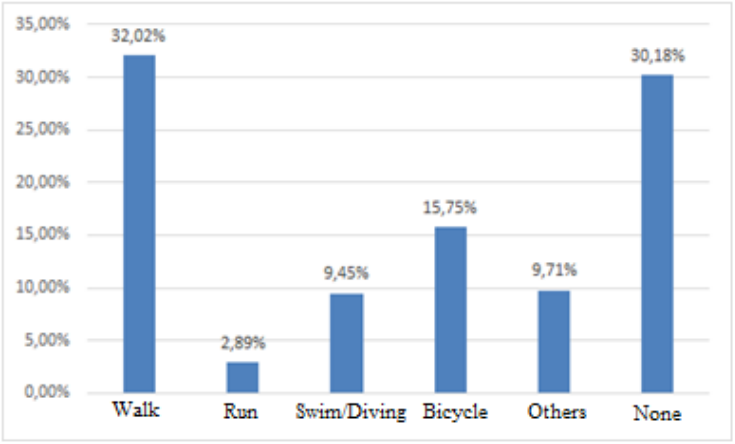


Figure 6. Relative frequency referring to the type of sports practice carried out by the participants in the sample.

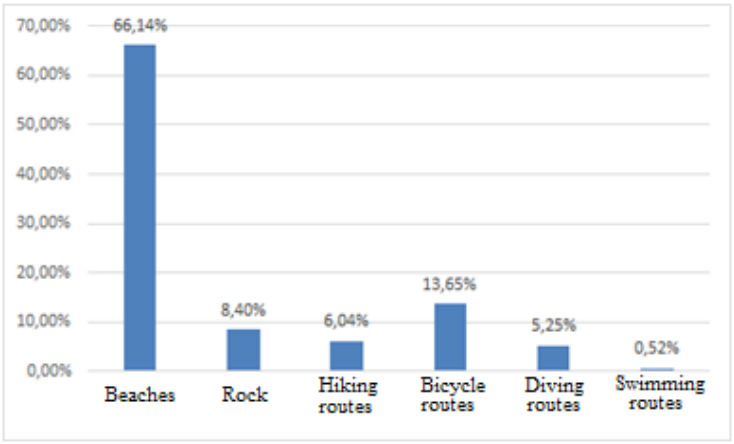


Figure 7. Relative frequency referred to place for the development of sports practice carried out by the participants in the sample.

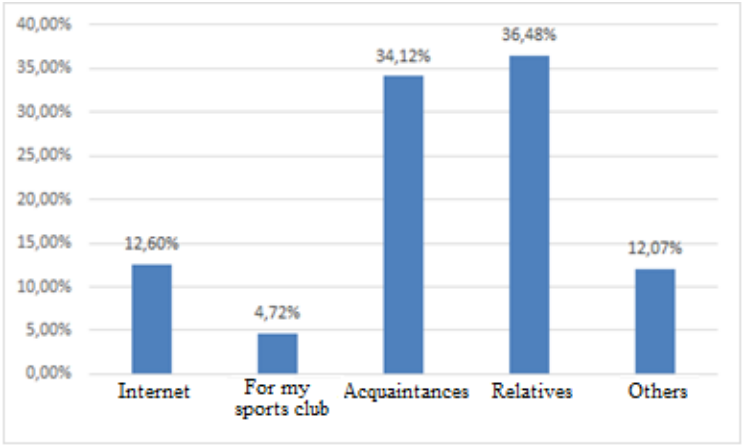


Figure 8. Relative frequency refers to the source of primary information about the locality acquired by the participants in the sample.

Finally, taking into account the average financial amount that an individual intends to spend per day in Calpe, 59.58% of the people surveyed have answered between €50-100, followed by an average daily individual expense of between €100- €200 in second place with 37.27% (Figure 9).

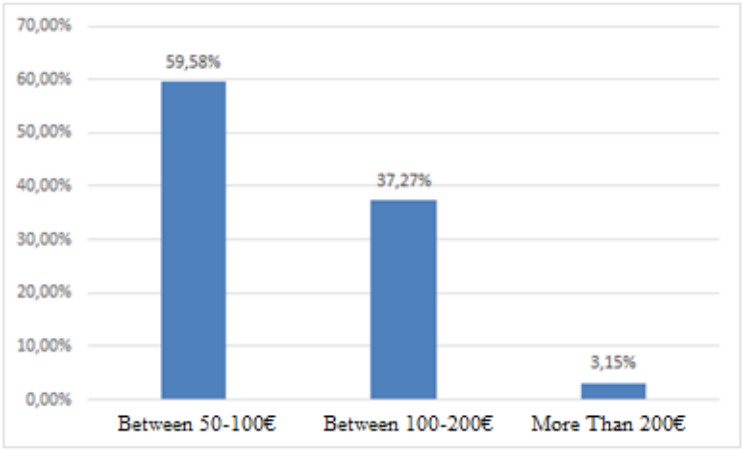


Figure 9. Relative frequency refers to the estimated amount of expenditure per person and day.

Conclusions from the survey and proposals derived prior to the development of the application

After analysing the results obtained from the survey data, the following conclusions were reached in reference to the profile of the sports tourist in Calpe.

1. The most important age sector is between 45 and 65 years old. However, due to their proximity, the presence of the two immediately lower sectors - between 31 and 45 years old - and the upper ones - over 65 years old - should not be underestimated. The offer must contain activities and services that cover the three age sectors contemplated.

2. The most sensitive countries for coming to Calpe are European, so this fact must be kept in mind so that the application contemplates the possibility of being translated into at least 3 languages.

3. The main physical activity they carry out is hiking and cycling. Taking into account this clear conclusion, the total digitalization of Calpe is proposed in routes and geolocations of all sports complexes and facilities, separated by sports modality and sports level (competitive or recreational).

4. The centres of sports practice in Calpe continue to be the beaches, so it is proposed to enhance the situation of this environment and protect it since it is the most used and demanded for practising physical activity and leisure.

5. Finally, the results provide information about the locality through highly concentrated channels such as family members and acquaintances, that is, based on previous experiences of people who have already visited the locality. Given this situation and the low incidence of the internet in this sense, it is proposed to enhance the digital positioning of the entire sports network in the different areas of Calpe, to network, as well as facilitate the digital connection between the hospitality industry, shopping centres, health centres, and sports clubs and associations.

Finally, and taking into account these conclusions and recommendations, we proceeded to the third and final step of this research, the approach to the development of an application prototype based on the sports tourism map of the town of Calpe, where all the agents related to sports tourism.

The typology of the proposed application, as an Alpha phase, responds to the "*search engine*" format whose purpose is the identification and obtaining of the most relevant information regarding sports clubs in the city of Calpe, where aspects related to their location can be found. social networks, restaurant services and nearby parking lots, events they hold, etc.

The development of the application, as an approach and test -alpha phase-, has been carried out with FlutterFlow, based on the Flutter software development kit (SDK). Flutter is an SDK developed by Google that allows the creation of applications for both Android and iOS (Apple). It is open source, which has allowed it to become one of the most growing mobile application development projects. FlutterFlow is a Flutter-based online app developer that allows users to easily create native cross-platform apps. The advantage that this developer and platform is proposed is because, as it is online, it is not necessary to install any software but rather start a new project and build the interface by adding Widgets, whose properties and design can be modified.

This first approach to the sports tourism map as an Alfa version has focused on sports clubs, as they are interested agents, who hold sporting events and maintain constant sports offer throughout the year. In this way, all the information regarding them was obtained: location, social networks, telephone number and contact email.

These sports clubs were registered in a database which will provide information to the search engine. The search can be carried out without having to be registered in the application. However, if any owner wants to store their own club they can do so by creating an account in the app and logging in. With this option, the search engine's database is constantly updated, allowing the implementation of new features and the intervention of new agents related to sports tourism.

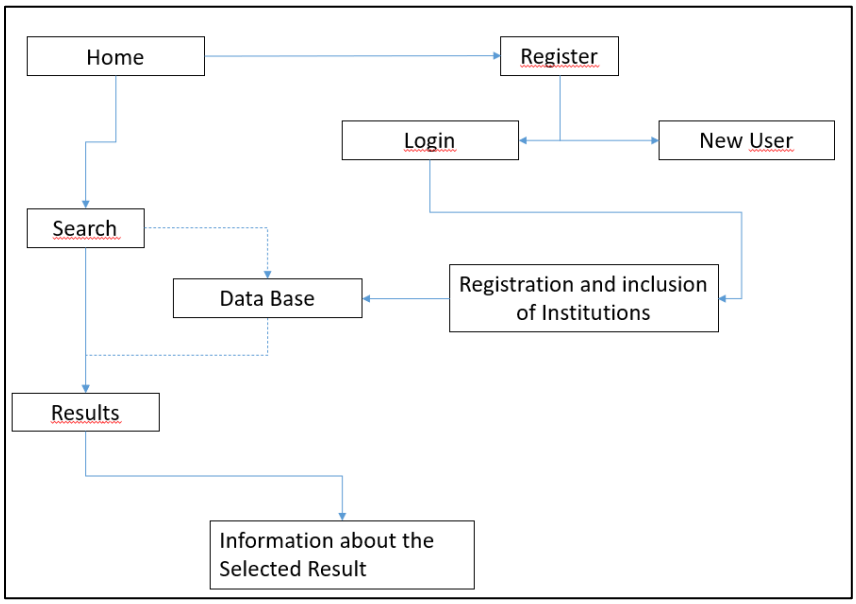
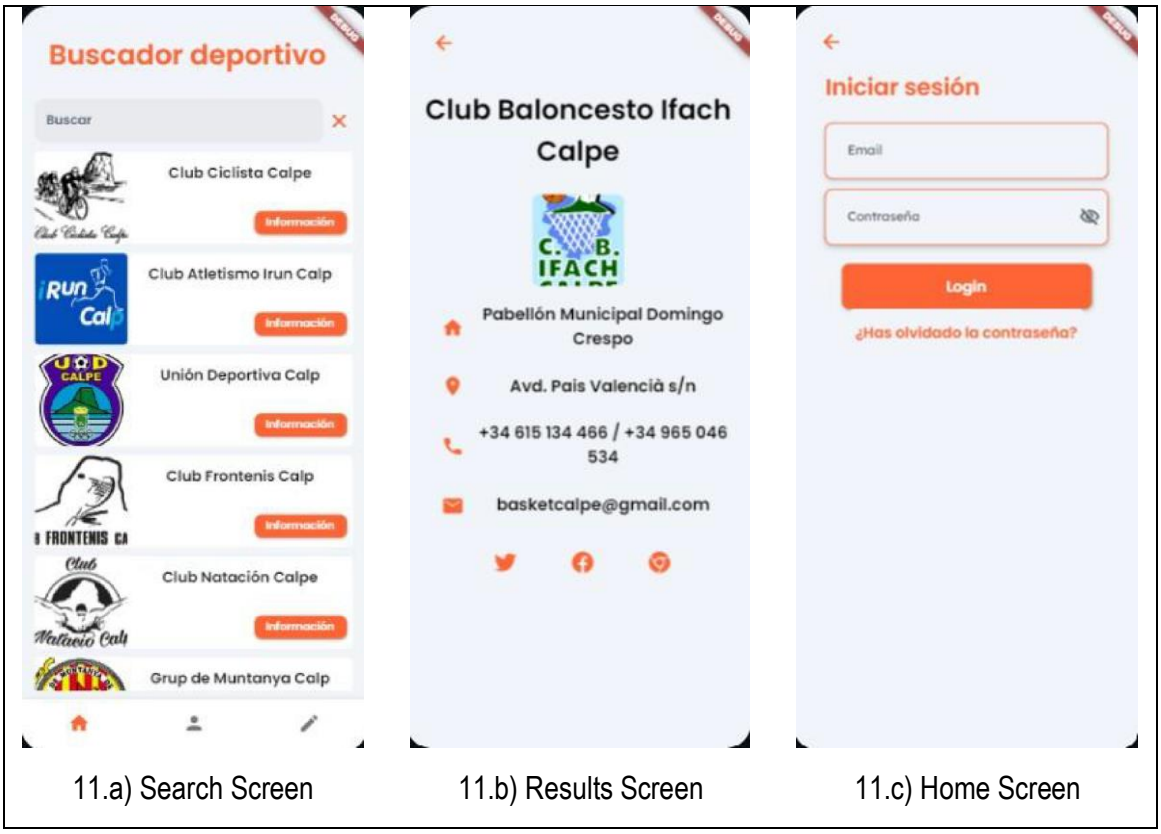


Figure 10. Application structure diagram.

The structure of the application can be seen in Figure 10, as well as the final display that the user would have on their terminal (Figure 11).



11.a) Search Screen 11.b) Results Screen 11.c) Home Screen

Figure 11. Application structure diagram.

CONCLUSIONS

The objectives of the present investigation established for the present investigation have been satisfied, reaching the following conclusions.

Regarding the first objective, identifying the profile of the tourist and their habits regarding sports tourism in the town of Calpe, the answer has been given by identifying a user profile with an age between 45-65 years, European, whose main Physical activity is walking, with the beach being its main practice.

In reference to the second objective, establish the development guides for the sports tourism map of the town of Calpe where all the agents related to sports tourism come together. A basic application has been developed, limited exclusively to sports clubs where all the information collected and required by the different sports tourism agents can be approximated, as well as the possibility of including new agents that give the application greater visibility and service.

This work is the first approach for the final development of the application, for which it is recommended to take into account the following elements in its development:

- Have the mobile application in 5 languages of European countries.

- Fully digitise Calpe in routes and geo locations of all sports complexes and facilities, separated by sports modality and sports level (competitive or recreational).
- Enhance the situation of this natural environment and protect it.
- Strengthen the digital positioning of the entire sports network in the different areas of Calpe, to work as a network.
- Facilitate the digital connection between the hospitality industry, shopping centres, health centres, and sports clubs and associations.

AUTHOR CONTRIBUTIONS

All authors have contributed equally to all sections of this article.

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REFERENCES

Araújo, N., Fraiz, J.A. y Araújo, A.F. 2020. Health and Sport. Economic and Social Impact of Active Tourism. Eur. J. Investig. Health Psychol. Educ. 10. https://doi.org/10.3390/ejihpe10010007

Araujo, N., Paül, V y Fraiz, J.A. 2011.El turismo activo o de aventura como componente destacado del turismo de naturaleza. Análisis de la oferta en Galicia. Gran Tour, ISSN-e 2172-8690, Nº. 4, págs. 8-31.

García Ferrando, M. 2001. La gestión del deporte en el ámbito municipal: de la promoción a la fidelización del cliente. In: Latiesa, M.; Martos, P.; Paniza, J. L. Deporte y cambio social en el umbral del siglo XXI. Madrid: Esteban Sanz S. L.

Gonzalez Molina, A. 2008. Rasgos caracterizadores del turismo activo y turismo deportivo e importancia económico-social y estructural de nuevas formas emergentes. Acción Motriz.

INECA, 2020, ALICANTE.

Latiesa, M. y Paniza, J.L.. 2006. Turistas deportivos una perspectiva de análisis. Revista Internacional de Sociología , vol. LXIV, 44, mayo-agosto, 133-149, 2006ISSN: 0034-9712.

Leal, M.P., Travé, R., Medina, F.X., Abadia, S. y Sánchez, S. 2021. Turismo deportivo: Una oportunidad para los territorios locales en un contexto global. Un estudio Delphi. Retos, 42, 77-88. https://doi.org/10.47197/retos.v42i0.86696

Ministerio de Cultura y Deporte. 2022. Anuario de Estadísticas Deportivas 2022 Ministerio de Cultura y Deporte Mayo 2022.

Pedote, G.S. 2023. History of some tourism denominations in Spain: Turismo Deportivo, Turismo Cultural, Turismo marinero and Turismo gastronómico. Cuadernos de Turismo, 51. P.405-408. Murcia.

Simoes, Rebollo y Cabrera, 2008. Turismo deportivo de litoral: Un análisis desde la oferta. Rev. Bras. Cienc. Esporte, Campinas, v. 29, 3, p. 75-89.

SUSTAINABILITY & SPORTS SCIENCE JOURNAL

ORIGINAL ARTICLE

The functional rehabilitation of ankle trauma by the graduate in motor science: Experimental study

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ABSTRACT

Sports trauma commonly affects joints of the extremities; ankle injuries are one of the most common. The study aimed to rehabilitate ankle trauma with proprioceptive exercise, performed, by graduate in motor science. Trauma causes joint instability, which is manifested mainly in running and walking. For this reason, baropodometry and motor tests were used as evaluation criteria; evaluating joint instability in both static and dynamic and neuromotor abilities. Seven athletes (aged 17 and 24 years old) are recruited for the study; they had suffered ankle trauma. The rehabilitation program involved the supervision of a multidisciplinary team (neurologist, posturologist, kinesiologist, sports doctor, observers). Each treatment was always at the same time and included 3 phases: the first on specific work to recover joint mobility, in the second the work was focused on recovering strength, third phase was aimed at recovering ankle sprains. The athletes were administered proprioceptive functional rehabilitation programs aimed at recovering the ankle trauma and plantar pressures. The data were positive and encouraging with respect to the planned goal, supporting the importance of proprioception and the role of the graduate in motor science in the functional re- education of trauma.

Keywords: Health, Ankle trauma, Athletes, Rehab.

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INTRODUCTION

The ankle is a diarthrosis, a type of joint between two bones that allows considerable mobility to two articular heads, located at the distal ends of the tibia and fibula and at the proximal end of the talus. The ankle has the important task of connecting the leg to the foot and thus promoting locomotion movements, maintaining the upright position and the postural system. The ankle is made up of a complex osteo-muscular-ligament system which together give stability to the articulation. Specifically, the ankle ligaments have the task of giving stability to the ankle joint in plantar flexion, dorsiflexion, inversion and eversion movements. In detail, these are the medial or deltoid and lateral ligaments. Despite bearing high compressive and shear forces during gait, the ankle's bony and ligamentous structure enables it to function with a high degree of stability and compared with other joints such as the hip or knee, it appears far less susceptible to degenerative processes unless associated with prior trauma (Brockett et al.,2016).

The complexity of the ankle makes it difficult to understand its instability. (Bonnel et al., 2010) Although in the literature risk factors are classified into intrinsic (bone, ligament and posture) and extrinsic (environment and context).

Mechanical instability is often caused by ligamentous laxity, while functional instability is caused by proprioceptive deficiency. In addition, there are also postural factors such as the varus of the hind feet that promote instability. Understanding the cause of ankle injuries is an essential part of effective injury prevention, but it is so far incomplete.

Nearly 70% of cases of ankle osteoarthritic are secondary to a traumatic event, most frequently involving ankle fractures and subsequently unaddressed chronic ankle instability (Jess et al., 2012). Lateral ankle sprains are one of the most common lower extremity joint injuries and have a high recurrence rate (Van Rijn et al., 2008).

The clinical manifestation is pain and decreased function relating to deficits in strength, range of motion (ROM), and dynamic balance that can last for weeks after injury (Basnett et al., 2013).

The key movement of the ankle joint are plantar and dorsiflexion, occurring in the sagittal plane; ab-/adduction occurring in the transverse plane and inversion-eversion, occurring in the frontal plane (Zwipp et al., 1994). Combinations of these motions create three-dimensional motions called supination and pronation. Both terms define the position of the plantar surface of the foot (Nordin et al., 2001). Motion of the ankle occurs primarily in the sagittal plane, with plantar- and dorsiflexion occurring predominantly at the tibiotalar joint.

The range of ankle movement (ROM) varies between individuals. The movement of the whole ankle in the sagittal plane is between 65 and 70 degrees; the dorsal flexion goes from 10 to 20 degrees, the plantar from 40 to 55 degrees. In daily activities the necessary ROM is very reduced, 30 degrees to walk, 37-56 degrees to go up and down stairs. Ankle dorsiflexion ROM can influence dynamic balance, specifically the anterior reach portion of the Star Excursion Balance Test (SEBT). Mechanical and functional ankle instability can contribute to Chronic Ankle instability (CAI) independently or in combination (Hiller et al., 2011).

Impairments in both static and dynamic balance have been shown to be present in individuals with CAI (De Noronha et al., 2008). These deficits are likely due to altered proprioception and neuromuscular control (Arnold et al., 2009). Moreover, CAI demonstrated significantly less maximum dorsiflexion range of motion on the Weight-Bearing Lunge Test (WBLT) and shorter reach distances on the normalized anterior (ANT)

direction of the SEBT (Hoch et al., 2012). The purpose of this study was to determine the relationship between a weight bearing measure of ankle dorsiflexion ROM and SEBT reach distance in the anterior, posterolateral, and posteromedial reach directions as well as the composite SEBT scores in individuals with CAI.

Ankle sprain

The ankle is the articulation most often affected by sprain, both in the sporting context and in the daily activities; other factors that can lead to the sprain are of an intrinsic type, therefore linked to the characteristics of the articulation and proprioception. For example, high ankle mobility and reduced ability to control position and movement of the ankle and foot increase the risk of sprains. Ankle sprains are known to be a frequent occurrence across all sports, accounting for 15% of injuries (Fong et al., 2007).

Furthermore, in many sports, ankle sprains are the most common injury that athletes sustain. The resulting symptoms are acute pain and swelling with possible development of a hematoma, more or less accentuated in relation to the cases, which involve a functional limitation of the district (Hootman et al., 2007). The manifestations are localized in the malleolar and central centre and can extend into the dorsal region of the foot, up to reach the fingers.

The strongest of these structures is the deep portion of the deltoid ligament, the anterior and posterior talo-tibial complex, located at the medial ankle. The ligamentous support on the lateral side is less substantial, and includes the anterior talofibular (ATF), calcaneofibular (CF), and posterior talofibular (PTF) ligaments. Of the two commonly injured lateral ligaments, the ATF and CF, the ATF is the weaker (Siegler et al., 1988). Subjects may also complain of tendinopathies, stiffness, increased muscle volume with instability of the instep with difficulty in walking, this is because the damage of the sprained trauma occurs not only on the ligament that holds the joint stable, but also because nerves, muscles and tendons in the ankle are injured. The contralateral limb is used as a reference.

The common standard for acute care of an ankle injury is known by the acronym P.R.I.C.E.: protection, rest, ice, compression, and elevation (Flegel et al., 2008). The generally accepted period for the acute treatment described below is the first 48 to 72 hours following injury. Protection, in the form of bracing, splinting, or non-weightbearing transport is important to reduce the chance of further trauma to an injured area. Rest from the activity that caused the injury, or similar activities, is war- ranted when a significant potential exists for re-injury or further injury. Applying ice to the injured ankle is helpful for reducing pain, minimizing edema. The treatment and rehabilitation of physically active people trying to return to high level activity requires a proactive and creative approach. In athletes, return of function must be maximized while duration of time away from sport is minimized without introducing unnecessary or unwise risk of re-injury or further injury, either to the ankle or another body region. The rehabilitation and rehabilitation phase in the injury of the ankle in the athlete is of fundamental importance to help the latter to return to the field in an optimal way and without relapses. In the field of ankle re-education we can talk about "*proprioceptive re-education*".

that is, all those methods and exercises aimed at stimulating and re-educating the proprioception, that is the ability to know, even with closed eyes, the position of our body in space. We recall that particular receptors collect input of peripheral origin and transmit them to the SNC that processes the information received and integrates them with other affiliations to organize motor responses. The function of the proprioceptors is therefore important for muscle tone, posture and movement. Proprioception exercises are specific exercises that stimulate the proprioceptive system, to train it to provide quick and adequate responses in destabilizing and dangerous situations, with the aim of making the individual better understand his own body. As for the ankle, proprioceptive re-education must aim to acquire greater coordination in the articulation muscle

contractions and bone levers, in accordance with the movement. Initially the re-education is carried out in a passive way, to accustom the athlete to perceive different characteristics of the movement induced and making him aware of his motor possibilities. Then we will work to recover a correct distribution of the load. Exercises develop on unstable surfaces, such as semispheres or square tablets. The athlete must learn to maintain balance with simple movements of the ankle, first with open eyes with our help, and then without help and visual control. It continues working in monopodalica both on the injured ankle and on the healthy one. When the athlete has recovered a good walking, we proceed with the development of a proprioceptive path composed of cushions that have a different consistency and deformity, to adapt the pace and stimulate the proprioceptive receptors during the walk on a non-homogeneous ground.

In the re-education and in the motor reactivation post distortive trauma is fundamental the muscular reinforcement, because a good trophism of the muscles reduces the risk of relapses and allows the athlete to resume the sporting activity. In the re-education of the ankle after a sprained trauma, we must pay attention to the movements that we will do to the athlete because they could again damage the ankle injured by the trauma. So, it is advisable to begin with light exercises, divided into several sets with a few repetitions.

Growing evidence supports the use of exercise therapy as the main component of the treatment program (Kerkhoffs et al., 2012) (Bleakley et al., 2010). The efficacy of exercise therapy programs has been established, especially when initiated early following an acute ankle sprain (Vuurberg et al., 2018) (Van Rijn et al., 2009).

MATERIALS AND METHODS

Seven athletes (Table 1) aged between 17 and 24 years were recruited for the study. Inclusion criteria were: absence of neurological deficits, absence of vestibular disorders, presence of functional ankle deficits, presence of ankle deficits caused by sprain, being an athlete. Exclusion criteria consisted of currently participating in a structured post-injury ankle recovery exercise programme. All participants was recruited after an examination by the sports and orthopaedic physician. All athletes received a full explanation of the protocols prior to the start of the study and signed an informed consent form for the tests and motor protocol.

Table 1. Participants.

Case	Age	Gender	Height
1	24	M	191 cm
2	22	F	163 cm
3	26	F	170 cm
4	18	M	180 cm
5	19	F	168 cm
6	20	M	184 cm
7	17	M	170 cm

Procedures

The experimental group (n = 7) performed the training using functional re-education protocols, under the supervision of the same investigator (kinesiologist and posturologist) and at the same time of day (between 18:00 and 19:30). The protocols were programmed both in relation to the condition of the athlete himself, and in relation to the specific injury for which it is necessary to recover all joint and motor functions. It was structured in 3 phases: the first ~~phase~~ on specific work to recover joint mobility, in the second phase the work was focused on recovering strength, and the third phase was aimed at recovering ankle sprains. An incorrect

re-educational programme results in a very high incidence of new injuries. Functional re-education plays a key role in this.

Methodology

The method of investigation used to analyse the various samples examined is the Baropodometric examination, a technique that can measure, point by point, the pressures exerted by the foot on the ground. The baropodometric platform is an instrument for measuring foot support that gives us the opportunity to evaluate the subjects while keeping their point of view unchanged. As for the intervention protocol for the re-education the method used is the proprioceptive exercise on particular carpets called "*SINERGY MAT*". (Figure 1) Proprioception is an important mechanism in stability and function (Boerboom et al., 2008).

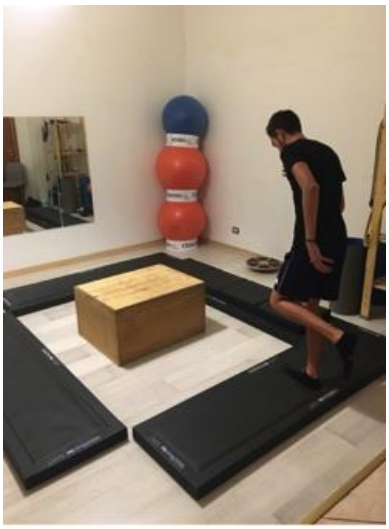

Figure 1. Sinergy Mat.

Human Tecar Synergy Mat consists of a series of platforms that simulate different terrain at different levels of instability. It allows to stimulate the muscles especially the one suitable for stabilization, avoiding the impact on the joint surfaces as happens on rigid soils like a balance training using unstable boards.

Protocol

Exercises included in the motor protocol had the common goal to reduce ankle instability. The entire training was performed for 48 weeks (two sessions per week) for a total of 96 sessions. Each training session consisted of 60 minutes of specific exercises. Specifically:

- Proprioceptive exercises, both static and dynamic.
- Isometric and joint and muscle stabilization exercises.
- Muscle strengthening and strength exercises.
- Stretching exercises.

The aim of this protocol was to stimulate both static and dynamic balance, encourage joint stabilization, restore the receptor system, improve muscular tropism and encourage post-traumatic recovery and thus the resumption of sporting activity. Below, a detailed description of the same.

Step 1: Maintain balance in bipodal support by moving the board vertically and diagonally. Time 20-30 sec. Figure 2.

Figure 2. Step 1.

Step 2: Maintain balance in monopodalic stance on the proprioceptive board. Time 20/30 sec. Figure 3.

Figure 3. Step 2.

Step 3: Maintain balance in bipodal stance by picking up a ball from the ground and holding it in your hands. Time 20/30 sec. Figure 4.

Figure 4. Step 3.

Step 4: Maintain balance in monopodalic stance by picking up a ball from the ground and holding it in your hands. Time 20/30 sec. Figure 5.

Figure 5. Step 4.

Step 5: Maintain balance in monopodalic phase on proprioceptive cushion. Time 20/30 sec. Figure 6.

Figure 6. Step 5.

Step 6: bipodal squats on proprioceptive cushion. 3 sets of 10 repetitions. Figure 7.

Figure 7. Step 6.

Step 7: single leg squats on proprioceptive cushion. 3 sets of 10 repetitions. Figure 8.

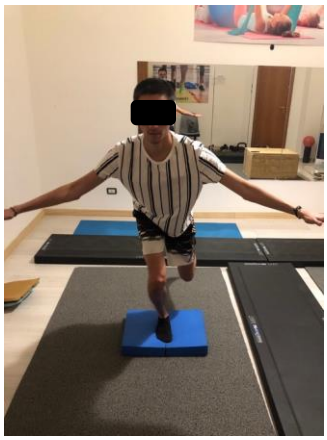

Figure 8. Step 7.

Step 8: alternating course with boards and proprioceptive cushions. They walked the course 5 times. Figure 9.

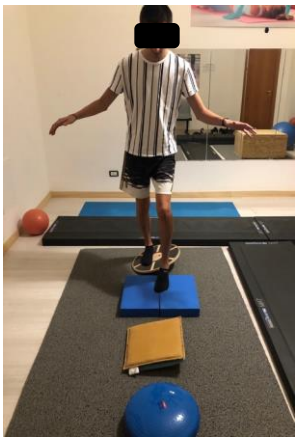

Figure 9. Step 8.

Step 9: low and high Skip on Sinergy Mat for 5/10 min. Figure 10.

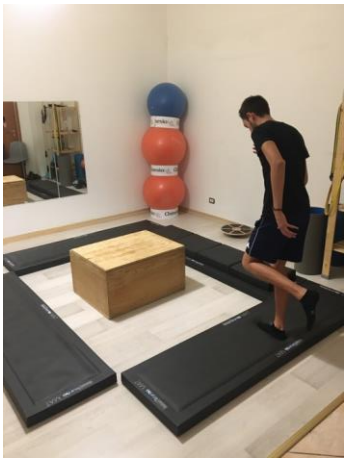

Figure 10. Step 9.

Step 10: Lateral and frontal lunges on Sinergy Mat 3x10. Figure 11.

Figure 11. Step 10.

Step 11: box jump (3x10). Figure 12.

Figure 12. Step 11.

Step 12: Foot thrusts in supination and pronation with small Fitness Ball in counter resistance (3x10). Figure 13.

Figure 13. Step 12.

Step 13: Foot flexion-extension with elastic in counter-resistance (3x10). Figure 14.

Figure 14. Step 13.

Postural balance assessment

Static bipedal stabilometry

Stabilometric parameters were measured using a Freemed baropodometric platform (sensor medica, 00012, Guidonia Montecelio, Rimini, Italy) with the following specifications: platform surface 640 x 740 mm, weight 8.5 kg and thickness 8 mm. The participants were positioned in bipedal mode, with their bare feet side by side on the platform, each foot approximately 20 cm away from the other, without any other type of support. All subjects were oriented to maintain a natural upright position, always looking at a fixed point in front of them for 30.5 seconds with their eyes open. The software obtains the position of the centre of pressure (CoP) load distribution. It also measures the speed of movement of the CoP and the length covered by the CoP. Data were collected and analysed using the software supplied with the platform (FreeStep), which continuously records CoP trajectories at a sampling rate of 100 Hz.

Gait analysis

For the initial and final gait evaluation was used "*Gait analysis*". Using sophisticated instrumentation, it was possible to measure foot and ankle movements and mechanics in relation to the body and the activity of the musculoskeletal systems (Levine et al., 2012). Gait analysis is used to assess and treat individuals with conditions affecting their ability to walk. It is also commonly used in sports biomechanics to help athletes run more efficiently and to identify posture-related or movement-related problems in people with injuries. The pioneers of scientific gait analysis were Aristotle in De Motu Animalium (Aristotle, 2004). The most recent scientists were Giovanni Alfonso and Borelli in 1600 and Eadweard Muybridge e Etienne Jules Marey in '900.

RESULTS

Report clinical case

Case 1

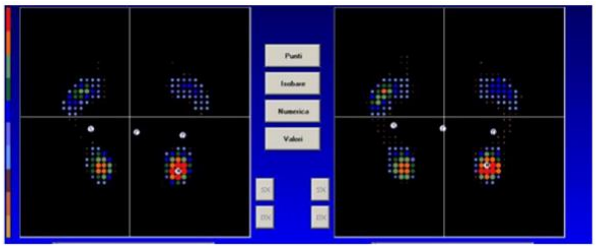

Figure 15. First clinical case before and later.

Table 2. Characteristics of the subject of case 1.

Sex	M
Age	24
Height	1.91 m
Injury	First degree ankle sprain
Sport	Basketball

Subject had a slight ankle sprain due to a change of direction in training and was subjected to a proprioceptive functional re-education plan.

Case 2

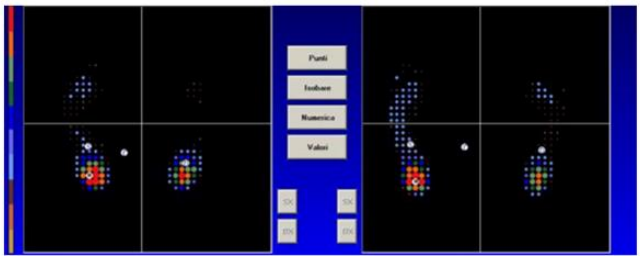

Figure 16. Second clinical case before and later.

Table 3. Characteristics of the subject of case 2.

Sex	F
Age	22
Height	1.63 m
Injury	Second degree ankle sprain
Sport	Fitness

The subject had an injury while warming up at the gym on the tapis and underwent a proprioceptive functional rehabilitation plan.

Case 3

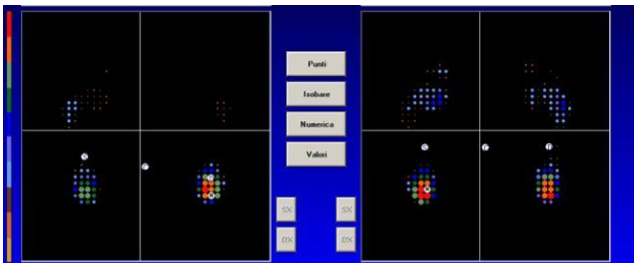

Figure 17. Third clinical case before and later.

Table 4. Characteristics of the subject of case 3.

Sex	F
Age	26
Height	1.70 m
Injury	Second degree ankle sprain
Sport	Dance

The subject, following an exercise on the tips, had a sprained ankle and was subjected to a protocol of proprioceptive functional re-education.

Case 4

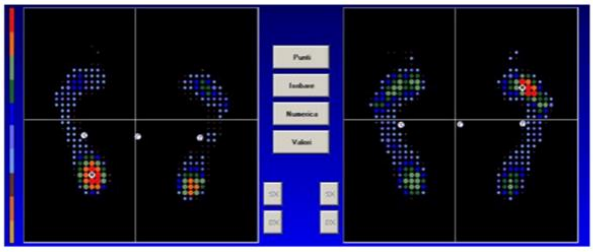

Figure 18. Fourth clinical case before and later.

Table 5. Characteristics of the subject of case 4.

Sex	M
Age	18
Height	1.80 m
Injury	First degree ankle sprain
Sport	Volleyball

Subject injured himself after he'd done the volleyball wall for putting his foot wrong on the ground when he landed. He then underwent a proprioceptive functional rehabilitation protocol.

Case 5

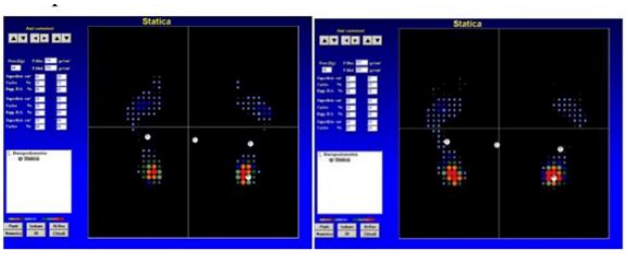

Figure 19. Fifth clinical case before and later.

Table 6. Characteristics of the subject of case 5.

Sex	F
Age	19
Height	1.68 m
Injury	First degree ankle sprain
Sport	Dance

Subject had a slight ankle sprain from a sudden change of direction and underwent proprioceptive functional re-education.

Case 6

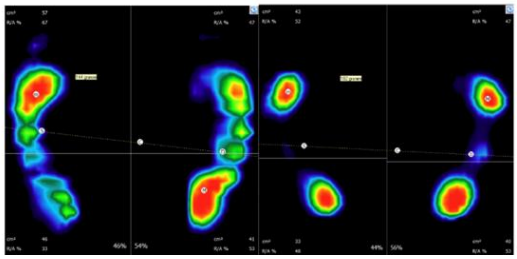

Figure 20. Sixth clinical case before and later.

Table 7. Characteristics of the subject of case 6.

Sex	M
Age	20
Height	1.84 m
Injury	Second degree ankle sprain
Sport	No sport practiced

Subject was injured during a football match and was subjected to a proprioceptive functional rehabilitation protocol.

Case 7

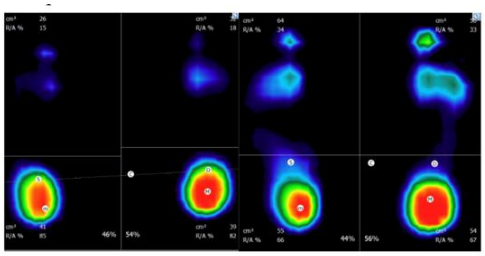

Figure 21. Seventh clinical case before and later.

Table 8. Characteristics of the subject of case 7.

Sex	M
Age	17
Height	1.70 m
Injury	Second degree ankle sprain
Sport	Fitness

The subject was injured playing tennis during a change of direction and was then subjected to a proprioceptive functional re-education protocol.

DISCUSSION

Joint stability is an indispensable component for performing daily activities and for overall physical performance, especially in athletes. Balance training is prescribed to prevent and treat injuries caused by a reduced ability to balance, and part of this training is a series of different plantar support exercises. The aim of this study was to investigate the effects of a specific motor protocol for post-traumatic ankle recovery,

conducted by a graduate in exercise science. Hypothesis was partially supported. We do not have absolute certainty that this type of protocol is effective for every case. But the study showed that this 48-week protocol used was associated with a significant improvement in ankle stability, reduced or eliminated pain under load, improved static and dynamic balance compared to baseline, and allowed athletes to return to the field. From the point of view of efficacy, in short- and long-term conditions, previous studies have found an improvement in postural stabilization and balance parameters following 4 weeks of specific sensorimotor training (Aggarwal et al., 2010). Some authors have shown that sensorimotor training is effective in preventing recurrences of ankle sprains, but the pathway through which this effect occurs is unknown. Biomechanical and neurophysiological analyses of sensorimotor training leading to functional changes in the ankle are required to establish this pathway (Hupperets et al., 2009).

The results on joint position sense and muscle reaction times showed a positive effect in both static and dynamic. Measurements taken at T0, taken three months after the start of use of the protocol, and a T1 measurement, taken at the end of the protocol (after 48 weeks) show clear improvements. The results collected in the study, summarised in the concept of variation of breech support and variation of the centre of gravity, are enclosed in the graph.

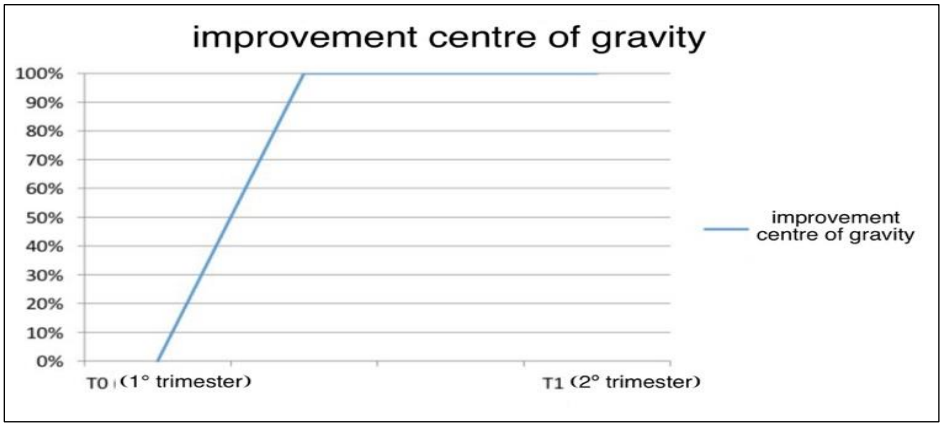

Figure 22. Graph on the change centre of gravity.

No effects on specific muscle strength were found because we did not provide tests to evaluate them. We believe that future studies must overcome our limitations and focus on (i) differentiation between morphological, physiological and functional changes; (ii) larger sample sizes and differentiation of athletes between amateurs and professionals; (iii) use of a longer follow-up period of 48 weeks.

CONCLUSIONS

Improved balance and joint stability of the ankle and the foot-ankle system, can ensure a better post-traumatic recovery of the athlete. The current study showed that only a good, adapted motor protocol, can promote an athlete's post-traumatic ankle sprain recovery. The results suggested that a newly developed protocol based on proprioception, balance and strength, could be an alternative to improve balance and prevent traumatic events in athletes. Furthermore, this type of programme, could be recommended to be included in the pre-competition training routine. In an injured athlete, a timely and safe return to training or competition is the desired outcome of the recovery process.

AUTHOR CONTRIBUTIONS

Conceptualization, M. C. P., O. M.; writing original draft M. C. P., O. M.; writing revision and editing: M. C. P.; visualization and supervision: V. C. F.; project design: M. C. P.; investigation, A. C., O. M.; data curation: O. M. All authors read and approved the final edited manuscript. All authors reviewed and approved the final manuscript.

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DISCLOSURE STATEMENT

No potential conflict of interest were reported by the authors.

ETHICAL PUBLICATION STATEMENT

We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

INSTITUTIONAL REVIEW BOARD STATEMENT

The study was conducted in accordance with the Declaration of Helsinki, and approved by Ethics Committee University Kore of Enna, for studies in-volving humans.

INFORMED CONSENT STATEMENT

Informed consent was obtained from all subjects involved in the study Written informed consent for publication must be obtained from participating patients who can be identified. Written informed consent has been obtained from the patient(s) to publish this paper if applicable.

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REFERENCES

Aggarwal, A., Zutshi, K., Munjal, J., Kumar, S., Sharma, V. (2010) Comparing stabilization training with balance training in recreationally active individuals. Int J Ther Rehabil., 17, 244-253. https://doi.org/10.12968/ijtr.2010.17.5.47843

Aristotle. (2004) On the Gait of Animals. Kessinger Publishing, 978-1-4191-3867-6.

Arnold B.L., De La Motte S., Linens S., Ross S.E. (2009). Ankle instability is associated with balance impairments: A meta-analysis. Med Sci Sports Exerc., 41(5):1048-1062. https://doi.org/10.1249/MSS.0b013e318192d044

Basnett, C. R., Hanish, M. J., Wheeler, T. J., Miriovsky, D. J., Danielson, E. L., Barr, J. B., & Grindstaff, T. L. (2013). An-kle dorsiflexion range of motion influences dynamic balance in individuals with chronic ankle instabil-ity. International journal of sports physical therapy, 8(2), 121-128.

Bleakley C.M., O'Connor S.R., Tully M.A., Rocke L.G., Macauley D.C., Bradbury I., Keegan S., McDonough S.M. (2010) Effect of accelerated rehabilitation on function after ankle sprain: randomised controlled trial. BMJ.; 340:c1964. https://doi.org/10.1136/bmj.c1964

Boerboom, A. L., Huizinga, M. R., Kaan, W. A., Stewart, R. E., Hof, A. L., Bulstra, S. K., & Diercks, R. L. (2008) Valida-tion of a method to measure the proprioception of the knee. Gait & Posture, 28(4), 610-614. https://doi.org/10.1016/j.gaitpost.2008.04.007

Bonnel, F; Toullec, E., Mabit, C., & Tourné, Y. (2010). Chronic ankle instability: biomechanics and pathomechanics of ligaments injury and associated lesions. Orthopaedics & traumatology: Surgery & research, 96(4), 424-432. https://doi.org/10.1016/j.otsr.2010.04.003

Brockett, C. L., & Chapman, G. J. (2016). Biomechanics of the ankle. Orthopaedics and trauma, 30(3), 232-238. https://doi.org/10.1016/j.mporth.2016.04.015

De Noronha M., Refshauge K.M., Crosbie J., Kilbreath S.L. (2008). Relationship between functional ankle instability and postural control. J Orthop Sports Phys Ther., 38(12):782-789. https://doi.org/10.2519/jospt.2008.2766

Flegel M.J. (2008) Sport First Aid (4th ed). Champaign, IL: Human Kinetics.

Fong D.T.P, Hong Y., Chan L.K., et al. (2007) A systematic review on ankle injury and ankle sprain in sports. Sports Med.; 37(1):73-94. https://doi.org/10.2165/00007256-200737010-00006

Hiller C.E., Kilbreath, S.L., Refshauge K.M. (2011). Chronic ankle instability: Evolution of the model. J Athl Train., 46(2):133-141. https://doi.org/10.4085/1062-6050-46.2.133

Hoch, M. C., Staton, G. S., McKeon, J. M. M., Mattacola, C. G., & McKeon, P. O. (2012) Dorsiflexion and dynamic pos-tural control deficits are present in those with chronic ankle instability. Journal of Science and Medicine in Sport, 15(6), 574-579. https://doi.org/10.1016/j.jsams.2012.02.009

Hootman J.M., Dick R., Agel J. (2007) Epidemiology of collegiate injuries for 15 sports: summary and recommenda-tions for injury prevention initiatives. J Athl Train.; 42(2):311-9.

Hupperets, M.D.W., Verhagen, E.A.L.M. & van Mechelen, W. (2009) Effect of Sensorimotor Training on Morphologi-cal, Neurophysiological and Functional Characteristics of the Ankle. Sports Med 39, 591-605. https://doi.org/10.2165/00007256-200939070-00005

Kerkhoffs G.M., Van Den Bekerom M., Elders L.A., Van Beek P.A., Hullegie W.A., Bloemers G.M., De Heus E.M., Loogman M.C., Rosenbrand K.C., Kuipers T., et al. (2012) Diagnosis, treatment and prevention of ankle sprains: an evidence-based clinical guideline. Br J Sports Med.; 46:854-860. https://doi.org/10.1136/bjsports-2011-090490

Levine D., Richards J., Whittle M. (2012) Whittle's Gait Analysis. Elsevier Health Sciences, ISBN 978-0702042652.

Nordin, M., & Frankel, V. H. (2011). Basic biomechanics of the musculoskeletal system. Lippincott Williams & Wilkins.

Siegler S., Block J., Schneck C.D. (1988) The mechanical characteristics of the collateral ligaments of the human ankle joint. Foot Ankle; 8(5):234-42. https://doi.org/10.1177/107110078800800502

Snedeker, J. E., Wirth, S. H., & Espinosa, N. (2012). Biomechanics of the Normal and Arthritic Ankle Joint, Foot and Ankle Clinics, Volume 17, Issue 4, 517-528. https://doi.org/10.1016/j.fcl.2012.08.001

Van Rijn R.M., Van Heest J.A., Van Der Wees P., Koes B.W., Bierma-Zeinstra S.M. (2009) Some benefit from physio-therapy intervention in the subgroup of patients with severe ankle sprain as determined by the ankle function score: a randomised trial. Aust J Physiother.; 55:107-113. https://doi.org/10.1016/S0004-9514(09)70040-6

Van Rijn, R.M., Van Os, A.G., Bernsen, R.M.D., Luijsterburg, P.A., Koes, B.W., & Bierma-Zeinstra S.M. (2008) What is the clinical course of acute ankle sprains? A systematic literature review. The American journal of medicine, 121(4), 324-331.e6. https://doi.org/10.1016/j.amjmed.2007.11.018

Vuurberg G., Hoorntje A., Wink L.M., Van Der Doelen B.F.W., Van Den Bekerom M.P., et al. (2018) Diagnosis, treat-ment and prevention of ankle sprains: update of an evidence-based clinical guideline. Br J Sports Med.; 52:956. https://doi.org/10.1136/bjsports-2017-098106

Zwipp, H., & Randt, T. Ankle joint biomechanics. (1994) Foot and Ankle Surgery, 1(1), 21-27. https://doi.org/10.1016/S1268-7731(05)80052-9