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Original Article

Physiotherapy Section

Predisposing Factors of Delayed Onset of Muscle Soreness in Untrained Athletes: A Cross-sectional Study

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ABSTRACT

Introduction: Delayed Onset Muscle Soreness (DOMS) is a common consequence of ultrastructural muscle damage. Following unusual eccentric exercises, individuals who are not professionally trained or are amateur athletes experience muscle tenderness that can range from mild discomfort to severe debilitating pain.

Aim: To identify the factors that contribute to the development of DOMS in untrained athletes and to raise awareness about these factors.

Materials and Methods: A cross-sectional observational study was conducted in the Department of Physiotherapy, GEMS College of Physiotherapy, Srikakulam, Andhra Pradesh, India on 50 untrained athletes aged 18-25 years, over a period of eight months from January to September 2022, with complete enrollment of untrained athletes. The history of pain, stiffness, decreased range of motion and DOMS was surveyed through a self-reported questionnaire, followed by quantitative statistical analysis using mean, standard deviation and percentages of the data.

Results: The mean age of the participants was 21.04±2.7401 years. The current research examined various predisposing factors that influenced the occurrence of DOMS. Specifically, 35 (70%) athletes reported engaging in eccentric exercises; 24 (48%) athletes reported exposure to hot weather and outdoor environments; 32 (64%) athletes reported neglecting warm-up sessions; and 43 (86%) athletes reported skipping cool-down exercises.

Conclusion: The study concluded that the group of muscles comprising the shoulders and biceps is particularly susceptible to experiencing pain, loss of strength, muscle tenderness and reduced range of motion as a result of DOMS. DOMS is commonly induced by engaging in high-intensity workouts, such as lifting heavy weights with eccentric contractions, without proper warm-up and cool-down routines, especially in hot outdoor environments.

Keywords: Amateur athletes, Cool-down, Eccentric contractions, Muscle tenderness, Warm-up

INTRODUCTION

The DOMS is the sensation of pain and stiffness in the muscles that occurs 1 to 5 days following unaccustomed exercise. It can adversely affect muscular performance, both due to voluntary reductions in effort and the inherent loss of capacity of the muscles to produce force [1]. DOMS manifests following high-intensity eccentric contractions of muscles that are unfamiliar to activities of daily living [2,3]. It is characterised by increased muscle proteins in the blood and decreased muscle function, primarily observed in untrained athletes [4]. Muscle soreness is caused by several factors, ranging from micro-tears to blood pooling [5].

The DOMS is an acute neuron compression axonopathy of the nerve terminal in the muscle spindle [6]. It may be initiated from the muscle spindle and could result from the hypnologic state of the "closed gate", caused by enhanced firing of the micro-injured type-I sensory fibres, in addition to initial Sympathetic Nervous System (SNS) suppression that keeps the gate closed during concentric exercise. This results in non pharmacological neuropathic pain [7]. DOMS may serve as a safety function in repetitive eccentric contractions, as it resolves when the micro-injury of the muscle spindle afferent sensory and motor neuron endings regenerate. The sensation of DOMS is primarily carried by group IV afferent fibres, as well as poly-modal responses to various stimuli, including chemical, mechanical and thermal responses. The chemical substances that elicit action potentials in group IV muscle fibres, in order of effectiveness, are bradykinin, serotonin, histamine and potassium [8].

The duration of exercise is considered a vital predisposing factor for DOMS. The length-dependent component has also been found to contribute to the development of pain and fatigue after eccentric exercises. Strozer A et al., demonstrated that near-maximal lengthening of the active muscles often serves as a predisposing factor for DOMS [9]. Tenderness, stiffness and loss of range of motion are clinical symptoms of DOMS. However, non steroidal anti-inflammatory drugs, massage [10], cold baths [11], warm baths [7], cryotherapy [12], Transcutaneous Electrical Nerve Stimulation (TENS) [8] and vibration [13] are treatment options. Hydrating the body with water [14], along with regular warm-ups [15] and cool-downs [16], helps to prevent DOMS. Warm-up and cool-down are important factors for reducing the minimal risk of muscle injury.

In light of the predisposing factors, DOMS more often manifests following excessive exercise duration, as well as skipping warm-ups and cool-downs [3]. There is a substantial lack of knowledge regarding predisposing factors among untrained athletes, which serves as a barrier to preventing the occurrence of DOMS. Hence, the present study aimed to explore the predisposing factors of DOMS among untrained athletes.

MATERIALS AND METHODS

A cross-sectional study was conducted the Department of Physiotherapy, GEMS College of Physiotherapy, Srikakulam, Andhra Pradesh, India following the attainment of ethical clearance with reference number 11/IEC/GEMS&H/2022, involving 50 untrained athletes. The study was conducted from January 2022 to September 2022, with complete enrollment of untrained athletes. Before study enrollment, the subjects were informed about the aim of the project, provided with information about the questionnaire, and informed consent was obtained.

Inclusion and Exclusion criteria: The study included untrained athletes aged 18 to 25 years [17] who had a history of pain, stiffness and decreased range of motion and who were willing to participate.

Individuals who were trained athletes were excluded from the study, as were illiterate persons, since they were unable to answer the questions.

Sample size calculation: The sample size was estimated following the Dobson formula ($n=Za^2(p)(1-p)/\delta^2$) [18], where Za=1.96, p=0.5, assuming that 50% of untrained athletes to be assessed have adequate knowledge. With a precision of 20% and a power of 80%, a sample size of 47 was derived, which was adjusted for a 6% non response rate, resulting in a final sample size of 50.

Study Procedure

During enrollment, the demographic details of the individuals were collected. A brief history of athletic leisure was noted, along with frequency and duration. The pattern of game practice was recorded, including any associated pain or discomfort afterwards. A self-reported questionnaire was devised by the principal investigator in collaboration with the supervisor, consisting of 14 questions. The questionnaire included demographic details, a history of DOMS and self-reported questions related to identifying predisposing factors based on the literature [3,7,16]. Experts in physiotherapy assessed the content and criteria of the questionnaire for its validity and suggested the removal of two questions. Following the experts' suggestions, the final draft of the questionnaire was prepared with 12 questions.

STATISTICAL ANALYSIS

The data was collected from each untrained athlete and analysed for appropriately answered questions from May to December 2022. The responses were tabulated using Microsoft Excel and the data was validated for analysis.

RESULTS

A total of 50 untrained athletes participated in the study, adhering to the inclusion and exclusion criteria. The mean age of the participants was 21.04±2.7401 years. Among the untrained athletes, 48 (96%) were non vegetarians. The participants were involved in various types of games, primarily cricket, throwball and badminton, with 21 (42%) participating in each. The baseline characteristics observed among the participants are illustrated in [Table/Fig-1].

Baseline characteristics		Frequency (n)	Percentage (%)
Gender	Female	26	52%
	Male	24	48%
Diet	Non vegetarian	48	96%
	Vegetarian	2	4%
Type of games	Cricket	21	42%
	Throwball	21	42%
	Badminton	21	42%
	Volleyball	14	28%
	Athletic track and field	7	14%
	Running	5	10%
	Tennikoit	3	6%
	Skating	3	6%
	Body building	2	4%
	Cycling	2	4%
	Basketball	1	2%
Regularity of practice	Frequent	27	54%
	Occasional	23	46%

[Table/Fig-1]: Baseline characteristics of participants.

The data collected through a questionnaire explored the predisposing factors of DOMS. The location of DOMS was predominantly around the shoulder region 26 respondents, (52%), followed by the biceps 20 respondents, (40%) and the calves 15 respondents, (30%). Among untrained athletes, 19 (38%) experienced a reduced range of motion due to pain and 15 (30%) reported observing DOMS following high-intensity exercises, which were notably more intense during nighttime as indicated by 29 (58%) untrained athletes. The pain and discomfort associated with DOMS were sustained for 3-5 days in 48 (96%) untrained athletes and 35 (70%) practiced eccentric muscle contractions, often neglecting warm-up and cool-down exercises. The questionnaire also examined the impact of hydration, the environment and other external predisposing and relieving factors. A summary of the responses obtained from the 12 questions of the self-reported questionnaire is illustrated in [Table/Fig-2].

S. No.	Questions		Frequency	Percentage
1.	Location of DOMS*	Shoulder	26	52%
		Biceps	20	40%
		Calf	15	30%
		Quadriceps	14	28%
		Triceps	13	26%
		Hamstrings	5	10%
		Hip	3	6%
		Chest	1	2%
		Upper back	1	2%
		Arm	1	2%
2.	What type of pain or disturbance you experienced during DOMS?*	Reduced range of motion at joint due to pain	19	38%
		Feeling loss of strength in the muscle	16	32%
		Tender muscle to touch	13	26%
		Fatigue in the muscles	13	26%
		Swelling in the muscles	4	8%
3.	Describe the activity or exercise which lead you to DOMS*	High intensity exercises	15	30%
		Lifts heavy weight	7	14%
		Playing games after long time	4	8%
		New exercises	5	10%
		Prolonged workouts	5	10%
		Activity like running	2	4%
		Athletic events	5	10%
		Continuous playing games	7	2%
4.	In which time you feel severe pain?	Night time only	29	58%
		Throughout the day	14	28%
		Day time only	7	14%
5.	How long been pain continued?	3-5 days	48	96%
		More than 5 days	2	4%
6.	What type of exercise you do during practice?	Eccentric	35	70%
		Concentric	15	30%
7.	Do you warm up before practice?	No	32	64%
		Yes	18	36%
8.	Will you do a cool-down exercise after practice?	No	43	86%
		Yes	7	14%
9.	Have you enough time for breaks during practice?	Yes	36	72%
		No	14	28%
10.	Have you drink plenty of water?	Yes	32	64%
		No	18	36%

11.	What type of environments when you practice?	Very hot atmosphere and outdoor	24	48%
		Air-conditioned	9	18%
		Very cold atmosphere and outdoor	6	12%
		Very hot atmosphere and indoor	4	8%
		Normal room temperature and well-ventilated	3	6%
		Very cold atmosphere and indoor	3	6%
		Normal room temperature but closed	1	2%
12.	How can you get relief from pain after DOMS?	Hot water bath and fomentation	23	46%
		Active rest	11	22%
		Cold water bath	9	18%
		Continuing workout like before	4	8%
		Complete bed rest	3	6%

[Table/Fig-2]: Summary of the responses obtained from the 12-questions of self-reported questionnaire.
*multiple responses

DISCUSSION

The purpose of the present study was to identify the predisposing factors leading to DOMS in untrained athletes. In the present study, a total of 50 participants who met the inclusion criteria were randomly selected. This included 26 females and 24 males who are untrained athletes within the age group of 18-25 years. The questionnaire method was utilised to record the factors contributing to the experience of pain among the untrained athletes.

The predisposing factors identified in the study included the performance of warm-up and cool-down exercises before and after activities, respectively, as well as the assessment of environmental influences, intervals during exercises, types of activities causing DOMS and hydration levels. The impact of these factors was assessed based on the location of DOMS, type of pain, duration of pain and relieving methods reported by untrained athletes. Eccentric exercises, exposure to hot weather and outdoor environments, negligence of warm-up sessions and skipping cool-down exercises were reported as major predisposing factors for the occurrence of DOMS.

A study conducted by Howatson G and van Someren KA concluded that when the body undergoes any unaccustomed mobility, it leads to exercise-induced muscle damage, resulting in a temporarily reduced production of muscle force, followed by a rise in passive tension, increased muscle soreness and an increase in intramuscular proteins in the blood [19]. The findings of this phenomenon were supported by the present study in terms of the duration of pain following the eccentric predisposition of exercises. Additionally, environmental factors, along with irregularities in warm-up and cool-down routines, contributed to the occurrence of DOMS.

The findings of the present study were supported by Cleak MJ and Eston RG, who conducted a study to describe the phenomenon of DOMS, concentrating on the types of muscle contractions likely to produce DOMS and the theories underlying the physiological mechanisms of DOMS [20]. They found that eccentric muscle contractions more often lead to DOMS, supporting the findings of the present study wherein more of the participating untrained athletes performed eccentric exercises.

The study conducted by Malmir K et al., investigated the effects of cryotherapy and TENS on the signs and symptoms of DOMS and concluded that cryotherapy was more effective [8]. However, in the present study, hot water baths and fomentation were found to be more commonly used by the untrained athletes to alleviate DOMS.

The present study is supported by Cheung K et al., who concluded that the strategies, theories and performance factors regarding eccentric exercises, which are an unaccustomed type of exercise for an untrained athlete's body, should begin progressively over the duration of adaptation [3]. This approach would help prevent the predisposition of untrained athletes to DOMS, leading to physical impairment or disruption.

Limitation(s)

The untrained athletes above the age of 25 years could not be assessed. The data was obtained using a self-reported questionnaire, which may have caused errors in data recording due to the participants' perception of the concept of DOMS. Further studies could be conducted with patients over the age of 25 years and a larger sample size.

CONCLUSION(S)

The present study concludes that various factors predominantly influence DOMS in untrained athletes. These factors include the predominance of eccentric contractions among untrained athletes, exposure to very hot temperatures and outdoor environments, insufficient breaks during practice, the absence of adequate warm-up and cool-down exercises and a lack of sufficient hydration. The present study aimed to raise awareness about the predisposing factors that lead to DOMS.

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