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Editorial

Discrepancy in cardiac rehabilitation: national and international perspective

Sana Bashir[1], Iqbal Tariq[2], Saad Rauf[2]*

Cardiac patients need cardiac rehabilitation (CR) as part of their post-hospital care, but there are significant global variations as CR is administered and designed. For improved patient outcomes following myocardial infarction (MI) or coronary artery bypass grafting (CABG), comprehensive cardiovascular rehabilitation (CR) programs are essential in developed nations. These programs include structured exercise plans, instruction on modifiable cardiovascular risks, and psychological therapy. Even though CR lowers rates of morbidity and death, there is not sufficient standardization or application of CR worldwide.

German CR programs, for instance, prioritize offering comprehensive residential care for a shorter three-week duration than programs in other Western countries [1]. This illustrates how different CR strategies can exist even in nations with comparable healthcare systems. Exercise tolerance, quality of life, and clinical outcomes are all improved by CR, according to research, especially in patients with heart failure and low ejection fraction (HFrEF)[2].

Even in low- and middle-income countries (LMICs), where there are limited healthcare resources and poor utilization rates, there are still disparities in access to CR. Understanding outcomes, quality, and service delivery requires national registries; yet little is known about the number, kinds, and elements of these registries in relation to cardiac rehabilitation. The use of national and international registries to define cardiac rehabilitation and establish quality enhancement standards is still in its early stages, but it has the potential to make cross-country comparisons easier [3].

Cardiac rehabilitation (CR) programs are not widely available in Low-Middle Income Countries (LMICs), and overall, these treatments are not sufficiently offered to meet the growing burden of cardiovascular disease (CVD) in these regions. It is also shown that the CR service utilization rates in LMICs are not up to optimal levels. Numerous CR challenges plague both high-income and low-income nations, but LMICs are more disadvantaged because of their lack of resources, inadequate health systems, and affordability issues [4].

Similarly, despite evidence connecting cardiac rehabilitation to lower mortality among PCI patients in the US, an international analysis focused on the consistently low rates of referral to cardiac rehabilitation after PCI. After PCI, only about 60% of patients receive a referral for cardiac rehabilitation, which is still below ideal levels [5]. It is not possible to attribute the significant disparity in referral rates amongst medical facilities to variations in insurance coverage. These results highlight the possible need for hospital-level measures targeted at improving the rates of cardiac rehabilitation referrals after percutaneous coronary intervention.

Globally, only a few nations have CR programs, and LMICs face more challenges when it comes to providing services. This demonstrates the urgent need for coordinated initiatives to boost CR competence and availability through innovative delivery strategies, efficient referral networks, and favourable health policies [6, 7].

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Likewise, cardiovascular disease (CVD) is avoidable and pushes for middle-income nations to adopt cardiac rehabilitation (CR) more widely. To reduce additional death and morbidity after CVD events, these components include initial assessment, management of lifestyle risk factors (such as diet, tobacco use, and mental health), medical risk factors (such as blood pressure, lipids, and blood pressure), self-management education, and assistance with returning to work. To cut expenses, the evaluation recommends alternate delivery sites such primary care, community, and home. Furthermore, suggestions are offered for situations in which a non-physician, such as an allied health professional or community health worker, serves as the primary provider of critical care[8].

Consequently, considering the benefits of cardiac rehabilitation, the purpose of this review was to emphasize how important it is to put cardiac rehabilitation into practice after procedures like PCI, CABG, and other heart surgeries. This calls for the creation of possibilities for cardiac rehabilitation specialists to maximize their contributions to the well-being of patients undergoing such surgeries in the community, as well as the facilitation of more efficient referral processes. Ensuring high-quality rehabilitation services is essential.

Finally, research on Pakistan indicates that while following some elements of standard cardiac rehabilitation after myocardial infarction may improve health-related quality of life, there are still issues with providing thorough and consistent cardiac rehabilitation throughout Phases II, III, and IV as well as sufficient psychosocial support. These issues stem from a lack of funding as well as barriers to receiving cardiac rehabilitation referrals and services.

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Research Article

A qualitative analysis of children with visual impairment by speech therapists and special education teachers

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ABSTRACT

Background: Visual impairment creates adverse effects on the affected individual and his family. Speech therapists played an essential role in the development of children who had communication problems.

Objective: To explore the perceptions of special education teachers and speech pathologists about the role of speech therapists in children with visual impairment.

Methodology: A qualitative study exploring the role of speech pathologists in visual impairment was conducted in Rawalpindi and Islamabad region in 2022. Purposive sampling was used to include 8 speech therapists and 7 special education teachers. Speech pathologists having minimum qualification of MS/SLP or PGD and Special education teachers with minimum qualification of master's in special education with a minimum of two years of experience were included. Open-ended questions were developed, and data was gathered by using semi-structured interviews. Recordings were done after informed consent. Thematic analysis was done to generate the themes.

Results: Four major themes were identified by both professionals. These include 1) the need for guidance for professionals 2) auditory and tactile orientations for the development of language 3) scarce resources in therapy, and 4) the need for training for professionals who are working with visually impaired children.

Conclusion: Speech therapists have a vital role in developing communication for children with visual impairment. Professionals suggested that speech therapists should work with children with VI as they work with sighted children.

Keywords: speech therapists; special education teachers; visual impairment.

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INTRODUCTION

Vision is the fundamental visual sense by which a person can give and receive messages in his surroundings[1]. WHO describes visual impairment as any irregularity in psychological, physiological, or anatomical structure and function [2]. According to ICD-10 visual impairment is defined as low vision and an individual's visual acuity should be less than 6/18 or better than 3/60. On the other hand, a person would be said as blind whose visual acuity would be 3/60 [3].

In line with the country-wide federation of the blind, inside the US, individuals who are younger than 20 and have a visual impairment are about 2.4% (694.300 children)[4]. The ratio of children with visual impairment in under-developing countries of Asia and Africa is greater than in other countries (90%). In Pakistan, the prevalence of visual impairment and severe visual impairment is 33.8% and 27.2% respectively [5].

In developed countries, Cerebral (or Cortical) Visual Impairment, cataracts, congenital diseases, rubella, ametropia, optic nerve damage, and inflammation of the cornea have become a leading etiology in children with visual impairment [5-10].

Visual Impairment had a major impact on individual daily life activities. It affects the individual's physical performance, creates stress and anxiety, and deteriorates the quality of life [11]. Researchers suggested that development and the process of early literacy like reading, writing mathematical concepts, and information about letters, starts in infancy[12].

Researchers investigated the impact of visual impairment on the development of language and communication skills. In a study, language, and communication skills in typical children and atypical children with visual impairment of age 6-12 years were investigated. The results revealed that sighted children showed better language and communication skills as compared to the children with visual impairment who have pragmatically poor language and communication skills for social purposes[13]. Researchers investigated that children with visual impairment face difficulties in the development of verbal expression because these children depend on their caregivers and do not understand facial expressions[12].

Researchers illustrated that infants with visual impairment babble less likely than typical infants. They have no visual experience of the rewards of their caretakers. Similarly, literature also indicated that visual impairment also creates hindrances in speech production of visually impaired children till adolescence period[14].

According to research, speech therapists are those who assess infants after birth. They assess their early reflexes, non-verbal gestures, and gross and fine motor movements. They also help to initiate sucking and chewing[15]. Researchers suggested that speech therapists played an essential role in the development of atypical children, especially in language acquisition and the development of social communication. In the field of visual impairment, limited studies have been conducted on the role of SLPs. However, the importance of SLPs cannot be denied. For this area, according to researchers, SLPs are the practitioners who work hard to rehabilitate individuals, especially visually impaired individuals according to their different needs to facilitate them in developing effective communication [16].

A study was conducted on the use of AAC devices with children with visual impairment. Speech therapists, teachers, and occupational therapists were included in this study. Results concluded that professionals lack adequate knowledge and experience about the use of AAC devices with children with visual impairment[17].

Special education teachers play an important role in the development of the mainstream education system. They require thorough knowledge about the needs of disabled students to meet their requirements [18]. Research was conducted in Zambia to determine the struggles of teachers working with children having visual impairment. The researchers suggested that the teachers faced troubles during question-answer sessions, teaching comprehension questions, and group discussions as they are not skilled in overcoming such challenges[19] A study was conducted to observe activities and teaching methodologies of teachers of visual impairment for the development of core curriculum. The results showed that for the development of communication skills teachers often use braille reading, soft wares, and electronic machines[20].

According to the research, students with visual impairment need a multidisciplinary team approach because they also struggle with other developmental processes throughout their life span. The multidisciplinary team should take the responsibility of assessing and developing strategies for the betterment of children having visual impairment [21].

Keeping in view the importance of the role of speech pathologists with visually impaired children, this research aimed to investigate an in-depth analysis of the perception of speech therapists and special education teachers from specialized centers about the role of SLPs. This study will allow professionals to think about early interventions and therapy goals for children having visual impairment.

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METHODOLOGY

A qualitative study was conducted in 2022, at special education schools of Rawalpindi and Islamabad region after the approval from the Research Ethical Committee of Riphah International University Islamabad (with Ref # Riphah/RCRS/REC/01339). A purposive sampling technique was used for data collection. 15 participants were selected for the semi-structured interviews who are working with visually impaired children (n=7 special education teachers, n=8 speech pathologists). Both male and female participants, who had more than 2 years of experience with visually impaired children (age range of 4-9 years) were selected for interviews. The speech pathologists having minimum qualification of PGD and MS/SLP and special education teachers with minimum qualification of master's in special education were included in the study.

Open-ended questions were developed after the literature review. Separate questions were developed for speech therapists and special education teachers. To save the data and avoid bias in the transcription of the data, interviews were recorded after obtaining consent from participants. Thematic analysis was conducted by using Braun and Clark's 6-step guidelines [22].

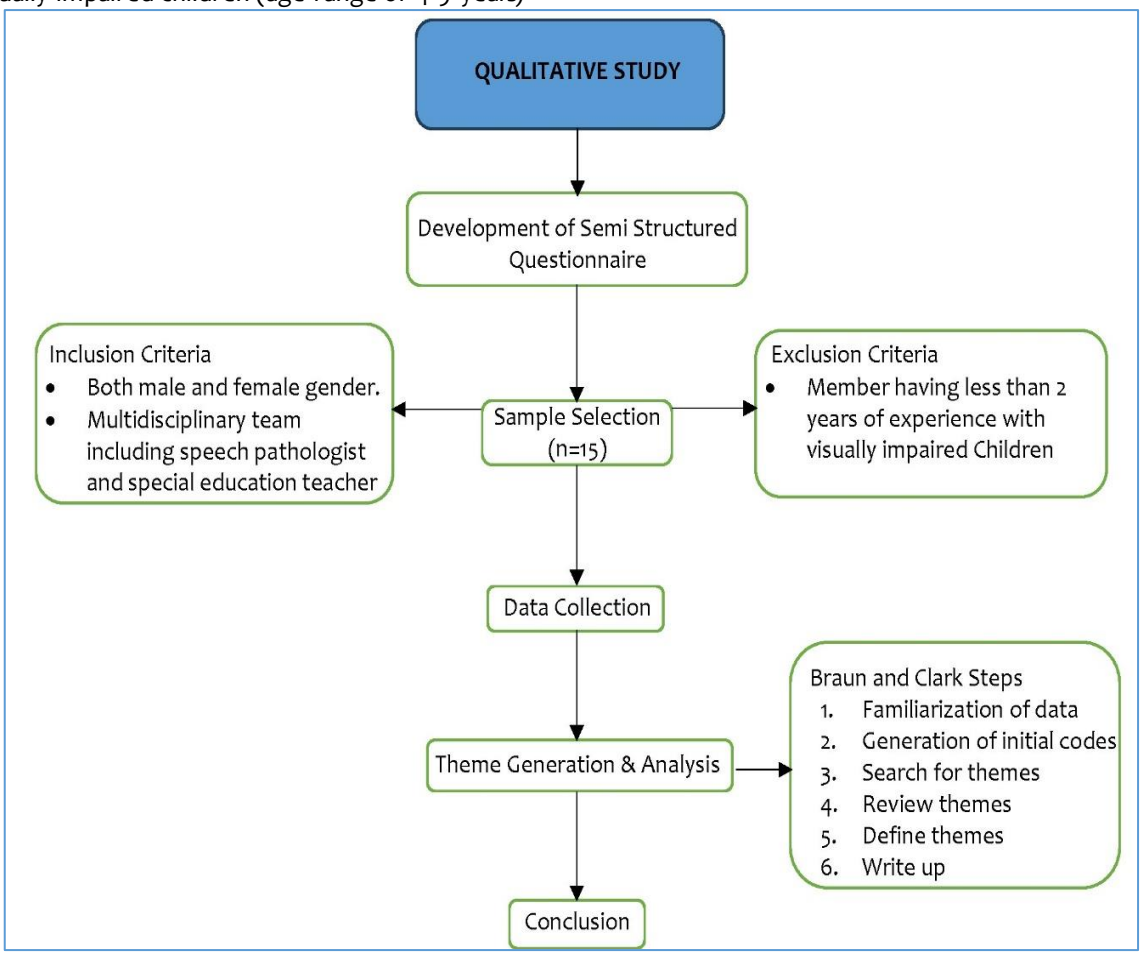

Figure 1: Study Flow Diagram

RESULTS

For a valid result, an expert panel was established to evaluate the research questions. Five experts in the field who were knowledgeable about the construct under inquiry made up the panel. Based on the opinions offered by the expert panel, 10 questions have been selected from a total of 21 questions for the final interview from both professionals.

The participant's experience was taken before conducting the interviews. Most of the participants had the experience of 2 to 5 years with visually impaired children. While 57% of the special education teachers were females who are working at special centers. On the contrary, 87% of the speech therapists were females who were working with children with visual impairment.

Theme Analysis: Thematic analysis was conducted manually by two researchers. Eleven interrelated themes along with 15 and 12 subthemes were identified by special education teachers and speech therapists respectively about their perceptions regarding the role of speech therapists with visually impaired children.

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The special education teachers perceived that the speech therapists should provide guidance and be involved in the development of auditory and verbal skills. While few of them consider their strong role in developing receptive skills. Similarly, speech therapist perceived their strong role in alternative augmentative communication, auditory bombardment, and oral motor exercises with visually impaired children. While few of them consider their role in stammering, articulation, and voice disorder.

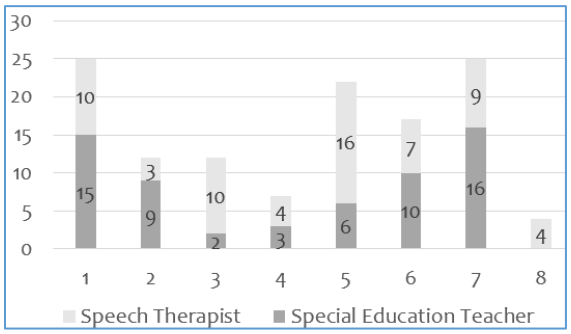

Figure 2: Experience of Professionals

Frequent Themes of Special Education Teachers

Theme 1: SLP help in Speech and Language Development: The special education teachers gave positive responses about the role of speech therapists. They suggested that children with a visual impairment might have the same language problems as sighted children. 4 out of 7 respondents gave suggestions that SLP should work on the child's receptive skills and others suggested that SLP should use drill and repetitive practices for the development of language skills.

Theme 2: Involvement of SLP in developing auditory-verbal skills: All special education teachers were positive about the role of SLP in developing literacy skills. One participant discussed about the SLP's role in schemas development and discrimination of the sounds. She reported that "children with visual impairment face issues in the development of these skills if their schemas would not develop properly. So, by making schemas and after developing fine motor skills, their literacy skills should be developed". Most of the respondents discussed the child's auditory-verbal skills through which an SLP could help children with visual impairment in developing literacy skills.

Theme 3: Modified Therapy Resources: Most of the participants suggested that the therapies should be modified and converted to tactile and auditory-based techniques. One of the participants discussed that therapy protocols should include "Poems, Listening, and drill method", while another participant responded that "Children with visual impairment can respond to tactile models so it should be included in therapies". One of the participants shared an example of teaching these children "If speech therapists want to teach them about sparrows, therapists should teach them through real sound of sparrows and other things". (table 1)

Frequent Themes of Speech Therapists

Theme 1: Atypical speech and language development with comorbidity: Most of the speech therapists shared their opinion that the difference can be seen if the child has multiple disabilities with visual impairment. One participant talks about a child's psychological state, due to which he can face the issue of stammering as seen in typical children. One participant discussed that the difference would always be seen because perception depends on our senses and the absence of vision makes our perceptions faulty.

Theme 2: Practice with the help of auditory and tactile sensations: Participants gave positive responses about the role of speech therapists. Some said that speech therapists should guide these children through auditory and listening skills. Some suggest that the tactile skills of children could also be used for the enhancement of the vocabulary of these children. One of the participants discussed that if these children have speech-related issues, the therapists will teach them through a tongue depressor if they want to teach them verbs like jumping then they can prompt them with tactile senses. Participants suggest that in social interaction speech pathologists can rehabilitate children with the help of their listening skills. They would provide auditory support through verbal instructions.

Theme 3: Factors affecting assessment and management" This theme was focused on analyzing those factors that could influence the SLP's decisions and interpretations. Most of them discussed that Visual impairment is itself a big factor that influences their decisions. Some talked about the caregiver support, and rapport building during sessions as a influencing factor. Two of the participants talked about the strengths and weaknesses of the child as an influencing factor in the assessment and management of the child during sessions. (table 2)

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Table 1: Perceptions of Special Education Teachers (Codes & Theme)

Sr. #	Codes	Subthemes	n	Themes	Example Quotes
1	Lack of resources	Scarce Resources	5	Academic progress requirements	*"In educational aspect, children with VI need attention." "Children with VI lack visual experience that's why they face career limitations." "They have lack of resources for their educational process, like we cannot provide them firsthand things so we can use embossed modeling"*
	Access to resources are difficult				
	Require specific tools	Need Specific Arrangements	2		
	Need for special setting/ environment				
	Need of training for professionals	Require Trainings	5		
2	SLP can help as like they help sighted children	Role Of SLP	6	SLP help in speech and language development	*"I cannot sign, so whatever I do, I use my language and power of speech for conveying my opinion." "Speech therapists are those who worked with the language development of children". "If they have issues related to language then drill method can be used with them. Repetitive use of tactile skills."*
	SLP can help as per requirement				
	SLP can help in language development more accurately as compared to SET				
	SLP should work on vocabulary				
	SLP can help through touch and listening				
	Drill method	Learning Practice/Rehearsals	4		
	Repetitive practice				
	Practice through exposure of natural things				
	Parent support should be strong during learning	Parental Support	5		
	Professional and parental support				
	Recognition of things through touch	Strong Receptive Skills	1		
	Receptively sharp without comorbidity				
	Clarity in words should be present while instructing the child				
3	Social communication is weak	Communication Gap	2	Lack of confidence / low self esteem	*"If their parent gave them exposure of educated people and guide them properly then they can communicate very nicely"*
	Low confidence while communicating others				
	Through vocal accent of others, visual impaired children can understand expressions	Prosody	1	Verbal and Nonverbal communication	*"Through accent they can access so many things in social communication but nonverbally they cannot communicate, if someone guide them then they can. In social communication they always need guidance"*
	They can understand by the tone of other individual/ verbal communication				
	They cannot communicate through gestures	Non-Verbal Communication	2		*"Those children who have acquire visual impairment, they have intact nonverbal communication and those who are visually impaired by birth totally depends on verbal communication."*
	Cannot communicate nonverbally				
	After guidance, sometimes can communicate through gestures but in rare cases				
	In different setting they can communicate but need guidance	Need Of Guidance	7		*"These children always need guidance in every situation like during azan time we guide them to stay quiet. They cannot anticipate things by themselves."*
	Without guidance they cannot communicate properly				
	Cannot anticipate by themselves				
4	Can acquire literacy skills with the passage of time after learning and practice	Use Of Auditory – Verbal Skills	7	Involvement of SLP In developing auditory verbal skills	*"Children with visual impairment are good listeners. They can recognize voices of people"." By simple instructions they cannot understand but with the addition of tactile they can understand best"*
	Schemas development				
	SLP can help in discrimination of sounds				
	Bombardment of nouns and then touch				
	If mental disability is present, then use auditory. skills				
5	Poems Musical therapy	Modified Therapy	7	Modified therapy resources	*"In intervention you should teach them through poems. Listen and repeat method should be used and if you further go for listening skills you follow listen and write listen and elaborate". "Speech therapists should work on guidance, listening and tactile senses. They should give them exposure of natural experiences. For example, if speech therapists want to teach them about sparrows, therapists should teach them through real sound of sparrows and other things."*
	Listening practice	Auditory Discrimination	2		
	Tactile modeling	Tactile Discrimination	5		
	Tactile Orientation should be provided				
	Original and tangible models should be provided				

Table 2: Perceptions of Speech Therapists (Codes & Themes)

o	Codes	Subthemes	n	Themes	Example Quotes
	Mostly they have issue only regarding to vision	No difference in speech development	2	Atypical speech and language development with comorbidity	*"Children with visual impairment had rare problems related to speech and language development."* *"As such no difference is seen because visual impairment didn't affect their language if the child has no other disability"*
	As such no difference is seen in speech development				
	In language development difference is seen if they have other disability	Difference in speech development with comorbidity	4		*"If the child is presented with multiple disorder, then we can say that there is a difference, but that difference would be according to the level of other disability".*
	Comorbidity with visual impairment mostly not properly diagnosed	Miss-Diagnosis	1		*"I observed that these children are not properly diagnosed with other disabilities"*
	Faulty perception due to Visual impairment	Misperceptions	1		-
	Audible prompts	Auditory perception	3	Practice with the help of auditory and tactile sensations	*"Speech therapists can also support them by enhancing their listening skills".* *"Speech therapists can use their therapies, but they cannot provide visual prompts, but they can give them audible prompts and tactile prompts."* *"Speech therapist can rehabilitate them through sense of touch and clear instruction".*
	Enhance listening skills				
	Clear instructions				
	Tactile prompts	Tactile sensations	3		
	Tactile modeling				
	Vocabulary enhancement	Auditory Bombardment	7		
	Rare oral difficulties	Poor oral motor musculature control	5	Oral motor musculature	*"I didn't see any vi child who has these types of difficulties because these problems arise with those children who have multiple disabilities."* *"If any physical issues arises or due to trauma or accident this difficulty may be occur just like in sighted children."* *"Sucking, chewing and swallowing problems are related to the individual's oral musculature and oral perceptions. It would be affected because whenever these children intake their food they would always be dependent on others"*
	Swallowing difficulty in down syndrome				
	If child has other disability, then these difficulties may be arisen				
	Physical disability				
	Oral motor exercises	Oral motor exercises	7		
	Home plans				
	Detailed Assessment needed	Screening and evaluation	5	Factors affecting assessment and management	*"In my opinion decision making process of SLP would automatically effect by this impairment."* *"Decision making depend on the assessment, your assessment should be strong enough if you are taking history of a child or building a rapport with the child then you would have definitely had idea about the problem of the child."* *"In decision making process we should make a triangle in which the therapist, parent and child should be involved"*
	Sometimes difficulty in vocabulary assessment (color recognition)				
	Rapport building	Professional assistance	4		
	Care giver support				
	Observation of SLP				
	SLP, parent and child make a triangle				
	Short comings of child	Strengths and weaknesses			
	Strengths				
	Attention of Child			-	
	Child with physical disability can use alternate mode of communication	Use of other mode of communication	8	Alternative Augmentative devices	*"With children with physical disabilities we might use AAC devices or other mode of communication."* *"We can modify our therapies by searching alternative ways which should be according to the requirements and beneficial for children with visual impairment"*
	High tech may be used but with children who have high socio-economic status				

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DISCUSSION

This study aimed to determine the perception of speech therapists and special education teachers about the role of speech therapists in children with visual impairment. The results of this study emphasize the value of early interventions and multidisciplinary strategies for helping children with visual impairment. The study suggested that speech therapists would have an indispensable role if children with visual impairment have speech and language problems.

The results of the current study indicated the limited resources in institutions, for children with visual impairment. Similar results were depicted in a study, conducted to determine the integration of children with visual impairment in a mainstream setting. In a study, 30 teachers and 40 pupils were interviewed. The results of that study concluded that the institutions had a lack of resources and untrained professionals (teachers) which influences the progress of children with visual impairment in academic settings [23]. Government should provide the required resources and tools for their academic progress. They should provide kits with repair facilities as well as laboratories. Devices should also be presented for children with visual impairment in a wide range.

Current study indicates that speech therapists can help children with visual impairment speech and language development by providing tactile cues. A study was published in which the purpose of the study was to introduce different ways of communication (the use of tactile modeling) in which multiple disabled sighted children and children with visual impairment were included. Training was given to these children for a period. For instance, therapists said that it was time for music and cued them tangible for the activity. Therapists allowed them to explore objects with tactile sense. Results indicated that children with mild and moderate multiple disabilities along with visual impairment learned with the help of tangible cues[24].

In a current study, professionals suggested that for intervention of children with severe visual impairment, speech therapists should use alternate modes of communication. One participant suggested the use of augmentative and alternative devices for language development. Similarly, study results indicated that the participants gained benefits from the use of alternative modes of communication and improved the development of literacy skills[25].

In the current study, professionals also discuss the role of speech therapists in enhancing the auditory or listening skills of children with visual impairment. In a study, it was highlighted that learning to listen or auditory reading plays an important role in children with visual impairment. They can identify different sounds along with physical exposure and label the objects or sounds easily[26].

Visual impairment restricts the child's accessibility to non-verbal communication which hinders their social interaction with others. Due to this children with visual impairment have low confidence and weak social communication skills. Similarly, a study was conducted to determine the language and social communication of children with visual impairment which concluded that children with visual impairment may face difficulties in socio-communication and pragmatic language [13]. At this point, professionals and caregiver support is very important for children with visual impairment. Children, parents, and professionals should make a triangle in which they work in collaboration.

So, the current study showed positive results about the role of speech therapists in children with visual impairment. After getting the professional's perceptions and collecting evidence it was concluded that children with visual impairment need professional support in their speech and language development. In the future, the perception of parents and psychologists about the role of speech therapists should also be included who have children with visual impairment. Studies can be conducted to find out the barriers regarding the speech and language assessment and management of visually impaired children.

CONCLUSION

This study revealed that the professionals emphasized the role of speech therapists in children with visual impairment. Most of the professionals encouraged the speech therapist's role by suggesting developing modified therapy techniques which should include auditory-tactile models. They also highlighted the lack of resources in the development of children with visual impairment. Speech therapists should also provide services regarding language development as they provide to the sighted children.

DECLARATIONS & STATEMENTS

Author's Contribution

JG: substantial contributions to the conception and design of the study.
JG: acquisition of data for the study.
JG and TI: interpretation of data for the study.
TI: analysis of the data for the study.
TI and MNK: drafted the work.
MNK: revised it critically for important intellectual content.
MNK: final approval of the version to be published and agreement to be accountable for all aspects.
of the work in ensuring that questions related to the accuracy or integrity of any part of the work are

appropriately investigated and resolved. All authors contributed to the article and approved the submitted version.

Ethical Statement

The study was conducted after approval from the Research Ethical Committee of Riphah International University Islamabad (with Ref # Riphah/RCRS/REC/01339). Data was coded for confidentially. No physical or psychological harm was caused to any participant.

Consent Statement

Written consent was obtained from participants and schools.

Data Availability Statement

Data can be provided by the corresponding author if needed.

Conflicts of Interest

There is no conflict of interest associated with this publication.

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Research Article

Dynamic stretching versus Plyometric push Training on upper body performance in cricketers

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ABSTRACT

Background: The cricketers may enhance their upper-body performance through dynamic stretching and plyometric push-up training. For tasks specific to cricket, plyometric push-up training promotes explosive strength and power, while dynamic stretching enhances flexibility, muscle activation, and coordination.

Objective: To compare the effects of dynamic stretching and plyometric push-ups on upper body performance tests in cricketers.

Methodology: A randomized control trial was conducted in which initially n=22 cricketers were enrolled. Out of them, two participants dropped out of the study after two weeks due to which a total number of n=20 participants participated in the six-week study. Participants were divided into two groups, one group performed upper body dynamic stretching exercises along with their usual warm-up routine and the other group did plyometric push-ups along with some variation of exercises. They performed the exercises for three days a week on alternate days. Upper body fitness tests were performed, i.e. one arm tests, Upper quadrant Y- y-balance test, and Medicine ball throw tests every week to gather data regarding participants' upper body fitness.

Results: there was no significant difference (p≥0.05) between the groups from the baseline to the 6th week in all variables except in upper quadrant Y balance tests left hand showed significant improvement (p=0.01) at the end of the 6th week. While in the one-arm hop test was not comparable at baseline due to a significant difference, so compared the mean of mean difference, which was also not statistically significant (4.18±0.79 vs 4.03±0.67, p=0.65).

Conclusion: The study concludes that both dynamic stretching and plyometric push-up exercises showed equal effects upper body performance among cricketers.

Keywords: dynamic stretching; plyometric push-up; upper body performance.

ClinicalTrials.gov Identifier: NCT05516706

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INTRODUCTION

Cricket is one of the popular and oldest noncontact bat and ball sports, which engages the players in running, throwing, and catching during bowling, fielding, wicket keeping, and batting these things make an athlete more prone to the risk of overuse and impact injuries to the head, back, upper, and lower extremities [1, 2]. The efficacy and capability of the upper limb in carrying out different movements necessary for cricket, like batting, bowling, throwing, and fielding is referred to as performance. It includes factors like power, strength, endurance, flexibility, and coordination [3]. Increased upper limb performance is essential for producing bat speed, accurate bowling, precise throwing, and quick fielding movements, all of which have a significant effect on a player's overall performance on the field[4]. Training programs that concentrate on upper limb performance seek to maximize these attributes, which will enhance a cricket player's capacity to carry out crucial movements and achieve success in the game [5].

Plyometric and dynamic stretching exercises are the exercises that help fulfil the demands placed by a game on an athlete. Plyometrics involve a sudden stretching of eccentric (lengthening) load of muscle followed by a concentric (shortening) action of the same muscle and connective tissue. Plyometric exercises involve skips, hops, jumps, throws, and bounds. All these exercises improve the agility of an athlete, which is defined as the capability of a body to diligently change the position and direction of a body and move towards another position [6-8]. At first plyometric exercises were used for the enhancement of sports performance and rehabilitation of sports injuries numerous sports performance [9]. Different types of plyometric exercise with diverse levels of intricacies in the musculoskeletal system are applied in rehabilitation [10, 11].

Dynamic stretching is a type is stretching that is applicable at both physical and functional levels in preparation for a sporting activity it gives considerable results in the enhancement of sprinting speed, power, and force[12, 13]. Proprioceptive Neuromuscular Facilitation is a flexibility training that is proven to be effective in active and passive range of motion exercises [13, 14].

A vast amount of work can be found on the effect of plyometric exercises on lower body performance while a scant amount of literature was found on the enhancement of upper body performance by including plyometric training exercises as well as dynamic stretching exercises. Because cricket requires certain upper body movements, training techniques that mimic these motions are necessary for maximum adaptation. The goal of plyometric push-up training is to improve upper body power by emphasizing explosive movements. On the other hand, dynamic stretching may not fully address overall performance even while it increases flexibility. Cricket players in Pakistan don't follow a set training schedule. To help with well-informed training decisions across the nation, this study compares the effectiveness of these two approaches on upper body performance in cricket players.

METHODOLOGY

Study Design: A randomized clinical trial (NCT05516706) was conducted at Quaid-e-Azam University Sports Club Islamabad, Pakistan, for a time duration of 6 weeks i.e. from 3rd January to 13th February 2022. The study was initiated after approval from the Institutional Review Board and Ethics Committee of Quaid-e-Azam University (IRB #. D.S/2021-126). Written informed consent was taken from the participants before the study.

Participants: A total number of n=22 participants of Quaid-e-Azam University, Islamabad who fulfilled the inclusion criteria were recruited in the current study through a nonprobability convenient sampling technique. The inclusion criteria were male cricket players, who were currently playing cricket on the field, aged between 18 to 25 years. However, cricketers with a history of musculoskeletal injuries i.e. fracture, sprain, or strain were excluded from the study. The participants were randomly divided into two groups i.e. group A received dynamic stretching exercises (n=10); group B received plyometric push-up exercises (n=10). There were two dropouts from each group in the study, due to the inability to come for follow-up training and assessment after the second week. (Figure 1)

Randomization: Random allocation of the participants was done through the coin toss method in which the subjects tossed a coin in the air. Heads mean the subject was allocated in group A (dynamic stretching group) and tail meant the subject to be allocated in group B (Plyometric push up). It was a single-blind in which the participant was kept blinded by the intervention. Informed consent was given to the participant and were guided about their participation in the research study.

Intervention: All participants received a total of 18 sessions, 3 sessions were performed a week for 6 weeks. Each session lasted for 20-25 minutes. Before the training, all participants were explained and taught the exercises that they were going to perform in their training session.

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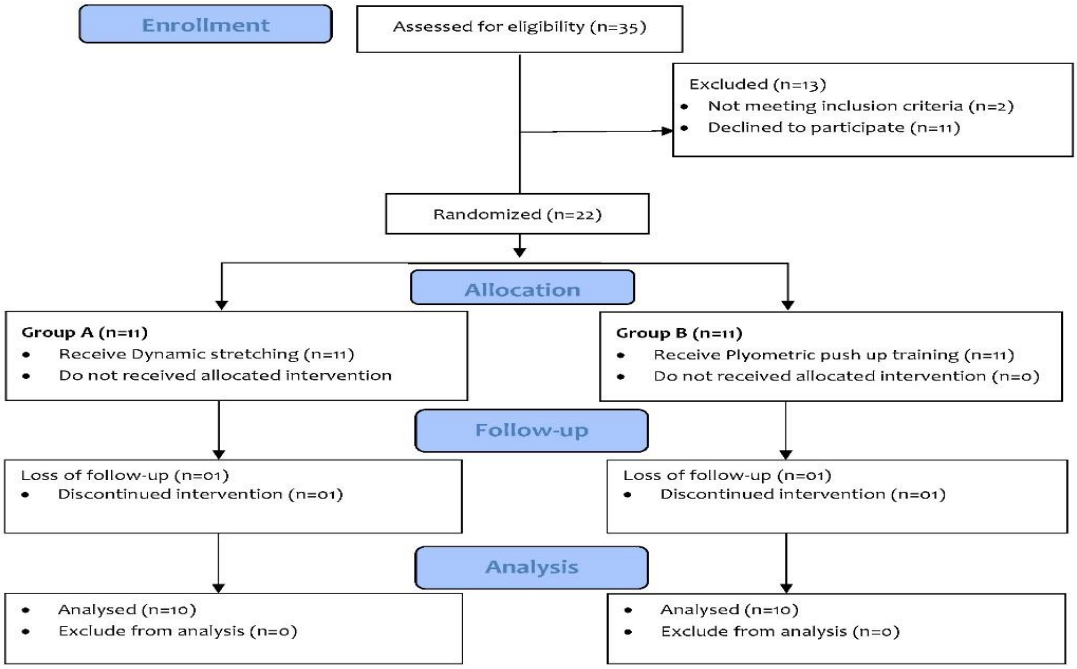

Figure 1: CONSORT diagram

Group A (Dynamic stretching): Participants in this group performed 10-minute warmup followed by 15 minutes of dynamic stretching exercises i.e. arm cross-over, Walking lunges, Upper body twist, Cat cow pose, Rotator cuff movements, Scapular retraction, Pectoral mobility with dowel,

Table 1: Detailed description of 6-week dynamic stretching

Week	Dynamic Stretching	Repetition and sets
1	Arm cross-over(side/front) Walking lunges Upper body twists Cat cow pose Scapular scaption	3 X10
2	Arm cross-over(side/front) Walking lunges Upper body twists Cat cow pose Scapular scaption	3 X10
3	Arm cross-over(side/front) Walking lunges Upper body twists Cat cow pose Scapular scaption Rotator cuff movements using Thera band	3 X11
4	Arm cross-over(side/front) Walking lunges Upper body twists Cat cow pose Scapular scaption Rotator cuff movements	3 X12
5	Arm cross-over(side/front) Walking lunges Upper body twists Cat cow pose Rotator cuff movements Scapular retraction Pect mobility with dowel	4X10
6	Arm cross-over(side/front) Walking lunges Upper body twists Cat cow pose Rotator cuff movements Scapular retraction Pect mobility with dowel	4X11

Group B (Plyometric push-up): Participants of this group performed 10 minutes of warm-up followed by plyometric push-up exercises (table 2)

Plyometric Push-up: Plyometric push-up was performed with the participant in plank position in which the participant was prone facing the group with his body weight supported on both hands and feet with back straight. The participant started by pushing his body forward by flexing his elbows coming up with a jump in his upper body clapping his hands and then coming back to the starting position and repeating the exercise.

One Arm Plyometric Push-up: One arm plyometric push-up was performed with the participant in plank position. Participant kept one hand on his back with his body weight supported on both feet and one hand. The participant started by pushing his upper body forward and coming back with a jump repeating the same procedure for the arm.

Depth Push-up: Participants began by placing two six-inch blocks shoulder-width apart. The participant should be in plank position and initiate the exercise by bending his elbows and pushing his body forward while straightening his elbows the participant placed both his hands on the block come back to start, and repeat the procedure.

Arm Cross-Over: Arm cross-over was performed with a participant in a standing position with feet shoulder-width apart. Keeping his back straight participants crossed his arm and brought it back as far as possible stretching his chest and arm.

Walking Lunges: Walking lunges were performed with the participant stepping forward

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putting weight on the forward leg pausing for one second and then coming backward.

Cat-Cow Pose: Participants began the exercise in a quadrupled position with their body weight supported in both hands and knees during inhalation he raised his back while in exhalation he curved his back inward.

Scapular Scaption: Scapular scaption was performed with a participant in a standing position with his back straight and feet shoulder-width apart he began to lift both arms to shoulder level with his thumb facing upward.

Rotator Cuff Movements using Thera band: Participant began with standing positioning his feet shoulder width apart with medium resistance Thera-band in his hands doing rotator cuff movement i.e. Abduction, internal and external rotations. (table 2)

Table 2. Detailed description of 6-week plyometric training

Weeks	Plyometric exercises	Repetitions and sets
1	Warm-up Plyometric push-up	3 X10
2	Warm-up Plyometric push-up	3 X10
3	Warm-up Plyometric push-up One arm plyometric push-up	3 X11
4	Warm-up Plyometric push-up One arm plyometric push-up	3 X12
5	Warm-up Plyometric push-up One arm plyometric push-up Depth push-up	4X10
6	Warm-up Plyometric push-up One arm plyometric push-up Depth push-up	4X11

Outcome Measures: The tests used to assess upper body performance were the One arm hop test, Upper quadrant Y balance test, and Medicine Ball throw test all these tests have good reliability. One arm hop test was used to assess upper body stability, power, and strength. Upper Quadrant Y balance strength was used to assess upper body stability and mobility while 3 Kg Medicine ball throw was used to assess upper body power and strength. Data was collected on the baseline, after 3rd week, and after 6th week by a physiotherapist.

Statistics*:* For gender and age frequency and mean ± SD were calculated. The normality of data was tested through the Shapiro-Wilk test according to which all variables were normally distributed except the One Arm Hop Test Non-Dominant Hand that's why the parametric test was applied to variables. For within-group analysis repeated measure ANOVA with pairwise comparison was applied. Independent test was used for between-group analyses. As the One Arm Hop Test Non-Dominant Hand was not comparable at the baseline Mean of the mean difference was compared. The level of significance was set at $p<0.05$, and SPSS ver 22 was used for data analysis.

RESULTS

The mean age of the study participants is 21.1 ± 2.02 years. The mean BMI was 20.03±1.65 kg/m^2 repeated measure ANOVA test was applied for the within-group analysis while an independent t-test was used for the analysis of between-group analysis.

As the sphericity was not assumed, the repeated measure ANOVA with the greenhouse Geisser effect showed that within-group changes were significant ($p<0.001$) in groups A and B from baseline to 6th week at each level of assessment. (table 3)

Table 1: Within-group comparison

		Group A (Dynamic stretching)				Group B (Plyometric push-up)			
		Mean	SD	MD/ F(df)	p-value	Mean	SD	MD/ F(df)	p-value
One Arm Hop Test Dominant hand (Sec)	week 0	15.30	1.85	1.49	[a]0.00***	15.50	0.70	1.73	[a]0.00***
	After 3rd week	13.57	1.65	2.56	[b]0.00***	14.01	0.69	2.44	[b]0.00***
	After 6th week	11.13	1.19	1.04(9.40)	[c]0.00***	11.45	.73	1.21(10.92)	[c]0.00***
One Arm Hop Test Non-Dominant Hand (Sec)	week 0	17.00	0.94	1.48	[a]0.00***	17.07	2.22	1.67	[a]0.00***
	After 3rd week	15.52	0.91	2.70	[b]0.00***	15.40	2.11	2.36	[b]0.00***
	After 6th week	12.82	0.93	1(9.07)	[c]0.00***	13.04	1.72	1.51(13.65)	[c]0.00***
Medicine Ball Throw Test (Inches)	week 0	50.62	7.08	-3.12	[a]0.00***	55.47	8.16	-4.63	[a]0.00***
	After 3rd week	55.25	6.66	-3.44	[b]0.00***	58.59	8.46	-5	[b]0.00***
	After 6th week	60.25	6.54	1.06(9.55)	[c]0.00***	62.03	8.59	1.36(12.23)	[c]0.00***
Upper Quadrant Y Balance Test Right hand (cm)	week 0	30.25	1.06	-2.95	[a]0.00***	29.20	2.40	-4.48	[a]0.00***
	After 3rd week	33.20	1.31	-3.13	[b]0.00***	33.68	3.26	-4.61	[b]0.00***
	After 6th week	36.33	1.26	1.51(13.59)	[c]0.00***	38.29	4.01	1.09(9.86)	[c]0.00***
Upper Quadrant Y Balance Test Left hand (cm)	week 0	29.71	1.52	-2.79	[a]0.00***	29.22	1.37	-4.50	[a]0.00***
	After 3rd week	32.50	1.40	-2.86	[b]0.00***	33.72	2.01	-4.45	[b]0.00***
	After 6th week	35.36	1.31	1.32(11.89)	[c]0.00***	38.17	3.19	1.03(9.32)	[c]0.00***

Significance Level: p<0.05, p<0.01**, p<0.001***.*
[a] baseline to 3rd week, [b] 3rd week to 6th week, [c] baseline to 6th week

For between the group comparisons, there was no significant difference ($p\geq0.05$) between the groups from the baseline to the 6th week in all variables except in upper quadrant Y balance tests

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left hand showed significant improvement (p=0.01) at the end of the 6th week. While in the one-arm hop test was not comparable at baseline due to a significant difference. So compared the mean of mean difference, was also not statistically significant (4.18±0.79 vs 4.03±0.67, p=0.65). (table 4)

Table 2 Between-group comparisons

		Group A (*Dynamic stretching*)		Group B (*Plyometric push up*			
		Mean	SD	Mean	SD	M.D	p-value
One Arm Hop Test Dominant hand (Sec)	week 0	15.30	1.85	15.50	0.70	0.20	0.08
	After 3rd week	13.57	1.65	14.01	0.69	0.44	0.18
	After 6th week	11.13	1.19	11.45	0.73	0.32	0.19
One Arm Hop Test Non-Dominant Hand (Sec)	week 0	17.00	0.94	17.07	2.22	-0.07	0.005**
	After 3rd week	15.52	0.91	15.40	2.11	0.12	0.01*
	After 6th week	12.82	0.93	13.04	1.72	-.220	0.03*
Medicine Ball Throw Test (Inches)	week 0	50.62	7.08	55.47	8.16	4.85	0.48
	After 3rd week	55.25	6.66	58.59	8.46	3.34	0.36
	After 6th week	60.25	6.54	62.03	8.59	1.78	0.34
Upper Quadrant Y Balance Test Right hand (cm)	week 0	30.25	1.06	29.20	2.40	1.05	0.08
	After 3rd week	33.20	1.31	33.68	3.26	-0.48	0.11
	After 6th week	36.33	1.26	38.29	4.01	-1.96	0.05
Upper Quadrant Y Balance Test Left hand (cm)	week 0	29.71	1.52	29.22	1.37	0.49	0.77
	After 3rd week	32.50	1.40	33.72	2.01	-1.22	0.20
	After 6th week	35.36	1.31	38.17	3.19	-2.18	0.01*

Significance Level: p<0.05, p<0.01**, p<0.001****.

DISCUSSION

The objective of this study was to determine the effects of dynamic stretching and plyometric push-up training on upper-body performance tests in cricketers. The within-group comparison showed significant improvement in the results in both the Dynamic stretching group and the plyometric push-up group. While comparative analysis of the group revealed that no significant difference in all variables except in the Upper Quadrant Y Balance Test Left hand.

The participants who performed plyometric training showed improved, power, strength, and stability. A previous study in which the effect of plyometric training on muscle power and athlete's performance was done also showed an increase in muscle power and ball throw velocity [15]. A study by Vossen JF in which the comparative effect of plyometric push-ups and dynamic push-up training was observed for six weeks showed more significant results in the plyometric push-up group in the medicine ball put to test (p<0.05) [16]. Improved results in the plyometric training group may have occurred due to its physiological effects on both structural and neurological levels. The performance enhancement could have been visible due to improvement in physical function. At the neurological level, increased neural drive to agonist muscle and changes in muscle activation occur as a part of physiological adaptations [17, 18].

Improvement in the medicine ball throw test could have occurred due to enhanced throwing velocities due to increased peak power output in the upper extremity, it could have been caused by to possible increase in the cross-sectional area of fast twitch fiber along with neural activation, changes in intrinsic muscle properties, improved synchronization of motor units, increased firing frequency[19, 20].

In plyometric push-up training as the muscle undergoes an eccentric movement followed by a rapid concentric movement, the stored elastic energy emits additional force to facilitate muscle contraction due to the stretch reflex the additional force production is proportionate to the rate of the stretch rather than the amount of stretch applied [21]. It has been seen in previous literature that the muscle tendon complex stretch phase activity is the causative factor for change in tendon length which leads to change in muscle length [22].

Participants also showed improvement in dynamic balance which was seen in upper quadrant Y balance test results and one arm hop test. Cagri Guzelsoy did a study on volleyball players to see the effect of plyometric training on speed and dynamic balance and showed a significant difference in the speed and dynamic balance (p<0.05) of the volleyball players [23]. A study by Ramerriz Campillo et al. which commenced a six-week plyometric training program on young soccer players showed that anteroposterior and Medio lateral balance was improved by plyometric training (p ≤ 0.05), As balance is controlled by coordinated movement of brain muscle nerves and joint receptors. The enhancement in balance could have occurred due to changes in neuromuscular and proprioceptive control or co-contraction of muscles[24]. Proprioceptive control is described as a specialized type of sensation of touch that controls the sensation of joint position and joint movement i.e. kinesthesia while neuromuscular control is an innate efferent motor response to afferent sensory i.e.

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proprioceptive stimulus[25]. Co-contraction of muscles can be described as a sudden muscle activation on the opposite side of the joint [26]. All these mechanisms work in combination to provide movement accuracy and stability of joint and body positioning which result in improved balance and stability and decreased chances of injury.

The within-group analysis also showed the dominant showed more significant improvement than the non-dominant hand. This could have occurred due to repeated use of the dominant hand and shoulder for bowling and batting. In a study of junior tennis players results showed that a high level of isokinetic strength and the average internal rotation peak torque was higher in the dominant hand as compared to non - the dominant hand. A significant difference was found in dominant and non-dominant hands [27].

On the other hand, the Dynamic stretching group also showed improvement from the third to sixth week, research participants who performed dynamic stretching showed improved Range of Motion, balance, and flexibility. A study was conducted in which the acute effect of static and dynamic stretching on balance agility reaction time and movement time was observed on thirty-one female high school athletes showed that the Dynamic stretching group had improved agility and balance and enhanced upper body movement as compared to the Static stretching group. This enhancement could have occurred due to increased electromyography amplitude[28].

A study done by Brad S. Curry to assess the acute effect of dynamic stretching, static stretching, and light aerobic activity on muscular performance in women showed that the dynamic stretching group had enhanced power which led to enhanced muscle performance as compared to the static stretching group [29]. The improvement could have occurred due to physiological changes which led to improved speed of impulse conduction, neuromuscular facilitation, and receptor sensitivity [30]. Neuromuscular facilitation is the best technique used for muscle strengthening it's a string of movements that leads to the activation of neurological and muscular function it also facilitates in stretching of shortened soft tissues which leads to improved muscle strength and function [31].

Between-group comparisons the results only showed a significant difference in, the upper quadrant y balance test while a non-significant difference was found in the medicine ball throw test and one arm hop test dominant hand two groups which means both groups had similar effectiveness regarding these two tests. The ability of these tests to recognize variations or differences in outcome measures may vary. Between the medicine ball throw test and one arm hop test, the upper quadrant Y balance test may be more sensitive to detect the changes in the balance performance of the intervention under study [32].

Both dynamic stretching and plyometric push-up training were found to be equally helpful in improving upper body performance in test cricket players' upper limbs. The comparatively small sample size of 22 participants is one factor that could be responsible for the lack of significant changes; a bigger sample size may show more subtle variations. The intervention's six-week duration may have been insufficient to produce detectable differences; a longer time frame would have been beneficial. Variations in cricket players' individual fitness levels and training responses could potentially conceal disparities.

CONCLUSION

The study concludes that both dynamic stretching and plyometric push-up exercises showed equal effects on upper body performance among cricketers. Further research with a larger sample size and prolonged follow-up of at least for 12 weeks are recommended to see differences in the efficacy of these training programs.

DECLARATIONS & STATEMENTS

Author's Contribution

MS: substantial contributions to the conception and design of the study.
MS and AA: acquisition of data for the study.
AA and AA: interpretation of data for the study.
AA: analysis of the data for the study.
SA: drafted the work.
MS, AA, AA, and SA: revised it critically for important intellectual content.
MS, AA, AA, and SA: final approval of the version to be published and agreement to be accountable for all aspects. Of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All authors contributed to the article and approved the submitted version.

Ethical Statement

The study was initiated after the approval from the Institutional Review Board and Ethics Committee of Quaid-e-Azam University (IRB #. D.S/2021-126).

Consent Statement

The written informed consent was obtained from participants in the study.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data is not publicly available due to privacy or ethical restrictions.

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Conflicts of Interest

The authors declare no conflict of interest.

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Research Article

Effects of high-intensity interval training on cognitive flexibility among female teenagers

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Abstract

Background**:** Teenage is an important stage for brain development, with significant impacts on education and health. Exploring how high-intensity interval training (HIIT) affects cognitive function in this population is crucial to comprehending how HIIT can improve general well-being and academic performance.

Objective**:** To determine the effects of high-intensity interval training on cognitive flexibility among female teenagers

Methodology**:** A randomized clinical trial was conducted on n=40 female participants between 13-19 years without any serious medical, physical, and psychological illness for 6 months. All participants (n=40) were randomly divided into experimental (HIIT) and control groups equally. The protocols were performed in 4 mins in the first three weeks, 8 mins in the 4th to 6th week, and 12 mins in the 7th and 8th week, with sessions thrice a week. Data on cognitive flexibility was collected at baseline, after 4th week and 8th week from both groups through Digit Span (DST).

Results: With-in group analysis the experimental group showed significant improvement ($p<0.001$) at each level of assessment of DST (forward and backword) till the 8th-week session with large effect size whereas the non-significant improvement ($p\geq0.05$) has been observed in control group. For between Group Analysis, significant results ($p<0.001$) were obtained in experimental group for DST (forward and backward) after 4th week and at the end of intervention after 8th week as compared to control group.

Conclusion: It is concluded that the high-intensity exercise training program is beneficial for female teenagers to enhance their physical strengthening along with their cognitive abilities.

Keywords: cognitive flexibility; digit span; exercise, high-intensity interval.

ClinicalTrials.gov Identifier: NCT05873478

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INTRODUCTION

Cognitive flexibility is the ability to adapt one's cognitive processing strategies to new and unexpected environmental situations. [1, 2]. Automating skills is the primary objective of most skill training programs to expedite performance and free up cognitive resources for other task demands. Automation of skill can, however, be linked to cognitive rigidity and mistakes in performance[3, 4]. Different training programs have therefore been put forth to address performance issues brought on by automation and high-interval training programs help to achieve automation with the best results among different training programs [5].

Enhancing cognitive function has positive benefits on the body and mind of women since it is linked to increased resistance training and physical activity levels [6]. The higher incidence of mental health problems that manifest in adolescence may also be attributed to the loss in physical activity. It has been proposed that girls' cognitive performance may be enhanced by completing a high-intensity interval training program[7].

For both athletic and general/recreational populations, high-intensity interval training is currently highly advised, with the main goal being the improvement of aerobic power[8] In order to improve young people's physical health, high-intensity interval training (HIIT) has become a viable and effective approach [9, 10]. Vigorous-intensity exercise enhances cognition more than moderate- and light-intensity exercise, according to recent systematic evaluations conducted on school-aged kids [11].

Females show lacking in verbal communication, perceptual or thinking speed, accuracy, and fine motor skills. In terms of assertiveness, stress tolerance, and self-esteem or confidence, men tend to score higher than women. This shows that emotional intelligence may be a factor in the gender gap in leadership. In the workplace, these distinctions frequently favour men and disadvantage women [12].

As physical fitness levels are associated with improved cognitive performance[6] and there is limited literature on high-intensity interval training for female teenagers for improving cognition between the age group of 13 to 19 years. Therefore, the purpose of this study is to evaluate the effect of 8 weeks of high-intensity interval training on cognitive flexibility in female teenagers in a specific age group to overcome deficits further.

METHODOLOGY

Study Design: A randomized clinical trial (NCT05873478) was conducted at the Royal Institute of Physiotherapy and Rehabilitation Sciences (RIPRS/20220716-1), Hidayat campus Sukkur, Pakistan, for a time duration of 6 months from July 2022 to December 2023. The study was initially approved by research and ethical committee (REC) of Riphah International University, Islamabad (Riphah/RCRS/REC/Letter-01497). Written informed consent was taken from the students and as well as from their parents before the study.

Participants: the inclusion criteria were teenage females (13 to 19 years of age) without any serious medical illness whereas those with physical or psychological illness were excluded from the study.

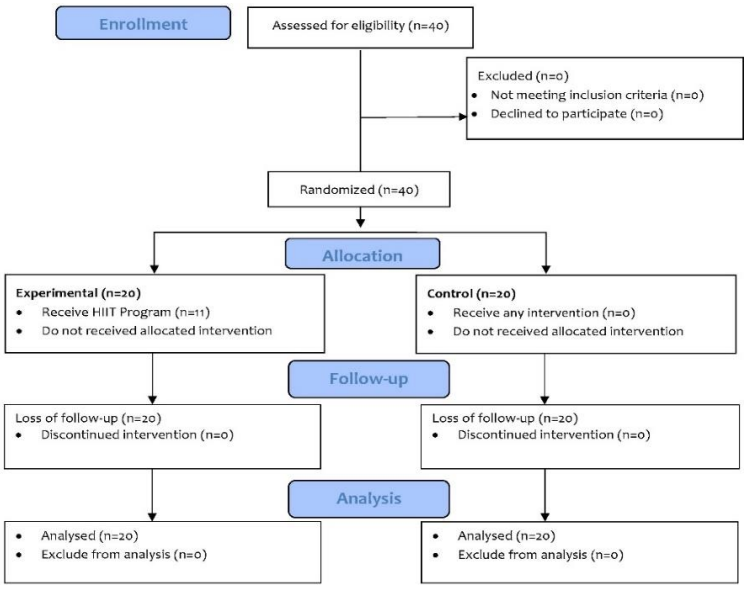

Figure 1: CONSORT Diagram

Sample Size: Using G power, a sample size of n=40 was determined, with an α error margin of 0.05 and a small effect size of 0.25. To mitigate the risk of β mistake, a power (1-β) of 0.93% was chosen. The participants were randomly divided into two groups i.e., the Experimental group (n=20) and the Control group (n=20) (Figure 1).

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Randomization: A computerized random number generator was used to randomly choose the participants using the sealed envelope approach. A person not directly involved in the study completed the random assignment sequence. Prior to the investigation, sequential random numbers were written on index cards and put in thick, opaque sealed envelopes. The treating physiotherapist opened the envelope and administered the appropriate intervention to the patient after getting approval from the participants' legal guardians or next of kin. The evaluating physiotherapist was unaware of the participant's intervention, so the trial was single blinded.

Intervention: The HIIT sessions ranged from 4-12 minutes in duration for 8 weeks in which three sessions were conducted each week (weeks 1-3: 4 minutes; weeks 4-6: 8 minutes; weeks 7-8: 12 minutes respectively), with a work to rest ratio of 30sec: 10sec, as mentioned in table 1. The experimental group/HIT group engaged in their HIIT sessions (inclusive of a short warm-up activity including dynamic exercises i.e., walking/running, 8-10 minutes of HIIT, and cool down which includes static exercises i.e., shoulder and hip muscle stretches). Session duration and intensity were increased with weekly progression in intervention groups. The high-resistance training sessions were delivered by the researcher to the HIT group, as mentioned in Table 1

Experimental Group: High-Intensity Interval Training (HIIT): Participants complete HIIT sessions that include bodyweight resistance training exercises (e.g., walking lunges, walk sit, sprinting in place, planks, and jumping jacks & skipping, etc). For example, the HIIT work phase includes the following sequence of resistance exercises (30-second walking lunges, 10-second rest then 30-second sprinting in place, 10-second rest & 30-second planks, 10-second rest intervals, etc.) All the exercises as mentioned in Table 1, were performed by the participant beginning with low-intensity exercise and then progressing to high-intensity training from week 1 to week 8, in this pattern repetition and sets increase every week, with 10-sec rest duration required after every set and proper warm up and cool down is mandatory for every session. Progression in repetition sets in every week with 10-sec rest after every session, 10 minutes warm up & cool down following 3 sessions per week

Control Group: Participants in the control group were not bound to do any specific activity; they all were engaged in normal daily routines.

Table 1: Detail Intervention Protocol (High-intensity training)

Weeks	Time (min.)	HIIT	Repetition and sets	Intensity
1st week	4 minutes for each Exercise	Walking Lunges	15X2	Low intensity
		Wall Sit	15X2	
		Sprinting In Place	15X2	
		Ankle Hoops	15X2	
2nd week		Walking Lunges	20X2	Low to medium
		Wall Sit	20X2	
		Sprinting In Place	20X2	
		Ankle Hoops	20X2	
3rd week		Walking Lunges	30X2	Medium
		Ankle Hoops	30X2	
		Sprinting In Place	30X2	
		Planks	30x1	
4th week	8 minutes for each Exercise	Walking Lunges	30X2	Medium
		Box Jump	40X2	
		Sprinting In Place	40X2	
		Planks	50x1	
5th week		Walking Lunges	40X2	Medium to High
		Box Jump	40X2	
		Sprinting In Place	40X2	
		Planks	60x1	
6th week		Walking Lunges	40X2	Medium to High
		Box Jump	40X2	
		Jump Squats	60X2	
		Planks	60x1	
7th week	12 minutes for each Exercise	Walking Lunges	60X2	High
		Box Jump	60X2	
		Jump Squats	60X2	
		Planks	60x1	
		Alternate Lunge Jumps	40X2	
8th week		Walking Lunges	60X3	High
		Box Jump	60X3	
		Jump Squats	60X3	
		Planks	60x2	
		Alternate Lunge Jumps	40X3	

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Outcome Measures: Digit Span (DST) was used for the assessment of female teenagers' cognition during training. Digit Span (DGS) is a measure of verbal short-term and working memory that can be used in two formats, Forward Digit Span and Reverse Digit Span. This is a verbal task, with stimuli presented auditory, and responses spoken by the participant and interpreted accordingly [13]. Reliable Digit Span Cutoff Scores of ≤7 and ≤6 From the Personal Database show 90% and 88% specificity in 10 to 12 years of age [14].

Statistics: For the interaction effects, mixed ANOVA was analyzed. the main effects were measured through Repeated measures ANOVA for with-in group changes along with pairwise comparison and independent t-test used for between the group differences in the DST score. The data was analyzed by using SPSS version 21. The $p<0.05$ was considered a statistically significant.

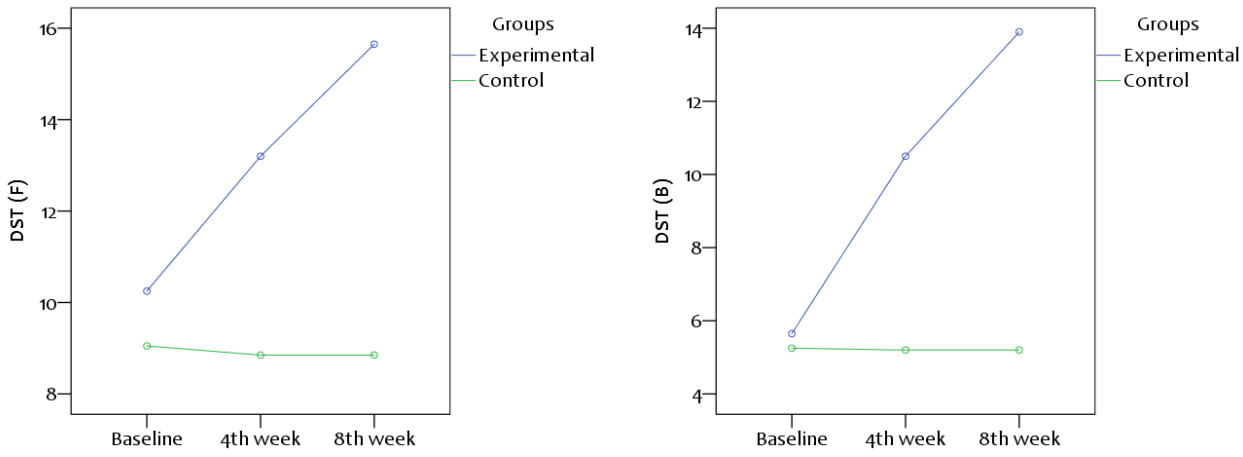
RESULTS

A total of n=40 female teenage participants with the Mean age was 17.37±.89 years. All participants were in normal BMI range with mean BMI of 20.10±0.99 kg/m^2.

As the sphericity was not assumed, the Greenhouse-Geisser values showed that there is a significant interaction effect between interventions and time factor for DST (Forward) {$F= 140.26(1.72,64.68)$, $p<0.001$, $\eta p^2=.787$} as well as for DST (Backward) {$F= 54.59(1.38,52.63)$, $p<0.001$, $\eta p^2=0.59$}. (Figure 2)

In the With-in group analysis the experimental group showed significant improvement ($p<0.001$) at each level of assessment of DST (forward and backword) till the 8th-week session with large effect size whereas the non-significant improvement ($p\geq0.05$) has been observed in control group. (Table 2)

For between Group Analysis, an independent t-test was run and significant results ($p<0.001$) were obtained in experimental group for DST (forward and backward) after 4th week and at the end of intervention after 8th week as compared to control group. (table 3)



a: Forward **b: Backward**

Figure 2: Interaction Effect Between Intervention and Time Factor

Table 2: Repeated Measure (Within Group) For DST

			Mean	SD	MD/$F_{(df)}$	p-value	ηp^2
Digit span forward test	Experimental	Baseline	10.25	2.04	-2.950	0.001[a]**	0.73
		4th week	13.20	1.82	-2.450	0.00[b]***	
		8th week	15.65	.58	$52.30_{(1.38, 26.25)}$	0.00[c]***	
	Control	Baseline	9.05	1.90	0.20	0.31[a]	0.133
		4th week	8.85	2.00	0.00	1[b]	
		8th week	8.85	2.00	$2.92_{(1,19)}$	0.104[c]	
Digit Span Backward test	Experimental	Baseline	5.65	1.69	-4.850*	0.00[a]***	0.88
		4th week	10.50	2.11	-3.400	0.00[b]***	
		8th week	13.90	.30	$150.11_{(1.69,32.13)}$	0.00[c]***	
	Control	Baseline	5.25	1.99	0.05	1[a]	0.005
		4th week	5.20	1.82	0.00	1[b]	
		8th week	5.20	1.82	$0.08_{(1,19)}$	1[c]	

*[a] 0 week vs. week 4th, [b] week 4th vs. week 8th, [c]week 0 vs. week 8th; Significance Level: p<0.001***, p<0.001** & p<0.05*; SD-Standard Deviation; MD-Mean Difference; df-Degree of Freedom; ηp^2- Partial Eta Square*

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Table 3: Independent t-test between the groups for DST

		Groups	Mean	SD	MD	p-value	Cohen's d
Digit Span Test (Forward)	Baseline	Experimental	10.25	2.04	1.2	0.06	0.61
		Control	9.05	1.9			
	4th week	Experimental	13.2	1.82	4.35	0.00***	2.34
		Control	8.85	2			
	8th week	Experimental	15.65	0.58	6.8	0.00***	3.56
		Control	8.85	2			
Digit Span Test (Forward)	Baseline	Experimental	5.65	1.69	0.4	0.49	0.27
		Control	5.25	1.99			
	4th week	Experimental	10.5	2.11	5.3	0.00***	3.60
		Control	5.2	1.82			
	8th week	Experimental	13.9	0.3	8.7	0.00***	4.70
		Control	5.2	1.82			

*Significance Level: p<0.001***, p<0.001** & p<0.05*; SD-Standard Deviation; MD-Mean Difference*

DISCUSSION

The current study examined the effects of high-intensity interval training (HIIT) performed for 8 weeks on cognitive flexibility performance among female teenagers belonging to the age range 13 to 19 years. The data showed how HIIT significantly enhanced cognitive flexibility, which was based on the result of the digit span test (DST), and that a control group engaged in regular daily routines had lower scores. This evidence suggests that HIIT can be a good method of enriching the cognitive function of females during adolescence.

Evidence indicates that regular physical activity and high-intensity interval training improve physical strengthening and corresponding improvements in cardiopulmonary physical fitness that result in an increase in cerebral perfusion and vasoreactivity across the human lifespan. The betterment of cerebral perfusion leads to better cognitive ability and mental health [15].

The study's results further support the previous status on the benefits of physical activity to brain health [16]. HIIT, in which young people do efficient exercise and jogging for small periods and then have little time for rest, makes a positive impact on aerobic fitness and physical health outcomes in youth. This research, by coincidence, extends the findings of cognitive flexibility which is a key aspect of cognitive functions as a kind of problem-solving situation.

The breakthrough regarding cognitive flexibility that was detected in the youth population is very remarkable [17]. Throughout the teenage years, the brain functions grow and mature. Therefore, interventions that provide cognitive improvement in this period, can turn up to be lifelong improvements that shape academic performance and general sensitivity. The research's results show that HIIT might be considered an effective way of keeping an adolescent's brain functional.

It is still unknown how working out in intervals helps the cognitive function of the brain; possible effects could be changes in the brain structure and function. Evidence supports the existence of neurotrophic factors, for example, brain-derived neurotrophic factors, which are commonly referred to as BDNF, one of the factors that contribute heavily to the growth and survival of nerve cells [18, 19]. HIIT may also stimulate cerebrovascular functions, thus increasing blood flow and oxygen supply to the brain which is represented as necessary elite cognitive functioning [20].

The mental health was observed by evaluation of the level of alertness in the questionnaire and significant improvements were observed in the mental health of the female participants in the current study. Similar results were obtained by the researcher who conducted research on the adults and school-going students to check the effectiveness of the moderate and high-intensity exercise training program and concluded that better results were observed on the young(school-going) population and significant results were obtained in the high-intensity exercise training program [21].Mental health and cognitive ability were also observed by the current study by using a digital span test that comprised a set of figures that had to be repeated in the forward (forward digital span test) and in the back (backward digital span test). Consistent results were obtained in the study conducted on the teenager to evaluate the level of memory improvements and the author revealed that those who are involved in any physical activity like sports or other training programs have better memory and show significant improvement over time [22].

The interaction effect between the two groups (Experimental and Control) of the current study revealed that the Greenhouse Geisser values showed that there is a significant interaction effect between interventions and time factor/assessment in all domains of the Digital Span Test (forward) as p>0.05 and non-significant for the Digital Span Test

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(backward) as p>0.05. The results were consistent with the study conducted by Suda S who used a mini-mental state questionnaire to evaluate the level of mental health of the participants of acute stroke who followed the exercise training program of 10 weeks [23].

There are a few limitations to the present study. Firstly, the values are recorded solemnly on the effectiveness of the training program provided to the subjects. Several confounding factors like stress, physical activity, and physical health were not maintained. Secondly, the short-term effects were observed in the enrolled population. Moreover, the duration of the training program was standardized irrespective of the participant's mental ability i.e., both scruffy and smart female teenagers received the same set and intensity of training which can affect the outcome variables.

CONCLUSION

The high-intensity exercise training program is beneficial for female teenagers to enhance their cognitive abilities along with physical strengthening. It also helps teenagers to increase their mental health for better health and memory.

The long course of interventional treatment should be monitored with a large sample size to generalize the results with a better understanding. Confounding factors like the performance of physical activity, stress level, and physical health issues that can delay the outcomes of interventional therapy should be considered.

DECLARATIONS & STATEMENTS

Author's Contribution

NJ: substantial contributions to the conception and design of the study.
NJ, SK and AT: acquisition of data for the study.
HA: analysis of the data for the study.
NJ, HA and MAMA: interpretation of data for the study.
BS and QI: drafted the work.
NJ, MAMA, SK, AT, HA, BS and QI: revised it critically for important intellectual content.
NJ, MAMA, SK, AT, HA, BS and QI: final approval of the version to be published and agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All authors contributed to the article and approved the submitted version.

Ethical Statement

The study was initially approved by the research and ethical committee (REC) of Riphah International University, Islamabad (Riphah/RCRS/REC/Letter-01497). It was conducted at the Royal Institute of Physiotherapy and Rehabilitation Sciences (RIPRS/20220716-1), Hidayat campus Sukkur, Pakistan.

Consent Statement

The written informed consent was obtained from participants as well as from the care givers to participate in the study.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data is not publicly available due to privacy or ethical restrictions.

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Thanks to the participants of this study for sharing their personal experiences with pain.

Conflicts of Interest

The authors declare no conflict of interest.

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Research Article

Effects of hamstring stretching using pressure bio feedback unit in patients with low back pain

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ABSTRACT

Background: Hamstring tightness can alter lumbar posture, impact pelvic alignment, and exacerbate low back pain. It's important to research whether hamstring stretches with a pressure biofeedback unit work for those with low back pain.

Objectives: To determine the effects of hamstring stretching using a pressure biofeedback unit in patients with low back pain.

Methodology: A total of n=38 Male and female subjects between the ages of 25-40 years, with >3 months history of low back pain having bilateral hamstring shortening less than 70O, and (ODI) score between 20% to 40% were enrolled in the study. The data was collected from Railway General Hospital and randomly assigned into 2 groups. Group A (n=18) received Active Hamstring stretch with a pressure biofeedback unit (PBU). Group B (n=19) received only Active Hamstring stretch without PBU Outcome measures such as pain, hamstring length, and ODI score were measured at baseline, after the second and fourth weeks. The data was entered and evaluated by using SPSS-25.

Results: The results of this study showed no significant difference between the group A and group B for ODI individual items as well as ODI overall score $p \geq 0.05$. Moreover, no significant difference in NPRS score $p \geq 0.05$. however, it showed a significant difference ($p < 0.05$) in hamstring muscle length on both legs $p < 0.01$.

Conclusion: It is concluded that hamstring stretching using a PBU causes a greater improvement in the flexibility of hamstring muscles as compared to the flexibility of hamstrings when stretched without PBU.

Keywords: flexibility; hamstring muscle; low back pain; pressure bio feedback

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INTRODUCTION

Low back ache remains a particularly common physical structure illness that takes place in 80% of individuals at a certain point in their lifespans [1, 2]. Low back pain causes limited compliance and several physical structure disorders resulting from muscle stiffness and postural instabilities. For the proper functioning of the musculoskeletal system, flexibility is a vigorous part of maintaining fitness and maximizing physical activity performance. Dysfunction in flexibility is a common issue encountered by sportsmen as well as normal individuals, particularly of hamstring muscles. Decreased flexibility causes the beginning of a vicious cycle which results in a decreased range along with increased postural complications [3].

Research showed that hamstring muscle flexibility is significantly decreased in people with nonspecific low back pain, which affects anterior pelvic rotation and forward bending range. Low back pain may be exacerbated by increased lumbar flexion brought on by decreased hamstring flexibility. While people experiencing low back pain have shorter hamstring muscles [4-6].

Studies conducted by Shrivastava et. al, and Han et. al. on the effect of hamstring stretches while maintaining pelvic control on low back pain, find that hamstring stretching exercises while maintaining pelvic control are more useful in alleviating lower back discomfort [7, 8]. Patients with back pain can benefit from proprioceptive neuromuscular facilitation (PNF), ballistic, static, and other stretching treatments to increase the flexibility of their hamstrings. a study suggested using a PBU to keep the pelvic anterior tilting position when performing the AKE test or AKE stretching for length test and hamstring muscle stretching [9].

Previous studies demonstrate that stretching with an anterior pelvic tilt may be more effective for hamstring length than a posterior pelvic tilt. While maintaining pelvic tilt during stretching sessions can be facilitated using devices such as pressure biofeedback units (PBUs), their efficacy in this regard is still unknown. So, this study aims to find out whether hamstring stretching while maintaining anterior pelvic tilt using pressure biofeedback is more effective than hamstring stretching without using pressure biofeedback on pain, muscle length, and functional status of patients with low back pain.

METHODOLOGY

The single-blinded randomized controlled trial (NCT05059496) study was conducted at Railway General Hospital from February to November 2021. The study was conducted at the physical therapy department of Pakistan Railway Hospital. The ethical approval was obtained from the Research and Ethical Committee (RIPHAH/RCRS/REC/Letter-00854) of Riphah International University, Islamabad Pakistan.

Male and female subjects between the ages of 25-40 years, with >3 months history of mild to moderate low back pain having bilateral hamstring shortening less than 70^{0}, and (ODI) score between 20% to 40% were enrolled in the study. Patients with osteoarthritis or spondylolisthesis, systemic disease, disc herniation or leg length discrepancy, pregnant females, and participants with severe back pain or excessive lumber lordosis were excluded.

The G Power software was used to determine the sample size. The effect size (Cohen's d=0.92) obtained from a prior study was used to calculate the sample size of n=38. During the calculation, the power (1-β) was 85% and the alpha level was kept at 0.05 to achieve the sample size [8].

The nonprobability convenience sampling technique was used for sample selection. A total of n=90 subjects were evaluated for eligibility criteria. Out of which n=52 patients were excluded due to not meeting the selection criteria (n=45) and declining to participate (n=7) in the study. From n=38 participants equally allocated to Group A (n=19) receiving Active Hamstring stretch with pressure biofeedback unit (PBU) and Group B (n=19) receiving stretching exercise without pressure biofeedback unit There were n=2 loss of follow up from both groups due to lack of adherence with research protocols. A total of n=34 participants completed the study and were included in the data analysis. (Figure 1)

The randomization was done through the flip-coin method. In this method, a coin was tossed in the air. If it lands on one side (head), it represents Group A, and if it lands on the other side (tail), it represents Group B. This method was used repeatedly to assign participants to their respective groups. The patients were blinded in the study and unaware of the group being allocated.

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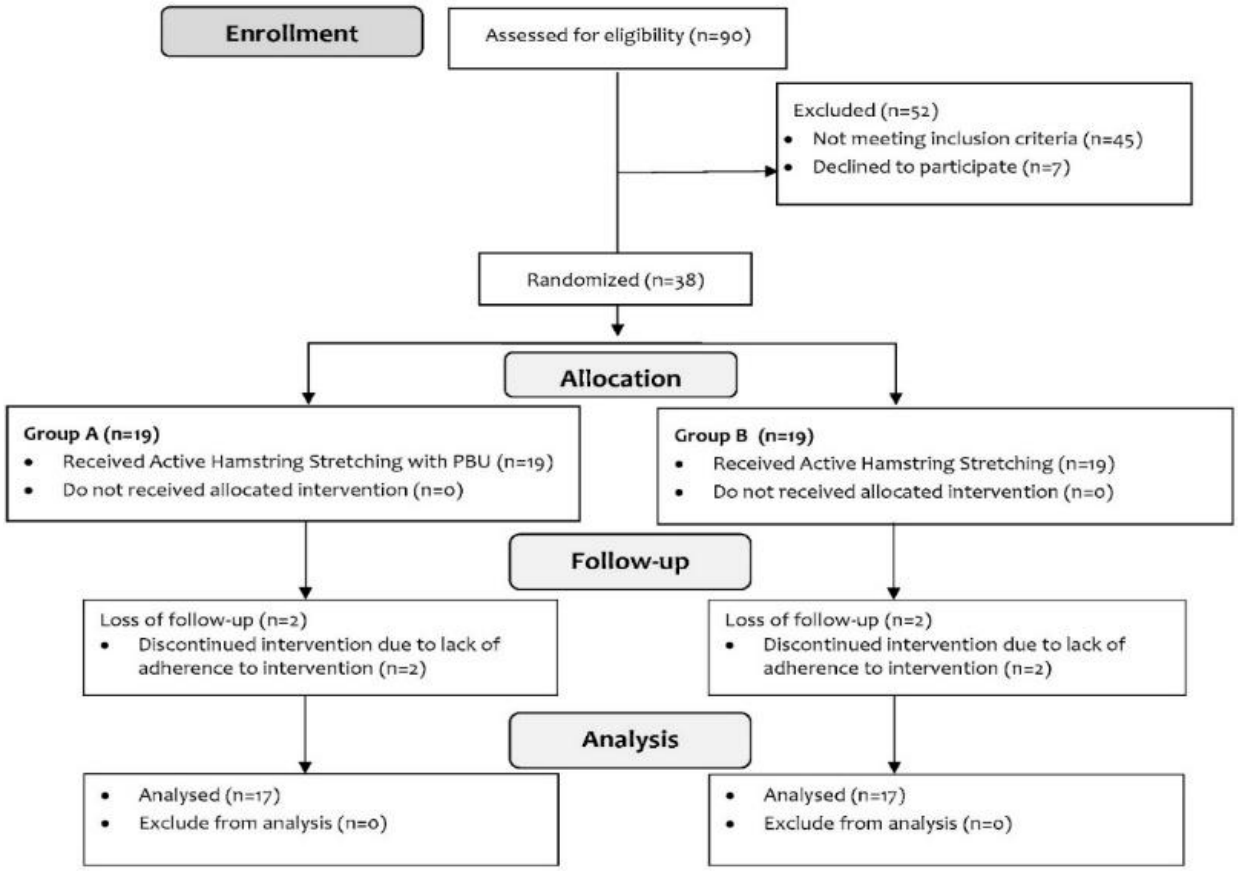

Figure 1: CONSORT

Both groups received a hot pack for 15 min before the stretching protocol and TENS for 15 min after the stretching protocol over the lumber area in prone lying. Group A received an Active Hamstring stretch with PBU maintained at 40mmHg pressure performed 3 times for each leg with a 30-sec hold and 15-sec rest between each stretch 3 days a week. Group B performed Active Hamstring stretch without PBU performed 3 times for each leg with a 30-second hold and 15-second rest between each stretch 3 days a week. The total treatment session was 35 minutes. Numeric Pain Rating Scale (NPRS) was used to measure pain scores. The Oswestry Disability Index was used to measure pain-related disability in persons with low back discomfort It contains a total of 10 items, and each item is scored from 0 to 5. The overall score is calculated by multiplying the sum of the scores by 2, giving a scale of 0 to 100[10].

An active knee extension test (AKE) was used to measure hamstring elasticity. To perform this test patient is positioned in a supine lying and a pillow is placed under the patient's head and neck. The non-tested lower extremity is stabilized with the help of straps along the table. The goniometer axis is placed on the knee axis with the stationary arm aligned with the greater trochanter and the moving arm aligned with the lateral malleolus. Using a horizontal bar with the two wooden legs, the intended hip joint is maintained at 90 degrees of flexion and the patient is asked to perform active knee extension with the ankle in the neutral position. This angle is measured by goniometer [11].

Outcome measures such as pain, hamstring length, and ODI score were measured at baseline, at the end of the second and fourth weeks. The data was entered and evaluated by using SPSS-25 software and expressed in a structure of tables and figures. All the individuals were analyzed at baseline and then at the end of 2nd week and 4th week. The Shapiro-Wilk test revealed that the data was non-normally distributed ($p<0.05$). So, the non-parametric tests were applied including the Mann-Whitney U-test for the group comparison. Friedman's Test along with Wilcoxon sign Rank test for within-group changes from baseline to end of 4th week. The level of significance was set at $p<0.05$.

RESULTS

The mean age of study participants was 33.18±4.380 years. The mean body mass index was 24.650 ± 3.141. Out of n=34 participants, there was only

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1(2.9%) participant who was underweight and only n=1(2.9%) participant who was obese=19 (55.9%) participants had normal weight and n=13(38.2%) was overweight. Out of total participants= 8(23.5%) were males and n= 26(76.5%) were females.

Overall Oswestry Disability Index (ODI) scores, Hamstring muscle length (right & left), and pain were significantly improved in both Group A and B from baseline to the fourth week, with large effect sizes ($p<0.05$) on each assessment. Regarding the ODI domains, in group A sleeping did not significantly improve ($p=0.315$) from 2nd week to 4th week. While in group B sleeping was not significantly improved throughout the intervention. Sitting was not also improve significantly from the 2nd week to the 4th week in group B. (Table 1).

When comparing the group A with the group B significant improvement was seen in the hamstring length of the right and left leg as well at 2nd week and 4th week respectively. When comparing pain and ODI scores between the group A and the group B no significant difference ($p=0.120$) was seen from baseline to fourth week. (Table 2)

Table 1: Within Group ODI Changes

		Group A (n=17)					Group B (n=17)				
		M	IQR	MR	X^2/Z	p-value	M	IQR	MR	X^2/Z	p-value
Pain Intensity	Baseline	2.00	1.00	2.97	-4.000[a]	0.00***	2.00	0.5	2.88	-3.500[a]	0.00***
	2nd week	1.00	1.00	1.91	-3.606[b]	0.00***	1.00	1.00	1.91	-3.162[b]	0.002**
	4th week	1.00	1.00	1.12	31.714[c]	0.00***	1.00	0.00	1.21	28.737[c]	0.00***
Personal Care	Baseline	1.00	0.00	2.82	-3.464[a]	0.001**	1.00	0.5	2.65	-2.828[a]	0.005**
	2nd week	0.00	1.00	1.85	-2.646[b]	0.008**	1.00	1.00	2.03	3.000[b]	0.003**
	4th week	0.00	0.00	1.32	26.235[c]	0.00***	0.00	0.00	1.32	22.533[c]	0.00***
Lifting	Baseline	2.00	0.00	2.79	-3.464[a]	0.001**	2.00	0.00	2.79	-3.162[a]	0.002**
	2nd week	1.00	1.00	1.82	-2.449[b]	0.014*	1.00	1.00	2.00	-3.162[b]	0.002**
	4th week	1.00	0.00	1.38	25.125[c]	0.00***	1.00	0.5	1.21	27.000[c]	0.00***
Walking	Baseline	1.00	1.00	2.56	-2.646[a]	0.008**	1.00	1.00	2.59	-2.449[a]	0.014*
	2nd week	1.00	1.00	1.97	-2.449[b]	0.014*	1.00	0.00	2.18	-3.464[b]	0.001**
	4th week	0.00	0.50	1.47	18.541[c]	0.00***	0.00	0.5	1.24	24.174[c]	0.00***
Sitting	Baseline	2.00	2.00	2.82	-3.207[a]	0.001**	2.00	1.00	2.62	-3.000[a]	0.003**
	2nd week	1.00	1.00	1.97	-3.317[b]	0.001**	1.00	1.00	1.88	-1.890[b]	0.059
	4th week	1.00	1.00	1.21	26.103[c]	0.00***	1.00	0.00	1.50	18.195[c]	0.00***
Standing	Baseline	2.00	1.50	2.59	-2.646[a]	0.008**	2.00	1.00	2.82	-3.357[a]	0.001**
	2nd week	2.00	1.00	2.09	-3.162[b]	0.002**	2.00	1.00	1.97	-3.207[b]	0.001**
	4th week	1.00	1.00	1.32	21.814[c]	0.00***	1.00	1.00	1.21	27.527[c]	0.00***
Sleeping	Baseline	0.00	1.00	2.26	-2.000[a]	0.046*	0.00	1.00	2.18	-1.414[a]	0.157
	2nd week	0.00	0.00	1.91	-1.000[b]	0.317	0.00	0.00	2.00	-1.414[b]	0.157
	4th week	0.00	0.00	1.82	8.400[c]	0.015*	0.00	0.00	1.82	6.000[c]	0.050
Social Life	Baseline	1.00	0.00	2.62	-2.333[a]	0.020*	1.00	0.00	2.62	-2.646[a]	0.008**
	2nd week	1.00	0.50	2.18	-3.464[b]	0.001**	1.00	0.50	2.09	-3.162[b]	0.002**
	4th week	0.00	0.00	1.21	25.125[c]	0.00***	0.00	0.00	1.29	22.800[c]	0.00***
Travelling	Baseline	2.00	1.50	2.71	-3.05[a]	0.002**	2.00	1.00	2.50	-2.449[a]	0.014*
	2nd week	1.00	1.00	1.91	-2.33[b]	0.020*	1.00	1.00	2.03	-2.646[b]	0.008**
	4th week	1.00	1.00	1.38	21.37[c]	0.00***	1.00	0.00	1.47	17.543[c]	0.00***
ODI Score	Baseline	28.88	11.11	3.00	-3.63[a]	0.00***	31.11	11.11	3.00	-3.628[a]	0.00***
	2nd week	20	10.0	2.00	-3.62[b]	0.00***	20	5.55	2.00	-3.623[b]	0.00***
	4th week	8.88	6.66	1.00	34.00[c]	0.00***	8.88	2.22	1.00	34.000[c]	0.00***
Hamstring Length Right Leg	Baseline	48.00	5.00	1.00	-3.645[a]	0.00***	44.00	8.00	1.00	-3.65[a]	0.00***
	2nd week	55.00	4.00	2.00	-3.635[b]	0.00***	50.00	8.00	2.00	-3.64[b]	0.00***
	4th week	62.00	5.00	3.00	34.00[c]	0.00***	56.00	8.00	3.00	34.00[c]	0.00***
Hamstring Length Left Leg	Baseline	48.00	5.00	1.00	-3.633[a]	0.00***	43.00	7.00	1.00	-3.64[a]	0.00***
	2nd week	55.00	8.00	2.00	-3.652[b]	0.00***	50.00	10.00	2.00	-3.63[b]	0.00***
	4th week	63.00	5.00	3.00	34.000[c]	0.00***	56.00	7.00	3.00	34.00[c]	0.00***
Pain (NPRS)	Baseline	5.00	1.00	3.00	-3.94[a]	0.00***	5.00	0.00	3.00	-3.727[a]	0.00***
	2nd week	3.00	1.00	2.00	-3.73[b]	0.00***	3.00	1.00	2.00	-3.823[b]	0.00***
	4th week	1.00	2.00	1.00	34.00[c]	0.00***	2.00	1.00	1.00	34.000[c]	0.00***

*[a]Baseline to after 2nd week, [b]after 2nd week to after 4th week, [c]baseline to after 4th week; Significance level: p<0.001***, p<0.01**, p<0.05*; M-Median; IQR-Interquartile Range; MR-Mean Rank*

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Table 2: Between Groups ODI Changes

		Group A (n=17)			Group B (n=17)				
		M	IQR	MR	M	IQR	MR	U-stats	p-value
Pain Intensity	Baseline	2.00	1.00	9.00	2.00	0.5	16.00	119	0.279
	2nd week	1.00	1.00	18.00	1.00	1.00	17.00	136	0.734
	4th week	1.00	1.00	16.50	1.00	0.00	15.50	127.5	0.426
Personal Care	Baseline	1.00	0.00	17.85	1.00	0.5	17.15	138.5	0.802
	2nd week	0.00	1.00	16.00	1.00	1.00	19.00	119	0.311
	4th week	0.00	0.00	17.00	0.00	0.00	18.00	136	0.317
Lifting	Baseline	2.00	0.00	18.32	2.00	0.00	16.68	130.5	0.548
	2nd week	1.00	1.00	17.24	1.00	1.00	17.76	140	0.861
	4th week	1.00	0.00	19.26	1.00	0.5	15.74	114	0.163
Walking	Baseline	1.00	1.00	15.85	1.00	1.00	19.15	116	0.299
	2nd week	1.00	1.00	14.88	1.00	0.00	20.12	100	0.079
	4th week	0.00	0.50	17.50	0.00	0.5	17.50	144..5	1.000
Sitting	Baseline	2.00	2.00	18.85	2.00	1.00	16.15	121.5	0.402
	2nd week	1.00	1.00	18.09	1.00	1.00	16.91	134.5	0.704
	4th week	1.00	1.00	15.21	1.00	0.00	19.79	105	0.100
Standing	Baseline	2.00	1.50	15.44	2.00	1.00	19.56	109.5	0.203
	2nd week	2.00	1.00	16.97	2.00	1.00	18.03	135.5	0.737
	4th week	1.00	1.00	17.50	1.00	1.00	17.50	144.5	1.000
Sleeping	Baseline	0.00	1.00	18.00	0.00	1.00	17.00	136	0.702
	2nd week	0.00	0.00	17.00	0.00	0.00	18.00	136	0.551
	4th week	0.00	0.00	17.50	0.00	0.00	17.50	144.5	1.000
Social Life	Baseline	1.00	0.00	17.26	1.00	0.00	17.74	140.5	0.868
	2nd week	1.00	0.50	17.88	1.00	0.50	17.12	138	0.771
	4th week	0.00	0.00	17.00	0.00	0.00	18.00	138	0.633
Travelling	Baseline	2.00	1.50	17.62	2.00	1.00	17.38	142	0.941
	2nd week	1.00	1.00	15.91	1.00	1.00	19.09	117.5	0.310
	4th week	1.00	1.00	15.65	1.00	0.00	19.35	113	0.141
ODI Score	Baseline	28.88	11.11	17.56	31.1111	11.1112	17.44	143.5	0.972
	2nd week	20.00	10.0	16.21	20.00	5.55	18.79	122.5	0.445
	4th week	8.88	6.66	16.24	8.88	2.22	18.76	123	0.446
Hamstring length right leg	Baseline	48.00	5.00	20.00	44.00	8.00	15.00	102	0.136
	2nd week	55.00	4.00	21.56	50.00	8.00	13.44	75.5	0.017*
	4th week	62.00	5.00	22.35	56.00	8.00	12.65	62	0.004**
Hamstring length left leg	Baseline	48.00	5.00	21.24	43.00	7.00	13.76	81	0.057
	2nd week	55.00	8.00	21.65	50.00	10.00	13.35	74	0.015*
	4th week	63.00	5.00	23.38	56.00	7.00	11.62	44.5	0.001**
NPRS	Baseline	5.00	1.00	3.00	5.00	0.00	3.00	97.5	0.052
	2nd week	3.00	1.00	2.00	3.00	1.00	2.00	136	0.734
	4th week	1.00	2.00	1.00	2.00	1.00	1.00	102.5	0.120

*Significance level: p<0.001***, p<0.01**, p<0.05*; *; M-Median; IQR-Interquartile Range; MR-Mean Rank*

DISCUSSION

This study aims to find out whether hamstring stretching while maintaining anterior pelvic tilt using pressure biofeedback is more effective than hamstring stretching without using pressure biofeedback on pain, muscle length, and functional status of patients with low back pain. The results of this study showed no significant difference among the group A and group B for ODI individual items as well as ODI overall score, it also showed no significant difference in NPRS score from baseline to second week however it showed a significant difference in hamstring muscle length.

Static stretching causes a greater improvement in the flexibility of hamstring muscles than active exercise methods [12]. Static stretching of hamstring muscles improves the viscoelasticity of a muscle which in return promotes increased tolerance to stretching and thus causes an improved flexibility of hamstring muscles [13]. Furthermore, stretching usually decreases the tension in a muscle by improving the length of the musculotendinous unit and there exists an inverse relation between muscle length and muscle tension, the greater the muscle tension lower the muscle length and vice versa so stretching aims to decrease the tension in the muscle and improves the flexibility of muscle [14].

Static stretching in the form of active knee extension position which this study also used as a position for hamstring stretching showed significant improvement in the length of hamstring muscles after using it because evidence has shown that static

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stretching as compared to other types of stretching may be additional or likewise effective for improving the length of hamstring muscles [15].

The current study showed that there is also an improvement in the NPRS scores with hamstring stretching without using a pressure biofeedback unit in patients with low back pain. A study suggested that hamstring stretching helps to alleviate low back pain because stretching helps to reduce muscle spasms and improves the flexibility and coordination of muscles and reduction in muscle spasms is one of the contributing factors in the alleviation of lower back pain [13]. Furthermore, the hamstring muscles are the ones that function as a connection between the lower back region and the posterior aspect of the thigh and stretching plays an important role in improving hamstring flexibility and reducing tightness, which in return helps to lower the tension on lower back area and contribute in the alleviation of lower back pain [16, 17].

In the current study, there is also improvement in the overall Oswestry disability index score as well as individual items including pain intensity, personal care, lifting, walking, sitting, standing, social life, and traveling this might be due to the reason that stretching helps to decrease pain in muscles, enhance flexibility, boost bodily performance as well as avoids injury chances[2, 17, 18]. No improvement in sleeping was noted which may be since sleep might not be affected at baseline, so no improvement was seen after the intervention in patients with chronic low back pain.

The results of this study showed that hamstring stretching using a pressure biofeedback unit in patients with low back pain causes an improvement in the flexibility of the hamstring muscles. An active knee extension test position for hamstring stretching using a pressure biofeedback unit is more effective for stretching as compared to using the same position without using a pressure bio feedback unit because a pressure biofeedback unit aims to put the pelvis in the anteriorly tilted position[9,18] and evidence has shown that hamstring stretching is more effective in the anterior pelvic tilt position as compared to posterior pelvic tilt position[19]. The focus of this study to use the anterior pelvic tilt position is because hamstring tightness might exist as a potential causative element of low back pain and anterior pelvic rotation might get limited when there is a decrease in the hamstring elasticity [6]. Further evidence has shown that posterior pelvic tilt as well as reduced lumbar lordosis which results from hamstring stiffness is a major cause of low back pain [9, 20]. So, this study uses a pressure biofeedback unit to maintain the anterior pelvic tilt position and restore lumber lordosis. Furthermore, the importance of reestablishing the normal lumber lordosis appears to be helpful in patients with low back pain because the loss of a normal lordotic curve causes an alteration in the mechanical properties of the nervous system [21]. Thus, the use of a pressure biofeedback unit helps to maintain the normal lordotic curve.

This study's results also showed that there is an improvement in the NPRS scores with hamstring stretching using a pressure biofeedback unit in patients with low back pain. The current findings were supported by a study on dentists who had mechanical low back pain. In this study hamstring stretching was performed in the anterior pelvic tilted and significant improvement was observed in pain and disability scores [8].

In the current study, the statistically significant difference implies that pressure biofeedback during stretching improved muscular elongation and relaxation, which may improve results for low back pain patients. Thus, while comprehensive treatment approaches are necessary to manage low back pain, biofeedback integration into hamstring stretching exercises may provide extra advantages by enhancing the length and functionality of the muscular fibers [9].

The Oswestry Disability Index (ODI) individual item and overall score did not significantly change between the groups, indicating that there may have been differences in the study populations, intervention strategies, or outcome measures used. Comparable decreases in pain intensity for both groups throughout the trial are suggested by the lack of a significant difference in Numeric Pain Rating Scale (NPRS) ratings from baseline to the fourth week. In the current study sample size was small, so the results of the non-parametric test may be distorted by their low power as compared to the parametric test.

CONCLUSION

It is concluded that hamstring stretching either by using a pressure biofeedback unit or alone may reduce pain levels and functional ability of patients with low back pain equally. However, using a pressure biofeedback unit in the anterior pelvic tilt position along with hamstring stretching causes a greater improvement in the flexibility of hamstring muscles.

DECLARATIONS & STATEMENTS

Author's Contribution

MR: substantial contributions to the conception and design of the study.
MR and SK: acquisition of data for the study.
MR: analysis of the data for the study.

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ZS and KK: interpretation of data for the study.
MR and SK: drafted the work.
MR, SK, ZS and KK: revised it critically for important intellectual content.
MR, SK, ZS and KK: final approval of the version to be published and agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All authors contributed to the article and approved the submitted version.

Ethical Statement

The study was conducted at the physical therapy department of Pakistan Railway Hospital. The ethical approval was obtained from the Research and Ethical Committee (RIPHAH/RCRS/REC/Letter-00854) of Riphah International University, Islamabad Pakistan.

Consent Statement

The written informed consent was obtained from participants as well as from the care givers to participate in the study.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data is not publicly available due to privacy or ethical restrictions.

Acknowledgments

None to declare

Conflicts of Interest

The authors declare no conflict of interest.

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Research Article

Placebo - a strategy to improve physical fitness of normal adolescents: a randomized control trial.

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ABSTRACT

Background: The capacity of the placebo effect to affect a range of physiological and psychological characteristics, including strength, endurance, and pain perception. Its use for teenage physical fitness, however, is still largely unknown.

Objective: To determine the effects of placebo drink administration on physical fitness among normal-weight adolescents compared to plain water.

Methods: This randomized control trial with n=60 adolescents aged 10-19 years, of both genders and normal weight was conducted at Shifa Tameer-e-Millat University, Islamabad from May 2021 to August 2021. Randomization was performed using the envelope method dividing the sample into an experimental group who were given a placebo drink (water + red food colour) and a control group who were given water. Tools used for data collection included the Physical Activity of Leisure Motivation Scale for motivation level determination, the Physical Activity Questionnaire, and four fitness tests including 20 m running, a broad jump, a reach test, and a reduced cooper test.

Results: Post-intervention results revealed a significant difference in means for experimental and control groups for reduced Cooper test (P=0.003), pulse rate (p=0.033), and exertion level (p<0.001). post-intervention palms score revealed significantly better results in the experimental group for mastery (p=0.004) physical (p=0.008) and psychological levels (p<0.001). the results also indicate that the experimental group showed a more significant mean difference regarding the affiliation subscale with (p<0.001) and total PALMS score (p<0.001).

Conclusion: Administered placebo drink boosts physical performance by increasing motivational levels and decreasing the exertion of normal-weight adolescents.

Keywords: Adolescent; exercise; health; heart rate; placebo; physical fitness; water.

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INTRODUCTION

In the current era, adolescents are facing challenges including growing academic competition, excessive exposure to the internet, consumption of junk food, and lack of opportunities for physical activity in daily routine. Declining physical fitness has beefed up serious concerns regarding upcoming challenges with health and physical functional capacity [1, 2].

Physical activity regularly improves the body's growth as well as development thus beneficially affecting social, psychological, mental as well as physical health which also contributes to learning [3]. Placebo & nocebo are also among the factors with their effects still waiting to be estimated and researched with placebo signifying positive beneficial effects [4]. Placebos, inactive substances, or processes that have no pharmacological impact, are becoming more and more popular in a variety of fields including clinical trials, where they are employed to assess the efficacy of various treatments [5].

Studies have demonstrated the impact of placebos on conditions including migraines [5-7]. Recent studies on their effects on fatigue have raised concerns that they could have an impact on exercise and physical performance. It has been seen that placebos have physiological and psychological effects, such as variations in heart rate, pain perception, and anxiety levels [8, 9]. There are brain regions involved in pain reduction, as well as the endogenous opioid system [10]. The use of placebos raises ethical questions; however, it is thought that doing so serves to assess therapeutic efficacy [11, 12]. Promoting regular physical activity is essential for growth and development, given the risks associated with inactivity, especially among adolescents. Both intrinsic and extrinsic motivation are essential for maintaining levels of physical activity [13, 14].

Keeping in view the dearth of literature on the subject, and the declining health status of adolescents, to determine ways to motivate adolescents to enhance physical activity and to determine the effect of placebo-like coloured water in non-clinical settings, it was hypothesized that administration of a placebo has both positive psychological and physiological outcomes to enhance physical activity. With this hypothesis, a current study was conducted to determine the effects of placebo administration on physical fitness among normal-weight adolescents. This study has significant importance, since proving the hypothesis of the study true, placebo administration methods can be used in non-clinical settings to foster the health of the younger generation. This study will also be a significant addition to the literature and a base for further research.

METHODOLOGY

This randomized control trial (IRCT # 20211052405138N1) was conducted at the Department of Rehabilitation Sciences, Shifa Tameer-e-Millat University, Islamabad, Pakistan following approval of the Institutional Review Board and Ethics Committee (IRB & EC), Shifa International Hospital Ltd. & Shifa Tameer-e-Millat University with Reference IRB # 066-21 dated 9th April, 2021 Sample was recruited using non–probability convenient sampling from Decent Public School, Islamabad, Pakistan over 4 months from 1st May 2021 to 31st August, 2021, after obtaining permission from the Principal of the School. Informed consent of participants was taken from their parents/guardians and ethical concerns were addressed.

The study participants included adolescents aged 10-19 years of either gender with normal BMI, who were less motivated, and who were residents of Islamabad were included in the study. Adolescents with any acute or chronic disease, deformity or psychological illness, family history of sudden cardiac death, comorbidities like asthma and diabetes, history of exercise-associated dizziness, pre-syncope, or collapse were excluded from the study.

A study sample of n=60 was utilized for the study. The sample was calculated using OpenEpi, Version 3, and an open-source calculator with a significance level of 95, power of 80, and Odds Ratio of 10. This revealed a total sample size of n=58 (29 in each group) hence, a sample of N=60 was taken for the study. To get this sample n=68 participants were enrolled of which 08 were excluded and a sample of N=60 was utilized for the study which was randomized into two groups with blinding using the envelope method with n=30 in the Experimental and n=30 in the control group (Figure 1).

The tools used to collect the data were a demographic sheet that inquired about age, gender, BMI, and comorbidity. Physical Activity of Leisure Motivation Scale (PALMS) and Physical Activity Questionnaire for Adults (PAQ-A) and Children (PAQ-C) for measuring physical activity [15-18]. The Rate of Perceived Exertion Scale (RPE) assesses exercise intensity; a digital pulse oximeter (model TCPOC L213) is used to measure heart rate.

Moreover, Physical fitness was measured with the Cooper 6-minute run test, for assessing aerobic fitness and endurance, the standing broad jump test is a measure of lower body strength and explosive power, and running as fast as possible for 20 meters test is a measure of speed and acceleration, and sit and reach test is a measure of flexibility hamstring muscles. Participants completed questionnaires and performed fitness tests measuring flexibility, endurance, speed, and jump. We continuously

tracked heart rate and exertion. Participants were ultimately categorized based on the information gathered.

Group A (Experimental Group): participants received a placebo drink (red food colouring added to water) and a leaflet with phrases that reinforced the placebo's possible impact on performance improvement within a half-hour time (30 minutes) frame. These assurances included a range of physical tests, including the sit-and-reach test, the running test, the standing broad jump, and the reduced Cooper test, which would be administered under close supervision with performance assessments; an energy drink being given; to repeat the aforementioned tests following the energy drink's consumption, with readings to be retaken; and The plan to compare performance during the physical activities both before and after consuming the energy drink, looking for any differences in results.

Group B. (Control Group): Participants of the control group were given water.

This whole procedure was done by the first investigator whereas the second investigator was blinded. This was necessarily done because to administer a placebo drink, which was coloured to bring a placebo effect, the first investigator could not be used for post-intervention result measurements for which a blinded investigator was used. All tests were repeated under the supervision of a second investigator and again exertion level and pulse rate were monitored. The difference between pre and post-reading was evaluated.

The statistical analysis of done by SPSS Version 21. The mean and standard deviation were used for descriptive statistics of continuous variables, while frequency and percentages were described for categorical variables. As the data assumed that assumption of parametric test. The paired sample t-test was performed to determine within-group changes. While an independent t-test was used to investigate the difference between the Experimental and Control groups as well as for the affiliation, competition, and total score of PALMS these were not comparable at the baseline, so the mean of mean differences of these variables were compared. The $p<0.05$ was considered significant.

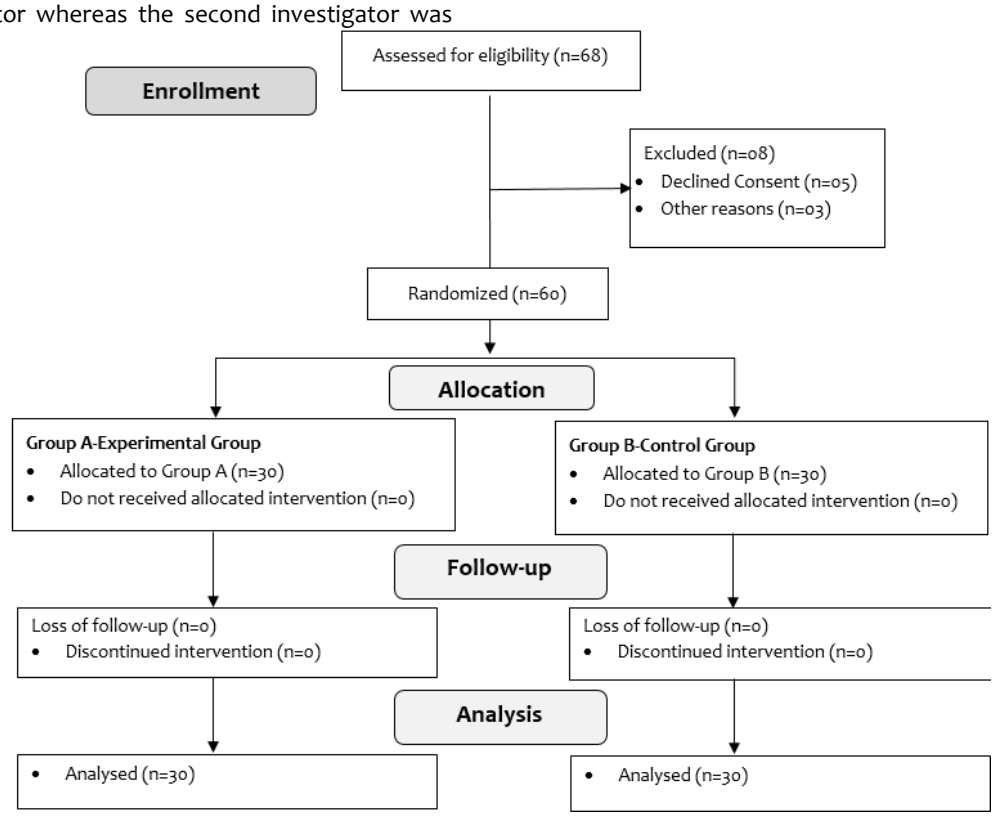

Figure 1: Consort Diagram

RESULTS

The mean age of the participants was 14.03±1.913 years, including 29(48.3%) boys and 31(51.7%) girls with no significant (p=.077) difference between the experimental and control groups.

The result of paired sample t-test showed that group A (Experimental) which received a placebo drink significant improvement in the pre-post analysis of all variables including lower body strength with broad jump test ($p<0.001$), speed through running as fast as possible for 20 meters test ($p=0.001$), flexibility of hamstring muscle with sit and reach test ($p<0.001$), aerobic fitness and

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endurance with reduced cooper test (p=0.002), Rate of Perceived Exertion (RPE) for assessing exercise intensity (p<0.001) and heart rate measurement with a digital pulse oximeter (p=0.002). In group B (Control), all variables were significantly improved (p<0.05) except pulse rate (p=0.23) and rate of perceived exertion (p=0.28) in pre-post analysis. The pre-post analysis of Physical Activity and Leisure Motivation Scale (PALMS) items and the total score showed that each group significantly improved p<0.001) in the emotional motivation of participants undergoing physical activity after the interventions. (Table 1)

Table 1: Pre & Post Test Comparative Statistics

	Experimental Group (n=30) Mean ± SD			Control Group (n=30) Mean ± SD		
	Pre-Test	Post-Test	P-value	Pre-Test	Post-Test	p-value
Broad jump test (cm)	161.17 ± 23.07	166.30 ± 21.78	0.000***	161.97 ± 22.43	163.80± 21.42	0.002**
20-m running test (sec)	3.97 ± 1.01	3.62 ± 0.69	0.001**	4.22 ± 1.06	3.97 ± 0.81	0.009**
Sit and reach test (cm)	99.39 ± 11.15	101.51 ± 11.25	0.000***	98.64 ± 10.09	100.25 ± 9.63	0.000***
Reduced cooper test (m)	339.60 ± 99.33	361.37 ± 89.54	0.002**	340.83 ± 105.76	296.80 ± 73.42	0.001**
Pulse Rate	131.47 ± 22.80	129.6 ± 22.61	0.002**	141.10 ± 19.83	141.63 ± 19.82	0.23
Rate of Perceived Exertion	8.00 ±1.01	6.77 ± 1.10	0.000***	7.93 ± 0.86	8.10 ± 0.80	0.28
PALMS Sub Scales						
Mastery	8.27 ± 1.41	14.50 ± 1.87	0.00***	8.80 ± 1.88	13.07 ± 1.81	0.00***
Physical condition	7.63 ± 1.40	13.07 ± 2.10	0.00***	8.23 ± 1.43	11.67 ± 1.80	0.00***
Affiliation	9.90 ± 2.09	18.03 ± 1.71	0.00***	12.77 ± 2.67	17.60 ± 2.44	0.00***
Psychological condition	8.07 ± 2.28	13.70 ± 3.14	0.00***	7.30 ± 2.07	9.87 ± 2.75	0.00***
Appearance	6.53 ± 1.22	9.80 ± 2.65	0.00***	6.40 ± 1.49	8.93 ± 2.21	0.00***
Enjoyment	12.07 ± 1.89	17.77 ± 2.81	0.00***	12.93 ± 2.31	17.17 ± 2.00	0.00***
Competition	8.53 ± 1.81	16.17 ± 1.82	0.00***	9.57 ± 1.99	16.10 ± 2.59	0.00***
Total	61.00 ± 5.23	103.47 ± 5.60	0.00***	66.0 ± 7.00	94.57 ± 6.92	0.00***

Significance level: p<0.05, p<0.001** & p<0.001***; PALMS- Physical activity and leisure motivation scale*

When comparing the groups after intervention significant improvement in group A (experimental) was observed as compared to group B (Control) in aerobic endurance (p=0.003), pulse rate (p=0.03), and rate of perceived exertion (p<0.001). But no significant difference was observed when comparing the lower limb strength (p=0.656), speed (p=0.079), and flexibility (p=0.64) were not significantly improved. When comparing the Physical activity and leisure motivation after the intervention, the result showed that subscales including mastery (p=0.004), physical condition (p=0.008), and psychological condition (p<0.001) were significantly better in the experimental group. But no significant difference in sub-scale appearance (p=0.175) and enjoyment (p=0.345) after intervention. (Table 2)

Table 2: Experimental & Control Group Comparative Statistics

	Pre-Test Mean ± SD			Post-Test Mean ± SD		
	Experimental Group (n=30)	Control Group (n=30)	p-value	Experimental Group (n=30)	Control Group (n=30)	p-value
Broad jump test (cm)	161.17 ± 23.074	161.97 ± 22.438	0.892	166.30 ± 21.780	163.80 ± 21.426	0.656
20-m running test (sec)	3.97 ± 1.017	4.22 ± 1.064	0.356	3.62 ± 0.691	3.97 ± 0.819	0.079
Sit and reach test (cm)	99.40 ± 11.156	98.64 ± 10.096	0.782	101.52 ± 11.251	100.25 ± 9.637	0.64
Reduced cooper test (m)	339.60 ± 99.335	340.83 ± 105.766	0.963	361.67 ± 89.542	296.80 ± 73.425	0.003**
Pulse Rate	131.47 ± 22.805	141.10 ± 19.833	0.086	129.63 ± 22.619	141.63 ± 19.826	0.033*
Rate of Perceived Exertion	8.00 ± 1.017	7.93 ± 0.868	0.786	6.77 ± 1.104	8.10 ± 0.803	0.000***
PALMS Sub Scales						
Mastery	8.27 ± 1.413	8.80 ± 1.883	0.220	14.50 ± 1.871	13.07 ± 1.818	0.004**
Physical condition	7.63 ± 1.402	8.23 ± 1.431	0.106	13.07 ± 2.100	11.67 ± 1.807	0.008**
Affiliation	9.90 ± 2.090	12.77 ± 2.674	0.00***	18.03 ± 1.712	17.60 ± 2.444	0.43
Psychological condition	8.07 ± 2.288	7.30 ± 2.070	0.179	13.70 ± 3.142	9.87 ± 2.751	0.00***
Appearance	6.53 ± 1.224	6.40 ± 1.499	0.707	9.80 ± 2.657	8.93 ± 2.212	0.175
Enjoyment	12.07 ± 1.893	12.93 ± 2.318	0.118	17.77 ± 2.812	17.17 ± 2.001	0.345
Competition	8.53 ± 1.814	9.57 ± 1.995	0.04*	16.17 ± 1.821	16.10 ± 2.591	0.909
Total	61.00 ± 5.239	66.00 ± 7.007	0.003**	103.47 ± 5.606	94.57 ± 6.922	0.00***

Significance level: p<0.05, p<0.001** & p<0.001***; PALMS- Physical activity and leisure motivation scale*

Moreover, the affiliation, competition, and total score of PALMS were not comparable at the baseline, so the mean differences of these variables were compared. The result showed that the placebo group showed more significant mean difference regarding the affiliation subscale (-8.13±2.33 vs. -4.83±2.08, p<0.001) and total PALMS score (-42.46±4.66 vs. -28.56±6.53, p<0.001). While the competition subscale showed no significant (p=0.06) difference between groups.

DISCUSSION

The current study determined the effectiveness of a placebo on physical fitness and motivation

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regarding exertion and pulse rate among adolescents. The study outcomes concluded that physical fitness was enhanced in the experimental group receiving a placebo, whereas the control group receiving water did not show much difference in results. This might be due to several underlying neuro-biological impacts of placebo with studies researching the mediators like opioids, dopamine, serotonin, etc., [19]. Though evidence on the exact mechanisms involved is deficient, the literature reveals that a placebo as a stimulating agent increases dopamine levels in mesocortical (pre-frontal) & mesolimbic regions of the brain [20].

In the current study, four different activities were performed including broad jump, 20m running, sit and reach test, and reduced cooper test. The experimental group showed a marked increase in all activities, reduced Cooper test post measurement showed mean value maximum difference. Whereas the control group didn't show the makeable difference in all activities. Similar results were reported in a study by Shira Fanti-Oren and Daphna Birenbaum-Carmeli in Israel, in 2019, which concluded that a placebo has beneficial outcomes on physical fitness. In that study, the effect of placebo was achieved by information, provided regarding a water drink consumed before testing-standard information (water) vs. deliberate positive information (presumed energy drink, placebo). When given in the form of administration and information. In this study, the treadmill test was performed twice, and results were based on exertional level, heart rate, and recovery time [21]. Whereas the current study concluded results based on variables including exertional level, pulse rate, motivational level, and post-activity measurements (speed, time, and distance).

Similarly, in another study by Crum & Langer at Harvard University, information on work-related exercise acted as a placebo resulting in a reduction in weight, fat, blood pressure, ratio of hip to waist, and body mass index. In that study, subjects in the experimental group were told that the work they do is good exercise and satisfies the Surgeon General's recommendations for an active lifestyle. Subjects in the control group were not given this information. The placebo effect is any effect that is not attributed to an actual pharmaceutical drug or remedy but rather is attributed to the individual's mindset (mindless beliefs and expectations). The experimental group was given information about how their work is a good exercise; this information was conveyed in the form of a verbal presentation, through individual handouts, and on larger posters tacked to the bulletin boards in their lounge in the hope that they would be reminded of how much exercise they were getting each day. The control group was not given this information [22]. Current study outcomes also showed the significance of a placebo in driving motivation. Similarly, a study conducted by Alves et al. in 2017 in Brazil, concluded that in the case of a placebo. In this study they evaluated the effect of a recognized brand (versus an unrecognized brand) in the placebo effect, subjects who were more motivated and had high expectancy showed improved results [14]. Another study was conducted by Davis et al. in 2019 in the UK, which explained motivation comes from giving cues i.e., rewards and benefits can boost physical performance or sports activity. Social information gleaned from competitors and teammates can also elicit a placebo effect and can change the optimal physical output strategies for athletes and exercisers. [23]. Hence there is a highly significant relationship between motivation and performance. Similarly, Hyland suggested that conditioning, the expectancy of response, and activation of goal have resulted in a placebo effect on a short-term basis only, while a long-term impact is obtained through goal satisfaction and the hypothalamic-pituitary-adrenal axis [24].

The current study utilized PALMs, which is a reliable, measure of participants' motivation, to study the various factors of motivation that are mastery, affiliation, physical condition, enjoyment, appearance, and psychological condition [23]. There was a significant difference in the pre and post-sub-category of enjoyment and competition among the experimental group, whereas the control group only showed a slight increase in enjoyment. In another study most respondents i.e., 97% believed, and 73% experienced placebo-impacted performance in competitive sports. The athletes who falsely believed that they had been administered anabolic or that they had ingested carbohydrate, caffeine, or a hypothetical 'new ergogenic' or who believed they were using a respiratory training device, performed better than baseline or controls. [25]. Similarly, a systematic review that investigated studies to see the impact of placebo and nocebo revealed a small to moderate impact on performance in sports[26].

The current study also concluded that high motivational level and expectancy leads to decreased exertion levels and pulse rate. Participants after receiving a placebo showed a noticeable decline in exertion level, whereas subjects receiving water were more exhausted after performing exercise. Similarly, a study conducted in the United Kingdom in 2019, revealed a marked decrease in exertional level in the experimental group after receiving a placebo & subjects were able to perform more with less fatigue. In this study, the researcher compared the effect of information on physical fitness metrics in overweight or obese to normal-weight children. Each participant performed a treadmill exercise stress test twice under identical

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conditions except for the difference in the information provided regarding a drink consumed before testing. Before each testing session, the participants drank a glass of water. In one session, they were given standard information that they were drinking water. In the other session, deliberate positive information was given, and the water drink was described by the researchers as a drink that increases energy levels, strengthens muscles and therefore is likely to improve exercise performance. The water bottles were also styled differently for the two sessions; during the standard information session, plain transparent water bottles were used, whereas during the deliberate positive information sessions, the water bottles were opaque and blue-coloured, and included a label proclaiming the content to be an energy drink that strengthens muscles and improves athletic performance [21].

The present study has also inferred a slight decrease in pulse rate which might be associated with elevated motivational level and decreased exertional level. This complies with a study conducted by Crawford et al. in the United States in 2019, in which authors concluded that variability in heart rate drives motivation reduces fatigue and allows a person to perform high-intensity exercise for prolonged periods. Hence it can be assumed that the pulse rate might be altered with variations in motivation and fatigue [27]. Similarly, a study by Thai Tuong involving a virtual reality exergame reported significant ($p<0.05$) improvement in mean heart rate, intrinsic motivation & time spent exercising [28]. This is also in line with a study by Stöckel & Grimm, in which running with real-time feedback of heart rate seemed to augment motivation in running at increased exertional level [29]. Berdi M et al noted that in 14 studies involving different sports, the impact of placebo on physiological and performance indicators like the power of muscles, heart rate, speed, and psychological factors show significant [30].

Limitations: The results of the study cannot be generalized since the study was conducted at a local school in one city due to COVID-19 restrictions.

CONCLUSION

The study concludes that administering a placebo drink boosts physical performance by increasing motivational levels and decreasing the exertion of normal-weight adolescents. Hence it can be recommended for boosting physical performance in less motivated adolescents to avoid the unnecessary use of energy drinks.

DECLARATIONS & STATEMENTS

Author's Contribution

FB, NF, MA and AA: substantial contributions to the conception and design of the study.
MA, AA and MK: acquisition of data for the study.
MA, AA and FB: analysis of the data for the study.
MA, AA and NF: interpretation of data for the study.
FB and GS: drafted the work.
MK, GS, FB, NF, MA and AA: revised it critically for important intellectual content.
MK, GS, FB, NF, MA and AA: final approval of the version to be published and agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All authors contributed to the article and approved the submitted version.

Ethical Statement

The study was conducted after approval of the Institutional Review Board and Ethics Committee (IRB & EC), Shifa International Hospital Ltd. & Shifa Tameer-e-Millat University with Reference IRB # 066-21 dated 9th April 2021.

Consent Statement

Informed consent of participants was taken from their parents/guardians and ethical concerns were addressed.

Conflicts of Interest

None to declare.

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None to declare.

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