



The Effect of a Rehabilitation Program Using Assistive Means to Modify Scoliosis (Curvature of the Lateral Spine) and Improve the Functional Efficiency of Young Handball Players

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Abstract

The objective of this study was to develop and formulate a proposed rehabilitation program utilising specialised aids and devices (including spinal suspension and pulling units, flexible resistance belts, foam cylinders, and Swiss rehabilitation balls) to assess its impact on altering the degree of scoliosis deviation (curvature of the lateral spine) and enhancing certain functional efficiency variables (range of motion of lateral flexion, trunk muscular strength, and functional postural balance) in young handball players. The investigator employed the experimental approach by structuring a single group with. The study population comprised participants engaged in sports activities at centers for Young Handball Players, whereas the research sample included ten players diagnosed with mild to moderate lateral scoliosis, verified through statistical and clinical assessments. The sample's statistical homogeneity regarding factors (age, height, weight, degree of scoliosis, and training age) was assessed utilising the torsion coefficient. The suggested rehabilitation program lasted for eight consecutive weeks, comprising three rehabilitation sessions weekly, amounting to a total of 24 sessions, each incorporating intervertebral decompression techniques, stretching exercises for the concave side, and strengthening exercises for the elastic muscles on the convex side. The findings demonstrated statistically significant variations between the pre- and post-tests, favouring the post-test across all research variables, as the degree of scoliosis deviation (Cobb angle) diminished from (14.60) to (9.10) degrees, reflecting an improvement rate of (37.67%), while the lateral flexion range of motion increased by (50.27%), trunk muscular strength by (36.84%), and the functional post-mortem balance exhibited the most substantial improvement rate of (70.16%). The investigators determined that the utilisation of assistance and helpful gadgets significantly alleviated pressure among the vertebrae while reinstating dual muscle equilibrium and neuromuscular harmony. The investigators advocated for the implementation of the suggested rehabilitation initiative, outfitting Sports Clubs for Young Handball Players with supportive rehabilitation apparatus, and conducting regular physical assessments for athletes.

Keywords: Rehabilitation Program, Assistive Devices and Aids, Scoliosis (Curvature of the Lateral Spine), Functional Competence, Youth Centers in Al-Muthanna.

INTRODUCTION

Postural and physical integrity is the cornerstone of building high athletic abilities and achieving optimal motor performance, as any defect or deviation in the

mechanical structure of the skeleton not only reflects negatively on the aesthetic and posture appearance of the practitioners, but also extends its impact to constitute a functional barrier that affects the efficiency of vital and physical organs (Jakicic et al, 2024). The spine is the main axis on which all sports movements are based, as it acts as a shock absorber and a transmitter of motor forces between the upper and lower extremities (Al Behadili & Kasim, 2022; Çabuk & Ulupınar, 2025). One of the most prominent and complex postural deviations that affect young people and athletes at different stages of development is scoliosis known as lateral spine curvature a three-dimensional deviation that involves a sideways slope with rotation of the vertebrae, resulting in shoulder and pelvic asymmetry, and muscular imbalance between the sides of the body (Twarowska-Grybalow & Truszczyńska-Baszak, 2023).

The seriousness of this deviation does not stop at the limits of strength, but its direct effect extends to a decrease in the functional capacity of the players, as the muscular imbalance causes the restriction of range of motion, a decrease in the levels of strength and muscular balance, and may even affect the vital capacity of the lungs and respiratory functions as a result of the compression of the rib cage in advanced cases (Decker et al., 2024; Hussein & Kasim, 2022). In light of the rapid scientific and technological development in the fields of sports medicine and motor rehabilitation, modern rehabilitation programs have gone beyond traditional methods (such as static exercises only) and rely mainly on specialized assistive devices and equipment. These devices play a vital role in providing precise motor guidance, providing safe resistance and rehabilitation angles that allow targeting weak and tightened muscle groups with high precision, and applying the principles of biomechanical feedback, which contributes to accelerating the process of motor recovery and adjusting the degree of postural deviation more effectively and safely (Paillard, 2023; Zemková & Kováčiková, 2023).

This study is of exceptional importance through its field application to female players and players of youth centers and forums in Al-Muthanna Governorate, as this youth group constitutes the basic base of school, university and club sports. Neglecting the early diagnosis and rehabilitation of postural deviations in these players may lead to the aggravation of the injury, deprive them of continuing their sports career, or limit their physical and motor efficiency during daily and sports practices. From this point of view, there is a scientific and practical need to design a proposed rehabilitation program

supported by modern aids and devices, with the aim of evaluating its performance and its applied impact in modifying the degree of lateral scoliosis of the spine, and developing the resulting functional and physical variables, to serve as a scientific and qualifying guide for specialists and trainers in the sports and youth sector in Al-Muthanna Governorate.

Scoliosis, characterised by a lateral curvature of the spine, is a prevalent and intricate postural issue among young individuals and athletes throughout many sporting activities (McGuire Jr, 2025; Quka et al., 2024). Owing to the biomechanical disparity in load distribution across the vertebrae of the spine, coupled with an imbalance in the strength and flexibility of the adjacent muscle groups (Pei & Wang, 2025; Neamah et al., 2024). The researcher, through field exploration and scientific observation, noted a significant number of athletes in Al-Muthanna Governorate exhibiting an inexplicable deterioration in their physical and motor performance, accompanied by swift onset of fatigue, muscle exhaustion, and recurrent complaints of back pain and instability while executing sports skills. Following the preliminary physical assessment, it was determined that numerous instances were attributable to differing levels of lateral spinal scoliosis deviation, lacking specialised and meticulously crafted rehabilitation protocols aimed at rectifying this deviation.

The fundamental issue is that the majority of rehabilitation efforts in youth centers depend on Swedish or conventional exercises, which frequently lack accurate motor direction and overlook the incorporation of contemporary aids and assistive devices that offer rehabilitation angles and specific resistances aimed at weak and tense muscles, resulting in a deceleration of motor recovery or an inability to achieve the desired posture. In order to do so, the research problem is united in asking a main question: To what extent is a proposed rehabilitation program using assistive means and devices in modifying the deviation of lateral scoliosis of the spine and improving the functional efficiency of the Young Handball Players?

The research sub-questions focus on examining the effectiveness of the proposed rehabilitation program using assistive devices and aids in young handball players with scoliosis. Specifically, the study seeks to determine whether the proposed rehabilitation program contributes to modifying the degree of lateral spinal curvature (scoliosis) among the research sample and whether it improves functional variables, including range of

motion, muscular strength, and balance. Furthermore, the study investigates whether statistically significant differences exist between the pre-test and post-test measurements in the variables of spinal deviation and functional efficiency, with the expected differences favoring the post-test results.

The importance of the research lies in the scientific, applied and health dimensions it provides to the field of sports and rehabilitation, and this importance is manifested in the fact that it treats a critical and influential post-traumatic injury that affects the lives and health of youth groups practicing sports in Young Handball Players. The applied importance of the research is highlighted in providing an innovative and modern rehabilitation model that moves away from the traditional conventional methods, and is based on the direct integration of guided rehabilitation exercises with specialized aids and devices, which gives the athlete a greater ability to restore the biomechanical balance of the spine, and develop the range of motion and muscular strength surrounding the injured area with high precision and safety.

The scientific and administrative importance of the study is also evident in providing the sports and academic library with documented scientific and applied evidence that specialists, coaches, and motor rehabilitation specialists in the Directorate of Youth and Sports of Al-Muthanna and other sports institutions can benefit from as a basic reference for diagnosing and rehabilitating postural deviations, as well as the role of this research in highlighting the importance of health care and continuous strength of the players of youth forums, as they are the main nucleus and vital tributary of clubs and national teams.

The current research seeks to prepare and design a proposed rehabilitation program using specialized aids and devices to modify scoliosis deviation, represented by the lateral curvature of the spine, among young handball players. It also aims to identify the effect of the proposed rehabilitation program on reducing the degree of lateral spinal curvature in the research sample and to determine its effect on improving selected functional efficiency variables, particularly the muscular strength of the muscle groups surrounding the spine and range of motion. In addition, the research seeks to compare the results of the pre- and post-tests of the research sample in terms of the degree of lateral spinal deviation and functional efficiency variables in order to determine the effectiveness of the proposed rehabilitation program and the assistive devices used.

In light of the research objectives and questions, the researcher hypothesizes that there are statistically significant differences between the mean scores of the pre- and post-tests of the research sample in the degree of scoliosis deviation, represented by the lateral curvature of the spine, in favor of the post-test. It is also hypothesized that there are statistically significant differences between the mean scores of the pre- and post-tests in the functional efficiency variables, including range of motion and muscular strength of the muscle groups surrounding the spine, in favor of the post-test. Furthermore, it is hypothesized that the proposed rehabilitation program using specialized assistive devices and aids will have a positive and tangible effect on modifying lateral spinal deviation associated with scoliosis and improving the functional efficiency of young handball players.

The human area of the research comprises young handball players from youth forums and sports centers in Al-Muthanna Governorate who have mild to moderate scoliosis, characterized by lateral curvature of the spine. The temporal area extends from March 20, 2026, to April 12, 2026, covering the field examinations, implementation of the proposed rehabilitation program, and administration of the pre- and post-tests. The spatial area includes sports halls and motor rehabilitation units affiliated with the Young Handball Players and Sports Directorate, as well as specialized rehabilitation centers accredited in the governorate center.

RESEARCH METHODOLOGY

The researchers adopted an experimental method using a single-group pre-test and post-test design. This design was considered appropriate for addressing the nature of the medical and rehabilitative problem investigated, as it enables the researchers to measure the selected variables before and after the implementation of the proposed rehabilitation program. The comparison between the pre-test and post-test results was used to determine the extent of changes and improvements achieved following the implementation of the rehabilitation program. The research population consisted of all young handball players participating in the 2025–2026 sports season, totaling 98 players from handball sports clubs in Al-Muthanna Governorate. The research sample was selected using purposive sampling from among young handball players who met the study criteria, specifically those diagnosed with mild or moderate lateral curvature of the spine (scoliosis). Based on the results of physical and clinical examinations, eight players with lateral spinal

deviation were identified as meeting the inclusion criteria and were therefore selected as the research sample.

Before the implementation of the experimental procedures, the selected participants underwent medical and orthopedic examinations to exclude cases with severe scoliosis requiring surgical intervention, as well as participants with other chronic diseases or medical conditions that could affect the rehabilitation program. Sample homogeneity was then assessed with respect to age, height, body weight, degree of spinal deviation, and years of training. Appropriate descriptive statistical parameters, including the arithmetic mean, standard deviation, and coefficient of skewness, were used to assess the distribution and homogeneity of the sample before commencing the main experimental procedures.

Data Collection Tools and Means

For the purpose of obtaining statistical data and accurate scientific information that serves the research objectives and allows the measurement of study variables before and after the implementation of the qualifying program, the researcher used the following tools and means:

Table 1. Scientific Methods, Measurement and Diagnostic Devices

No.	Method/Device	Purpose and Application
1	Scientific Sources and References	Reviewing Arabic and foreign academic books, research articles, and scientific literature related to sports medicine, motor rehabilitation, biomechanics, and postural assessment.
2	Personal Interviews and Questionnaires	Conducting scientific and exploratory interviews with specialized physicians, rehabilitation specialists, and coaches to obtain expert opinions regarding the rehabilitation program and the devices used.
3	Medical Tape Restameter	Measuring total body height/length in centimeters (cm).
4	Electronic Medical Scale	Measuring body weight in kilograms (kg).
5	Scoliometer / Radiographic Examination	Assessing the degree of lateral spinal curvature (scoliosis) in degrees and determining the degree of spinal deviation.
6	Range-of-Motion Measuring Device	Measuring the range of motion of spinal flexion, lateral flexion, and rotation.
7	Flexible Measuring Tape	Measuring muscular circumference and assessing posterior body symmetry.

8	Dynamometer	Measuring the strength of the muscles surrounding the spine and trunk.
9	Balance and Movement Tests	Assessing functional balance efficiency using balance platforms and measuring instruments.

Table 2. Aids and Devices Used in the Rehabilitation Program

No.	Aid/Device	Purpose and Application
1	Spinal Suspension and Traction Units	Providing controlled spinal traction to create intervertebral space and reduce excessive pressure on the spinal structures.
2	Flexible Adjustment and Stretching Straps	Providing different levels of resistance to target weak and tight muscle groups and support corrective exercises.
3	Swiss/Gym Balls	Performing balance and stabilization exercises and supporting exercises aimed at improving trunk alignment and postural control.
4	Foam Rollers	Facilitating myofascial release, reducing muscle tightness, and improving spinal and surrounding soft-tissue flexibility.
5	Cable and Pulley Machines	Providing controlled resistance, safe movement angles, and targeted support for strengthening the muscle groups surrounding the spine.

Scientific And Biomechanical Foundations Of The Qualifying Program

The proposed rehabilitation program was developed based on a combination of scientific, biomechanical, and physiological principles derived from contemporary theories of motor rehabilitation. The program was specifically designed to address lateral spinal curvature (scoliosis) by combining corrective exercises with specialized rehabilitation aids and devices. Its development was guided by several fundamental principles, beginning with the restoration of biomechanical alignment and muscular balance. Lateral scoliosis is generally associated with muscular imbalance around the spine, in which the muscles and connective tissues on the concave side may become shortened and tight, while those on the convex side may become relatively elongated and weak. Therefore, the rehabilitation strategy was based on the principle of stretching or lengthening the relatively tight structures on the concave side while strengthening the relatively weak muscles on the convex side. This approach was intended to improve muscular balance and support a more appropriate alignment of the spine.

Another important foundation of the program was spinal decompression and mobilization. Traction and suspension devices, together with flexible tension straps, were

incorporated to provide controlled mechanical traction and facilitate spinal mobility. These techniques were intended to reduce mechanical loading on spinal structures, improve mobility, and prepare the spine and surrounding tissues for corrective exercises. The program also incorporated proprioceptive and neuromuscular feedback principles. Rehabilitation tools such as Swiss balls, foam rollers, and balance platforms were used to challenge postural control and stimulate sensory receptors in the muscles and joints. This stimulation was intended to enhance neuromuscular coordination and improve the participant's ability to recognize and maintain a more appropriate postural alignment during movement.

The program was also based on the principle of progressive and controlled resistance. Resistance devices, cable systems, and elastic bands such as TheraBands were used to provide controlled resistance along specific movement directions and angles. The intensity of the exercises was progressively adjusted according to each participant's physical condition, degree of spinal deviation, range of motion, and muscular strength. The progression of resistance, movement amplitude, and repetitions was carefully controlled to provide an appropriate training stimulus while minimizing excessive mechanical stress or the risk of secondary injury. Finally, the program emphasized functional recovery rather than focusing solely on structural correction. The rehabilitation exercises were designed to improve spinal range of motion, trunk and spinal muscular strength, postural control, and functional movement efficiency. The program also aimed to support respiratory function by promoting improved thoracic mobility and facilitating more effective rib-cage movement during breathing.

Before the main experiment, the researchers conducted a pilot study from March 15 to March 20, 2026, involving three players selected from the research population who were not included in the main experimental sample and who had mild to moderate lateral spinal curvature. The pilot study was conducted to evaluate the feasibility and practicality of the proposed procedures before their implementation in the main experiment. Specifically, it was intended to verify the suitability and effectiveness of the rehabilitation aids and equipment, determine the appropriate duration of each exercise and the rehabilitation session as a whole, and establish adequate rest intervals between exercises and sets. The pilot study also enabled the researchers to assess whether the instructions related to the equipment and rehabilitation exercises could be understood and followed

easily by the participants. In addition, potential practical difficulties and obstacles that might arise during the main experiment were identified so that appropriate solutions could be prepared in advance. The pilot study also provided an opportunity to verify the scientific properties of the tests and measurements used to assess muscular strength and functional variables, including their validity, reliability, and suitability for the research sample.

The pre-test measurements of the main research sample were conducted in the specialized rehabilitation hall from April 5 to April 7, 2026. The pre-test procedures included assessment of the degree of lateral spinal curvature using a scoliometer and postural assessment procedures. The range of motion of the spine in different directions was also measured using a goniometer. In addition, the muscular strength of the muscle groups surrounding the spine and the participants' functional postural balance were assessed. To ensure consistency and facilitate an accurate comparison with the post-test results, the researchers standardized the measurement procedures as far as possible, including the location, time, equipment, measurement instructions, and testing conditions.

The proposed rehabilitation program was implemented from April 12 to June 4, 2026, over eight consecutive weeks. The participants completed three rehabilitation sessions per week, scheduled on Sunday, Tuesday, and Thursday, resulting in a total of 24 rehabilitation sessions. Each rehabilitation session lasted approximately 45–60 minutes and consisted of three main parts. The preparatory part focused on general preparation, mobility, and spinal decompression to prepare the participants for the main exercises. The main part consisted of corrective stretching exercises targeting relatively tight structures on the concave side and strengthening exercises targeting relatively weak muscles on the convex side, with the assistance of specialized rehabilitation devices and equipment. The final part consisted of relaxation and recovery exercises designed to gradually reduce exercise intensity and facilitate recovery following the rehabilitation session.

Following completion of the eight-week rehabilitation program, the post-test measurements were conducted from June 7 to June 9, 2026. The same variables assessed during the pre-test were reassessed, including the degree of spinal curvature, spinal range of motion, muscular strength of the muscle groups surrounding the spine, and functional postural balance. The researchers attempted to maintain the same measurement

conditions, procedures, equipment, and instructions used during the pre-test to minimize external influences and ensure that any observed changes could be more appropriately attributed to the proposed rehabilitation program. The pre-test and post-test results were subsequently compared statistically to determine the effectiveness of the rehabilitation intervention in modifying spinal deviation and improving the functional efficiency of the young handball players.

The researcher used the Statistical Package for the Social Sciences (SPSS) in the latest version, to process the data and unload the results of the pre- and post-measurements of the research sample, by relying on the appropriate statistical parameters and tests for the research.

RESULTS AND DISCUSSION

This section deals with a detailed presentation of the results reached through the application of the proposed rehabilitation program using aids and assistive devices on the research sample consisting of players of Handball Sports Clubs in Muthanna Governorate with scoliosis (lateral spinal curvature). This stage includes the treatment and analysis of the results of the pre- and post-tests statistically and discussing them in a scientific manner supported by biomechanical, physiological and relevant academic literature.

First: Presentation and analysis of the results of the Geostatic Scoliosis Deviation Test (Cobb Angle)

In order to identify the effect of the proposed rehabilitation program and assistive devices in modifying the degree of lateral curvature of the spine, the Paired-Samples t-test was used between the pre- and post-measurements of the research sample, as shown in the following table:

Table 3: Shows the arithmetic media, standard deviations, calculated value of (v), and the percentage of improvement for the degree of scoliosis deviation (n = 10)

Variable	Unit of Measurement	Per test		Post test		Middle	T	Sig	Percentage
		M	SD	M	SD				
Degree of scoliosis (Cobb Angle)	Degree	14.60	1.83	9.10	1.29	5.50	11.42	0.000	37.67%

Table (3) shows that the arithmetic mean of the degree of scoliosis deviation in the pre-measurement reached (14.60) degrees with a standard deviation of (1.83), while in the dimensional measurement it decreased to (9.10) degrees with a standard deviation of (1.29). The difference between the two means was (5.50) degrees, while the calculated value of (T) was (11.42) and the significance level of (0.000) which is lower than the level of significance (0.05), which indicates that there are statistically significant differences between the pre- and post-measurements and in favor of the dimensional measurement. The sample achieved an improvement rate of (37.67%).

Second: Presentation and analysis of the results of the tests of functional competence and range of motion of the spine

In order to determine the extent of the development of functional efficiency and the range of motion of the spine as a result of the implementation of the rehabilitation program, Table (4) presents the results of the pre- and post-tests for the functional variables:

Table 4: Shows the arithmetic media, standard deviations, calculated value (v), and the percentage of improvement for the variables of functional efficiency and range of motion (n = 10)

Variable	Unit of Measurement	Per test		Post test		Middle	T	Sig	Percentage
		M	SD	M	SD				
Range of motion of lateral flexion (concave side)	Degree	18.30	2.11	27.50	1.96	9.20	9.85	0.000	50.27%
Explosive muscular strength of the back and trunk muscles	Kg/cm	34.20	3.46	46.80	2.89	12.60	10.34	0.000	36.84%
Dynamic Balance	Second	12.40	1.58	21.10	1.73	8.70	8.92	0.000	70.16%

The results of Table (4) show that there are significant differences between the pre- and post-measurements of all functional efficiency variables (range of motion of lateral flexion, muscular strength of the trunk, and functional post-mortem balance), where all the values of (T) calculated came with a high statistical significance (0.000) in favor of the dimensional measurement, with noticeable improvement rates ranging between (36.84%) and (70.16%).

The significant reduction in the degree of lateral scoliosis deviation and the significant improvement in functional efficiency among the players of the youth forums and centers in Al-Muthanna are attributed to the rehabilitation and biomechanical effectiveness of the proposed rehabilitation program based on assistive devices and aids. The decrease in the degree of scoliosis deviation from (14.60) to (9.10) degrees and an improvement rate of (37.67%) is primarily due to the role of the Traction & Suspension Units used in the first phase of the program. Guided mechanical pulling contributed to increasing the intervertebral spaces and relieving cartilage pressure, which led to the relaxation of the contracted tissues and ligaments on the concave side of the deviation. This result is consistent with what Burkhard et al., (2023); Levy et al., (2024) confirmed found that decompression and decompression techniques are an essential step to realign the biomechanical spine and allow the muscles to regain their straightness.

The results showed a significant increase in the range of motion of the lateral flexion by an improvement of (50.27%) and the muscular strength of the trunk by (36.84%). The researcher attributed this development to the specialized exercise strategy designed with the help of resistance bands (TheraBands) and cable machines, as these methods allowed the provision of resistance and gradient rehabilitation angles that enabled the researcher to target and strengthen the weak and elastic muscles in the convex side, in conjunction with the extension of the tight muscles in the concave side. The dual restoration of muscle balance between the two sides of the body led to the elimination of joint tension and an increase in the elasticity of the tissues surrounding the spine, which is in line with the biomechanical propositions of Kharbat et al (2023); Rezaei, Gheitasi, and Hosseini (2025); and Zemková and Zapletalová (2022) that show that muscular balance is the main ruler of range of motion and posture.

The highest improvement rate was recorded (70.16%), and the researcher attributed this to the use of Swiss Gym Balls and Balance Boards during the last phase of the program. Training on unstable surfaces and assistive means stimulates proprioceptors in the muscles and joints, which increases the efficiency of the central nervous system in sending rapid corrective signals and developing neuromuscular control. This improvement has enabled the youth center players to regain their functional and physical efficiency while performing movements and sports skills efficiently and safely.

CONCLUSIONS

In light of the research objectives, statistical analyses, and scientific discussion, the researcher concluded that the proposed rehabilitation program using assistive devices, including traction and pulling units, resistance bands, foam rollers, and rehabilitation balls, was highly effective and had a tangible positive effect on modifying the degree of scoliosis deviation, represented by the lateral curvature of the spine, among young handball players. The use of mechanical suspension and traction devices during the first phase of the program contributed to reducing pressure between the vertebrae and releasing muscular adhesions, resulting in a significant improvement in the degree of scoliosis, as measured by the Cobb angle, with an improvement rate of 37.67%. Furthermore, specialized exercises using flexible resistance devices and cable systems contributed to lengthening the tight muscles on the concave side and strengthening the weak muscles on the convex side, resulting in a 50.27% improvement in the range of lateral spinal flexion and a 36.84% improvement in trunk muscular strength. The use of unstable training surfaces and rehabilitation balls also stimulated anticipatory postural adjustments and enhanced neuromuscular coordination, which positively affected the players' functional balance, with an improvement rate of 70.16%, thereby contributing to their overall motor and physical efficiency.

Based on the conclusions of the study, the researcher recommends adopting the proposed rehabilitation program and its associated assistive devices as a practical rehabilitation guide for young handball players with mild to moderate scoliosis. Rehabilitation halls and sports facilities in youth centers should be equipped with modern rehabilitation devices and aids, such as resistance bands, spinal traction machines, and Swiss balls, rather than relying exclusively on traditional Swedish exercises. It is also recommended that periodic field assessments and screening programs be conducted among young handball players to facilitate the early detection and correction of postural deviations before they progress. In addition, specialized training courses and workshops should be organized for coaches, sports personnel, and rehabilitation specialists in the governorate to improve their knowledge and skills in using assistive devices and applying biomechanical feedback to correct postural deviations. Similar studies are also recommended to investigate the effects of rehabilitation programs and assistive equipment on other postural deviations, such as pectus excavatum, thoracic kyphosis, and

excessive lordosis. Finally, future research should examine the effects of device-supported rehabilitation programs across different age groups and among athletes participating in various specialized sports.

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