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The role of customized nutrition plans in enhancing fitness test outcomes and competitive performance in young soccer players

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Abstract
Adolescents are a unique group where rapid physiological changes and increased physical activity create high demands on fitness and well-being. Athletes in this age group, like soccer players, need structured training and nutritional programs to reach their best performance. The Khelo India Fitness Test is an important initiative for promoting fitness among Indian youth by testing core fitness components such as muscular endurance, abdominal strength, flexibility, speed, and stamina. This program provides a holistic development of adolescent physical capacities through athletic development. The study comprised 300 male adolescents representing three developmental stages: the pre-adolescence stage, that is, 10-12 years; 13-15 years which falls under the adolescence phase; and the post adolescence stage, representing the age group of 16-18 years. Equal numbers of participants were chosen for the control and experimentation groups. The Khelo India Fitness Test was assessed before and after the intervention session to all participants. The experimental group received an age-specific, highly nutritious diet according to the energy and nutrient requirements, whereas the control group followed standard physical routines and dietary habits. All fitness parameters showed significant improvements in the experimental group. The scores in the Push-Up Test, abdominal strength, flexibility, speed, and stamina were improved significantly. However, the experimental group had a better and more consistent progress than the control group. For example, flexibility and stamina have made significant improvements but mostly in the experimental group indicate the importance of focused intervention for the improvement of sport performance. These results thereby indicate the necessity of incorporating structured and age-specific dietary and exercise programs. The Khelo India Fitness Test and Nutrition approach by aligning age-specific interventions with requirements therefore supports better fitness and can promote a culture of high achievement in sports and well-being.

Keywords: Adolescent fitness, Khelo India, structured nutrition interventions, physical performance, athletic development

1. Introduction
Adolescents participating in competitive sports require a higher nutritional level to support growth, physical activity, and performance. The right nutrition, along with a systematic fitness program, is the need of the hour to help unlock their maximum athletic potential while also ensuring overall well-being (Desbrow, 2014) [1]. The Khelo India Fitness Test is an initiative of the Government of India to standardize youth fitness tests, focusing on the core components of muscular endurance, abdominal strength, flexibility, speed, and stamina. This study explores the effectiveness of a six-month nutrition and exercise intervention in enhancing these fitness measures and soccer performance in young players.

Physical fitness is a strong foundation for health and well-being, especially in adolescence when the child's body is undergoing rapid growth in terms of physical, mental, and emotional development. Well-planned fitness programs with nutrition education will in still lifelong habits that support the holistic development of a child and prevent the risks of a sedentary lifestyle (WHO, 2020; Guthold *et al*., 2020) [2, 3]. These include cardiovascular health, improved muscular strength, better flexibility, and general endurance through regular physical activity combined with proper nutrition (Malina *et al*., 2019) [4]. More so, optimal nutrition is seen to ensure that there is enough energy availability to support muscle repair and recovery, which are important factors for adolescent athletes (Thomas *et al*., 2016) [5].

The Khelo India program introduced in the year 2018 highlights that fitness is first followed by sports excellence at the grassroots level during school-going children's age. During adolescence, the age-appropriate interventions increase physical attributes, decrease potential risks of injuries, and enhance biomechanical efficiency (Lloyd *et al*., 2016; Beunen & Malina, 2008) [6, 9]. Nutritional education is a part and parcel of all these kinds of interventions through which energy increases, hydration benefits, and athletic performance maintains itself too (Smith *et al*., 2021) [8].

The results suggest that structured fitness programs combined with nutritional education play a synergistic role in enhancing the physical performance of adolescent athletes. Nutritional interventions improved the outcomes of fitness, recovery rates, and energy utilization overall, leading to greater consistency in athletic performance. Integrating scientifically designed fitness and dietary programs into the training of adolescents in sports shows substantial improvement in physical as well as mental health, creating a culture of fitness excellence (Faigenbaum *et al*., 2020; Morton *et al*., 2018) [7, 10]. This paper attempted to determine whether structured fitness interventions supplemented by nutritional education tailored for an individual improve the physical fitness of an adolescent. The findings underscore the importance of addressing both training and dietary aspects to maximize athletic performance.

2. Materials and Methods

The impact of a six-month structured fitness and nutritional intervention on the physical performance of adolescent soccer players was examined through the Khelo India Fitness Test. Participants were stratified into control and experimental groups across three age groups: pre-adolescence (10-12 years), adolescence (13-15 years), and post-adolescence (16-18 years).

2.1 Study design

A Randomized Controlled Trial (RCT) was performed on 300 male adolescents aged 10-18 years. It was a pre- and post-test comparative study in which the experimental group received a combined fitness and nutritional intervention and the control group continued their usual practices. The assessments were conducted at baseline (pre-test) and after the intervention period of 26 weeks (post-test).

The intervention in the experimental group was set as follows:

- A structured fitness program on the basis of Khelo India Fitness Test protocols with focus on core fitness components, including muscular endurance, abdominal strength, flexibility, speed, and stamina.
- Nutritional education and dietary intervention with an age-specific energy and macronutrient requirement for hydration strategies and nutrient timing education to optimize recovery, muscle repair, and energy utilization during exercise.

The control group remained to follow their usual diets and normal physical activities with no structured fitness counselling or dietary intervention.

2.2 Participants

- Pre-adolescents 96 (N=48 control; N=48 experimental).
- Adolescents 144 (N=72 control; N=72 experimental).
- Post-adolescents 60 (N=30 control; N=30 experimental).

Inclusion criteria

- Males aged 10-18 years.
- School enrolment or sports academies.
- Participation in regular physical education or sport trainings at least three times a week.
- Consent for the study.

Exclusion criteria

- Adolescents with medical conditions affecting physical fitness.
- Those on medication influencing exercise performance or energy levels.

2.3 Sampling method

Purposive sampling ensured equal representation across age groups. A total of 300 male adolescents were equally divided into control and experimental groups (150 each).

2.4. Fitness and nutritional intervention

Fitness program

The experimental group was given a structured fitness program based on the Khelo India Fitness Test protocols. The program included age-appropriate exercises, progressive overload techniques, and regular monitoring to improve fitness components: muscular endurance, abdominal strength, flexibility, speed, and stamina.

Nutritional education and diet

The experimental group was given a highly nutritious diet tailored to their specific energy, macronutrient, and hydration needs.

Nutrition education classes included topics like balanced meal planning, the importance of protein for muscle recovery, carbohydrate loading for energy, fat utilization, and effective hydration practices.

Nutrient timing strategies were applied to optimize pre- and post-exercise nutrition to enhance recovery and performance.

2.5 Data collection

Pre- and post-intervention data was collected using standardized methods consistent with the Khelo India Fitness Test. Performance measures were:

- **Muscular endurance:** Push-up test (repetitions in 30 seconds).
- **Abdominal strength:** Partial curl-up test (repetitions in 30 seconds).
- **Flexibility:** Sit-and-Reach Test (measured in cm).
- **Speed:** 50m Dash (measured in seconds).
- **Stamina:** 600m Run/Walk (measured in minutes and seconds).

2.6 Variables of the study

- **Independent variable:** The combined fitness and nutritional intervention based on the Khelo India Fitness Test.
- **Dependent variables:** Performance metrics—muscular endurance, abdominal strength, flexibility, speed, and stamina.

2.7 Duration of study

The intervention lasted six months, starting from December 2019 and concluding in March 2024.

2.8 Ethical considerations and informed consent

The Institutional Human Ethics Committee of Avinashilingam Deemed University, Coimbatore gave its approval for

conducting the study. Informed written consent was taken from the parents or legal guardians of all participants before starting the study. The participant confidentiality was maintained throughout, and a debriefing session was conducted at the end of the study.

2.9 Statistical analysis

Data analysis was done using SPSS software, and results were given as mean ± SD. Paired t-tests were used to compare the pre-test and post-test values within each group, and independent t-tests were used to compare the control and experimental groups. A p-value of < 0.05 was considered statistically significant.

3. Results and Discussion

This research examined the effects of a 26-week intervention consisting of a tailored fitness program supplemented with an individualized nutrition plan on 300 male adolescents split into control and experimental groups. The intervention included age-specific nutritional education on macronutrient timing, hydration strategies, and individualized meal planning related to the physical demands of soccer. Pre- and post-intervention assessments with the Khelo India Fitness Test had revealed improvements in all parameters of fitness, including muscular endurance, strength, flexibility, speed, and stamina, in the experimental group.

Moderate improvements were shown across all the fitness parameters for the control group; however, the extent of the improvement was less than in the case of the experimental group. For the 10-12 years control group, the Push-Up Test performance increased from a mean of 9.40±2.473 pre-intervention to 10.38±3.349 post-intervention. The Partial Curl-Up Test improved slightly from 9.90±2.699 to 10.77±2.875, while flexibility scores increased from 8.29±5.816 to 8.96±5.235. Speed (50m Dash) improved slightly, with times changing from 10.22±2.155 to 11.03±2.140 seconds and stamina (600m Run/Walk) improved from 4.18±1.112 to 4.09±1.149 minutes.

In the control group, aged 13-15 years, Push-Up Test scores rose from 9.49±2.556 to 11.07±2.474 and Partial Curl-Up Test scores fell slightly from 11.24±2.153 to 9.92±1.642. Flexibility scores gained modestly, changing from 11.14±1.656 to 9.99±1.631. Speed (50m Dash) scores declined slightly, where time changed from 9.16±1.632 to 11.13±1.662 seconds. 600m Run/Walk scores rose slightly with times moving down from 3.00±0.693 to 2.22±0.659 minutes.

In the control group of 16-18 years, there was a slight decline in performance of Push-Up Test that changed from 12.73±3.205 pre-intervention to 12.40±2.660 post-intervention. Partial Curl-Up Test scores decreased slightly, by 13.23±2.473 and reached 12.43±2.029 post-intervention. Scores in Flexibility decreased a bit from 11.57±1.924 to 10.93±1.701. Speed (50m Dash) scores improved minimally as times changed from 9.06±1.688 to 10.03±1.474 seconds. Stamina measures slightly improved, with 600m Run/Walk times changing from 3.13±0.707 to 3.07±0.787 minutes.

The intervention group in contrast showed significant improvements for all age groups and all fitness measures. For the 10-12 years old intervention group, Push-Up Test significantly increased from mean pre-intervention value of 12.06±3.111 to mean post-intervention value of 18.25±2.497. Similarly, the Partial Curl-Up Test increased from 11.58±2.191 to 16.83±2.167, and the flexibility scores increased from 11.69±2.317 to 15.73±2.507. Speed and stamina also significantly improved as measured by the 50m Dash, which increased from 9.82±1.391 to 8.70±1.477 seconds and the 600m Run/Walk time, decreased from 3.77±0.975 to 5.01±0.846 minutes.

In the 13-15 years experimental group, the Push-Up Test increased from 12.31±2.080 to 17.79±2.685. The strength of the abdominal musculature significantly improved due to increases in Partial Curl-Up Test scores from 12.26±1.884 to 18.08±2.206. Flexibility also significantly improved with increased scores from 10.99±2.452 to 15.38±2.364. Speed increased as the 50m Dash time decreased from 9.62±1.647 to 8.15±1.515 seconds, and endurance showed increase with the 600m Run/Walk time shifting from 2.96±0.765 to 3.84±0.806 minutes.

For the 16-18 years experimental group, Push-Up Test scores increased from 13.97±2.173 to 19.27±1.760, and Partial Curl-Up Test performance increased from 13.47±2.097 to 18.07±2.318. Scores of flexibilities rose from 11.80±2.759 to 15.70±2.307. Time for the 50m Dash decreased from 10.50±1.641 to 9.32±1.858 seconds. The Stamina scores rose slightly; however, time to complete the 600m Run/Walk was shorter from 2.74±0.607 to 3.10±0.982 minutes.

Table 1: Depicts a comparison between the control and experimental group (Pre and post-test) of the Khelo India fitness test variables

Age group	Variables	Control group				Experimental group			
		Pre		Post		Pre		Post	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
10-12 Years (N=96) CON 48 EXP 48	Muscular endurance push up test (30 seconds)	9.40	2.473	10.38	3.349	12.06	3.111	18.25	2.497
	Abdominal muscular strength partial curl up (30 seconds)	9.90	2.699	10.77	2.875	11.58	2.191	16.83	2.167
	Flexibility Test (cm)	8.29	5.816	8.96	5.235	11.69	2.317	15.73	2.507
	Speed 50 M Dash (30 seconds)	10.22	2.155	11.03	2.140	9.82	1.391	8.70	1.477
	Stamina 600m Run/Walk (min. sec)	4.18	1.112	4.09	1.149	3.77	0.975	5.01	0.846
13-15 Years (N=144) CON 72 EXP 72	Muscular endurance push up test (30 seconds)	9.49	2.556	11.07	2.474	12.31	2.080	17.79	2.685
	Abdominal muscular strength partial curl up (30 seconds)	11.24	2.153	9.92	1.642	12.26	1.884	18.08	2.206
	Flexibility Test (cm)	11.14	1.656	9.99	1.631	10.99	2.452	15.38	2.364
	Speed 50 M Dash (30 seconds)	9.16	1.632	11.13	1.662	9.62	1.647	8.15	1.515
	Stamina 600m Run/Walk (min. sec)	3.00	0.693	2.22	0.659	2.96	0.765	3.84	0.806
16-18 Years (N=60) CON 30 EXP 30	Muscular Endurance Push Up Test (30 seconds)	12.73	3.205	12.40	2.660	13.97	2.173	19.27	1.760
	Abdominal Muscular Strength Partial Curl Up (30 seconds)	13.23	2.473	12.43	2.029	13.47	2.097	18.07	2.318
	Flexibility Test (cm)	11.57	1.924	10.93	1.701	11.80	2.759	15.70	2.307
	Speed 50 M Dash (30 seconds)	9.06	1.688	10.03	1.474	10.50	1.641	9.32	1.858
	Stamina 600m Run/Walk (min. sec)	3.13	0.707	3.07	0.787	2.74	0.607	3.10	0.982

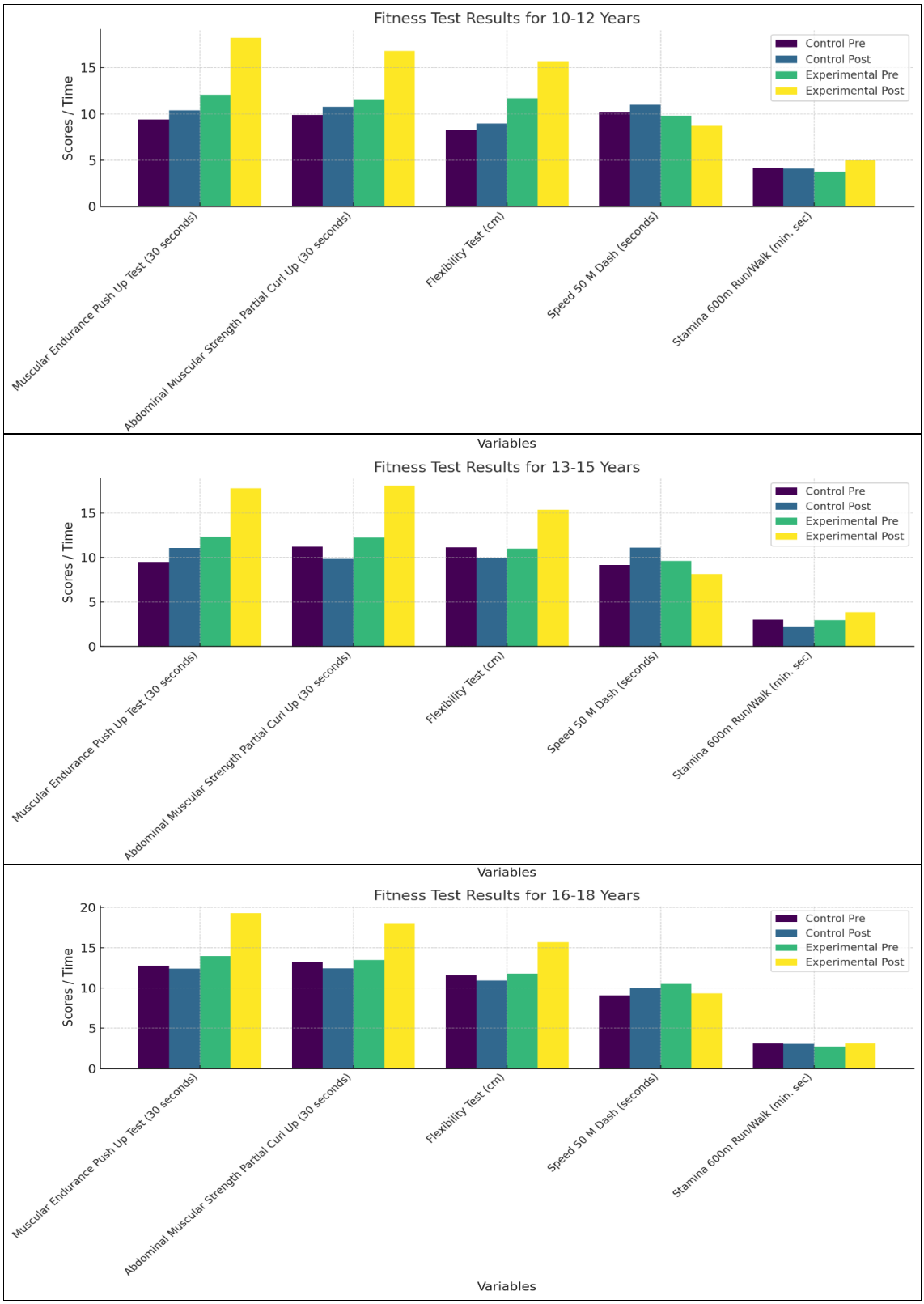

Table 1: Depicts a comparison between the control and experimental group (Pre and post-test) of the Khelo India fitness test variables

The control group's modest improvements suggest the importance of consistent physical activity. However, the experimental group's structured interventions resulted in significantly better outcomes, demonstrating the effectiveness of targeted fitness programs.

With consistency seen in all age categories as well as for every measure of fitness, the research group was clearly outperforming the control group for the effectiveness of structured interventions. The most notable areas of improvement were muscular endurance, abdominal strength, and flexibility-a real key here regarding tailor-made training programs.

The results of the Khelo India fitness test before and after intervention for control and experimental groups were given in Table 1 and Figure 1 below.

4. Conclusion

A consistent, nutrient-rich diet would further improve the performance and fitness of adolescent athletes when gauged on the basis of the Khelo India Fitness Test. This might mark a new precedent in youth athletics development by adding this component to regular training exercises.

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6. Declaration
This paper is not submitted anywhere else.

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