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Analyzing the Impact of an 8-Week Structured Physical Activity Program on Health-Related Fitness in Bhutanese Seventh-Grade Students

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

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Abstract

Objectives. This study aimed to evaluate the impact of an 8-week physical activity program (PAP) on health-related fitness (HRF) components of seventh graders in Bhutan. Its emphasis areas included assessing the program's effects on cardiorespiratory endurance, muscular strength, muscular endurance, flexibility, and body composition.

Materials and methods. Sixty-two students were allocated into two groups using simple random sampling: a control group (n = 31) following the standard physical education curriculum and an experimental group (n = 31) participating in the PAP utilizing the FITT (frequency, intensity, time, and type) principle. Fitness Gram assessments were used to measure HRF before implementing the intervention. Independent t-tests were used to compare results between groups, whereas paired t-tests were used to compare pre-test and post-test scores within groups.

Results. All HRF components demonstrated notable improvements in the experimental group. Cardiorespiratory endurance increased from a mean of 23.23 to 30.57 ($p < 0.05$), muscular strength – from 7.47 to 12.37 ($p < 0.05$), muscular endurance – from a mean of 10.10 to 16.40 ($p < 0.05$), and flexibility – from 27.98 to 29.85 ($p < 0.05$). It was additionally observed an improvement in body composition, with a notable decline in BMI. Conversely, the control group showed a less significant decrease in flexibility and BMI, while demonstrating marked enhancements in cardiorespiratory endurance, muscular strength, and muscular endurance.

Conclusions. The study indicates that the organized PAP was more effective than the standard physical education curriculum in improving HRF components. These findings suggest that the implementation of structured PA programs using the FITT principles can lead to enhanced physical fitness and health-related outcomes among children and young people.

Keywords: Bhutanese student, health-related fitness, physical activity program.

Introduction

The lifestyle changes that are caused by the COVID-19 pandemic have led to the adoption of physical inactivity which became a serious global threat affecting people of all ages. As a result, the decline in health-related fitness (HRF) among children and adolescents should be of particular concern because it increases the likelihood of cardiovascular disease, metabolic syndrome, obesity, and deterioration in life quality (Ye et al., 2018). An alarming trend that has emerged during the 21st century is the rising prevalence of obesity in children and adolescents (Gjonbalaj et al., 2022). Noteworthy is also the fact that 75-81 % of teenagers between 11-17 years from all over the world do not meet the recommended levels of physical activity (PA) (WHO, 2019), which indicates a monotonous trend of inactivity that needs quick intervention.

According to Carlson et al. (2015) and Tremblay et al. (2017), children's excessive screen time and a lack of outdoor activities in the modern day have made them physically inactive. This increases the chances of becoming overweight and less physically active because children find less time for PA at school (Himmelstein et al., 2017).

People who lead sedentary lives also prove burdensome to society due to the costs of healthcare, which represent 1 % to 3 % of the national expenditures (World Health Organization, 2019). This problem is also associated with an increase in non-communicable diseases (NCDs) including diabetes, obesity, and even cardiovascular disease (Bull et al., 2020).

In Bhutan, there is a noticeable increase in physical inactivity and sedentary behavior among adolescents, with

29.12 % reported as physically inactive according to the Global School-Based Health Survey. This decline in HRF corresponds with a rising burden of NCDs, which accounted for 69 % of deaths in 2014 and rose to 71 % by 2019 (Dendup et al., 2020). Conditions such as obesity, diabetes, and heart disease are becoming more prevalent among students (Tamang et al., 2022). The WHO STEPS survey identifies inactivity as a key risk factor for the increasing incidence of NCDs in Bhutan (World Health Organization, 2021).

The physical education curriculum in Bhutan does point out the merits of PA, however, it is rather vague about specific regimes to promote fitness levels (Gyaltshen, 2023). Also, there is a gap for such studies that would connect PA with HRF among children and adolescents based on the FITT principles (frequency, intensity, time, type).

Physical activity is defined as any movement of body muscles that results in energy expenditure greater than resting levels (Almnifi et al., 2023; Bearne, 2023; Kandola & Bann, 2021). Key factors in assessing physical activity include mode, frequency, intensity, duration, and context (Thivel et al., 2018). The NCDs view PA as a vital preventative strategy (Sánchez-Roa et al., 2024).

Engaging in regular PA improves oxygen transport, aerobic capacity, body composition, and muscular strength and endurance (Cooper Institute, 2017). It also strengthens core muscles and bones, helps maintain or reduce body mass, and reduces the risk of chronic conditions like CVD and diabetes, enhancing life expectancy (Amal et al., 2024). Additionally, PA positively impacts mental health by decreasing depression and anxiety while improving cognition (Melnyk et al., 2020; Northey et al., 2018; Rebar et al., 2015). It reduces the likelihood of developing chronic conditions such as CVD and metabolic syndrome (Swift et al., 2014). Pocaan (2024) makes an argument that is considered one of the key aspects that influence overall health.

HRF benefits from regular PA, which encompasses five components: 1) cardiovascular endurance (CRE), 2) muscular strength (MS), 3) muscular endurance (ME), 4) flexibility, and 5) body composition (BC) (American College of Sports Medicine, 2013; Britton et al., 2020). CRE indicates a person's ability to exert effort in cardiovascular and respiratory function (Britton et al., 2020), while MS measures the maximum force a muscle can generate (Smith et al., 2014). ME reflects the ability to sustain muscle strength over time (Smith et al., 2014), and flexibility pertains to the range of motion in joints (Knudson, 2018). Body composition involves the various components that make up the body (American College of Sports Medicine, 2013).

Research indicates that these five components are critical standards for assessing training effectiveness, enabling a comprehensive evaluation of HRF. This broader assessment provides a solid foundation for understanding an individual's fitness and health. Additionally, studies show that traditional gender role stereotypes affect HRF rates, with males generally outperforming females in all components except flexibility (Santos et al., 2014). However, the core elements of the HRF construct are consistent across genders.

The literature review revealed a gap in research on the impact of PAP on the HRF of adolescents in Bhutan, particularly concerning Bhutanese anthropology. While international studies show that physical inactivity harms HRF, most research has focused on developed countries, highlighting the need for region-specific studies.

This study evaluates the impact of PAP on HRF among Bhutanese students, focusing on CRE, MS, ME, flexibility, and BC. It is based on two hypotheses: that PAP will significantly improve HRF within the same group over time and that there will be notable HRF score differences between the two groups after a post-test. The findings aim to enhance scholarly literature and assist educators and decision-makers in promoting youth health and fitness in Bhutan.

Materials and Methods

Study Participants

The study participants were a total of 402 students of Pema Gatshel Middle Secondary School in Bhutan. The sample size n = 62 was computed using the G*Power program, version 3.1.9.7, and utilized an effect size of 0.8, p = 0.05, and test power of 95 % (1-β = 0.95). In this regard, it was determined that the sampling size was 28 participants per group. However, to prevent cases of potential dropouts during data collection, a further 10 % (3 participants per group) was included. As such, the 62 participants were divided, 31 into the experimental group and 31 in the control group. The inclusion and exclusion criteria were as follows:

Inclusion Criteria

1. Bhutanese students enrolled in an educational institution in Bhutan.
2. Aged 13 to 17 years.
3. Not involved in other research studies.
4. No history of chronic diseases (cardiovascular, diabetes, asthma, neurological conditions, hypertension).
5. Confirmed participation in the program.
6. Previous experience in physical activities without limitations.

Exclusion Criteria

1. History of chronic diseases.
2. Disabilities hindering participation in physical activities.
3. Aged under 13 or over 18 years.
4. Currently involved in other research studies.
5. No consent from a Legally Authorized Representative (LAR).

Due to one participant from the experimental group withdrawing and another from the control group being lost to follow-up, the final analysis included 60 participants: 30 from the experimental group and 30 from the control group as shown in the demographic characteristics in Table 1 and the outline of the PAP and HRF testing schedule in Figure 1.

Study Design

This study employed a two-group quasi-experimental design consisting of an experimental group (EG) and a control group (CG). The structure of the experimental plan is outlined as follows:

EG (n = 31): $O_1 \rightarrow X_1 \rightarrow O_2$

CG (n = 31): $O_3 \rightarrow X_2 \rightarrow O_4$

where X_1 represents the implementation of a PAP based on the FITT (frequency, intensity, time, and type) principle, developed by the research team.

X_2 represents the standard physical education class based on the prescribed PE curriculum in Bhutan.

O_1 and O_3 indicate pre-experiment HRF assessments for the experimental and control groups.

O_2 and O_4 represent post-experiment HRF assessments conducted after eight weeks of the intervention.

The research began with the administration of the HRF pre-test using the FitnessGram test batteries for both the experimental and control groups. The experimental group then participated in an 8-week structured PAP with two 60-minute sessions per week, while the control group followed Bhutan's Physical Education curriculum with one 40-minute session per week. After the intervention, both groups were retested to assess their HRF levels, and the mean scores were calculated.

Research Instrument

The research instrument for this study consists of adapted physical fitness test batteries from FitnessGram, developed by the Cooper Institute (Table 3). While various tools assess HRF globally, this study used FitnessGram because it includes a comprehensive set of age- and sex-specific tests that align with criterion-referenced health standards for children and youth (Cooper Institute, 2017).

Table 1. Demographic characteristics of participants (n = 60)

Variables	Experimental Group (n = 30)		Control Group (n = 30)	
	n	%	n	%
Sex				
Male	13	43.33	13	43.33
Female	17	56.67	17	56.67
Age (year)				
13	12	40.00	0	0.00
14	14	46.67	20	66.67
15	3	10.00	6	20.00
16	0	0.00	4	13.33
17	1	3.33	0	0.00

Adaptations were made from credible sources to ensure the instrument's validity and appropriateness for this research.

Human Research Ethics

This study received ethical approval from the research ethics review committee of Naresuan University, under

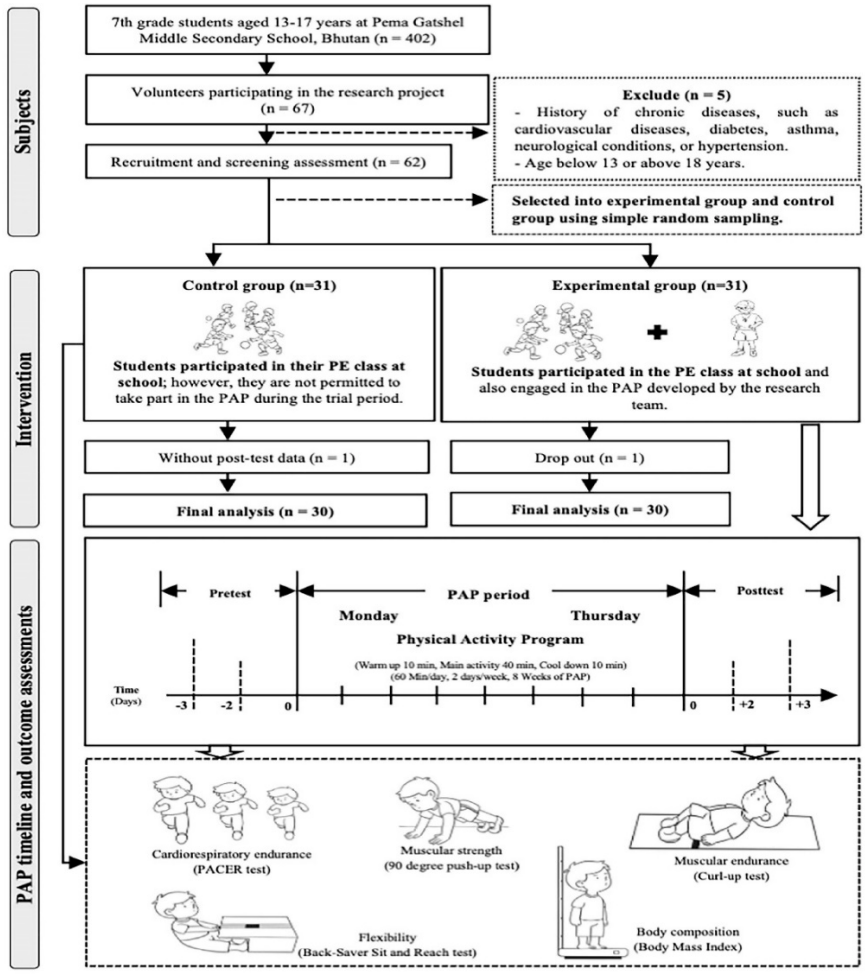

Fig. 1. Outline of PAP and HRF testing schedule

Table 2. Summary of treatment program design for week 1-8

Week	Experimental group (PAP)		Control group (PE)
	Activity	Duration	Activity Duration
1	Yoga for Flexibility.	60’	A 40-minute Physical Education (PE) class per week, with activities aligned to the prescribed Physical Education curriculum in Bhutan
	Partner Stretching.	60’	
2	Outdoor Stretching Adventure.	60’	
	Resistance Band Exercises.	60’	
3	Yoga for Strength.	60’	
	Flexibility Circuit Training.	60’	
4	Bodyweight Circuit.	60’	
	Resistance Band Workout.	60’	
5	Calisthenics Routine.	60’	
	Partner Squat.	60’	
6	Circuit Training.	60’	
	Aerobic Dance.	60’	
7	Run for Distance.	60’	
	Uphill Relay.	60’	
8	Soccer Drills.	60’	
	Team Sports.	60’	

Table 3. Health-Related Fitness Test Battery

Components	Test battery	Assessment
Cardiorespiratory Endurance (CRE)	Progressive Aerobic Cardiovascular Run (PACER)	Maximum aerobic fitness of students
Muscular Strength (MS)	90-degree push-up	Upper body strength and endurance
Muscular Endurance (ME)	Curl up	Abdominal muscle endurance
Flexibility	Back-Saver Sit and Reach	Flexibility of left and right legs
Body Composition (BC)	Body Mass Index (BMI)	Body composition

the approval code COA No. 309/2024 NU-IRB No. P1-0014/2567. Informed written consent was obtained from each volunteer before participation in the study.

Statistical analysis

This study analyzed data using descriptive and inferential statistics, specifically focusing on HRF mean scores. Descriptive statistics were used to present the mean HRF scores, providing an overview of data distribution and key characteristics (Wibowo et al., 2024). The Shapiro-Wilk test assessed normality before the experiment. Within-group comparisons of pre-test and post-experiment HRF scores used paired t-tests, while independent t-tests were applied for between-group comparisons after the 8-week intervention. Statistical significance was set at p = 0.05, with all analyses conducted using SPSS software.

Results

This study involved 60 seventh-grade students from Pema Gatshel Middle Secondary School in Bhutan, divided into an experimental group and a control group, each with 30 students (13 males and 17 females, average age 14 ± 0.9 years). It investigates the effects of a structured PAP on HRF across five components: CRE, MS, ME, flexibility, and BC, comparing the outcomes with those of standard PE.

Table 4 compares the mean scores for HRF components in the experimental group (n = 30) and control group (n = 30) before and after the intervention. The paired sample t-test showed significant differences (p = 0.05), indicating that the intervention improved all fitness components. In the context of CRE, the mean showed an increase of 7.34 (p = 0.00). MS rose by 4.90 (p = 0.00), and ME improved by 6.30 (p = 0.00). Flexibility showed a slight increase of 1.87 (p = 0.00), while BC experienced a decrease of 1.49 (p = 0.00).

The control group significantly improved several fitness components. CRE increased by 1.93 (p = 0.00), and MS rose by 1.70 (p = 0.00). The ME showed an improvement of 1.47 (p = 0.03), while flexibility remained unchanged (p = 0.14).

Table 4. Comparison of Pretest and Posttest Health-Related Fitness Scores in the experimental group and control group

Components	Group	Test	n	Mean	SD	t-value	Sig.
CRE	EXP	Pre	30	23.23	10.42	-6.23	0.00*
		Post	30	30.57	13.98		
	CON	Pre	30	21.30	9.91	-8.81	0.00*
		Post	30	23.23	10.64		
MS	EXP	Pre	30	7.47	4.34	-17.97	0.00*
		Post	30	12.37	4.98		
	CON	Pre	30	7.30	5.39	-5.16	0.00*
		Post	30	9.00	5.48		
ME	EXP	Pre	30	10.10	7.48	-10.10	0.00*
		Post	30	16.40	8.48		
	CON	Pre	30	10.00	6.03	-2.29	0.03*
		Post	30	11.47	7.11		
Flexibility	EXP	Pre	30	27.98	5.82	-3.33	0.00*
		Post	30	29.85	5.05		
	CON	Pre	30	24.43	5.30	-1.54	0.14
		Post	30	25.86	5.49		
BC	EXP	Pre	30	22.45	3.56	14.12	0.00*
		Post	30	20.96	3.54		
	CON	Pre	30	22.46	2.86	6.48	0.00*
		Post	30	21.67	2.77		

*Significant p = 0.05, CRE = cardiorespiratory endurance, MS = muscular strength, ME = muscular endurance, BC = body composition, EXP = experimental group, CON = control group.

Table 5. Comparison of Posttest Health-Related Fitness Scores between experimental group and control group (n = 60)

Components	Group	n	Mean	SD	t-value	Sig.
CRE	EXP	30	30.57	13.98	2.29	0.03*
	CON	30	23.23	10.64		
MS	EXP	30	12.37	4.98	2.49	0.02*
	CON	30	9.00	5.48		
ME	EXP	30	16.40	8.48	2.44	0.02*
	CON	30	11.47	7.11		
Flexibility	EXP	30	29.85	5.05	2.93	0.01*
	CON	30	25.86	5.49		
BC	EXP	30	20.96	3.54	-0.87	0.39
	CON	30	21.67	2.77		

*Significant $p < 0.05$, CRE = cardiorespiratory endurance, MS = muscular strength, ME = muscular endurance, BC = body composition, EXP = experimental group, CON = control group.

BC also improved, with a decrease of 0.79 in the mean ($p = 0.00$). Overall, there were notable improvements in endurance, strength, and body composition.

Table 5 indicates post-test analysis comparing the experimental group (EXP) and the control group (CON) reveals significant improvements in various fitness components. The EXP achieved a mean score in CRE that was higher than the CON by a mean difference of 7.34 ($p = 0.03$). In MS, EXP scored higher by a mean difference of 3.37 ($p = 0.02$). The EXP also recorded a higher mean in ME, with a mean difference of 4.93 compared to the CON ($p = 0.02$). Flexibility improved as well, with EXP scoring higher than CON by a mean difference of 3.99 ($p = 0.01$). Although BMI did not show a significant difference ($p = 0.39$), the EXP had a lower mean BMI, indicating a positive trend in body composition.

Discussion

The PAP was more effective at improving HRF than the standard PE program. Incorporating FITT principles, the PAP successfully enhanced students' fitness levels by targeting all HRF components. Significant improvements were observed after the 8-week program.

Figure 2 indicates that the results showed a significant improvement in post-test scores for CRE in the experimental group compared to the control group, which also showed some improvement but to a lesser extent. Participants in the experimental group had a mean difference of 7.34, demonstrating the benefits of organized PAP that included running, jogging, and movement exercises. Over the 8 weeks, increasing task difficulty enhanced oxygen uptake and cardiovascular efficiency. The FITT principles were applied to carefully monitor and adjust exercise frequency and intensity, ensuring students faced appropriate challenges. In contrast, the control group, following a standard PE curriculum, experienced limited improvements in CRE due to fewer aerobic workouts. This finding aligns with research by Song et al. (2021), which noted that targeted cardiovascular exercise programs can enhance strength among schoolchildren. The principle of specificity was crucial, as the PAP focused on exercises designed to boost cardiovascular efficiency, unlike standard PE programs.

Additionally, the experimental group exhibited a significant increase in muscular strength with a mean difference of 4.90. This improvement resulted from incorporating resistance exercises like push-ups and bodyweight training, which effectively overloaded the muscles within each student's physical limits. In contrast,

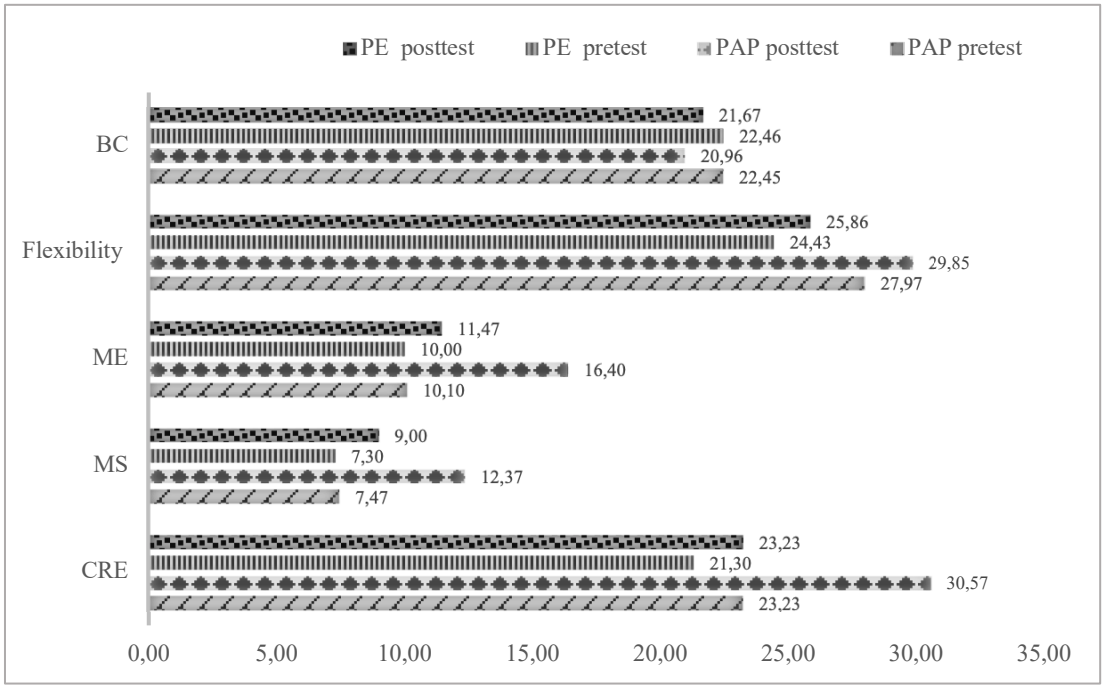

Fig. 2. Changes in HRF after 8 weeks of the intervention period

the control group experienced only a minimal increase in strength, with a mean difference of 1.70, likely due to the absence of systematic muscle toning activities in the standard PE curriculum. The overload principle was key to the PAP, enabling students to progressively enhance their strength. Gonçalves et al. (2019) highlighted that structured physical activity, including resistance training, significantly improves basic motor skills in schoolchildren. These findings suggest that targeted resistance exercises should be integrated into the PAP, as they are often overlooked in standard PE programs.

Similarly, the experimental group showed a significant improvement in muscular endurance, with a mean difference of 6.30. This increase reflects a better ability to sustain muscle contractions. The repetitive exercises in the PAP focused on low resistance and high repetitions, including bodyweight squats and planks. In contrast, the control group had a mean difference of 1.47, though this change was less significant due to a lack of structured endurance exercises in their PE sessions. The success of the PAP was largely due to its progressive design, enabling students to gradually enhance their endurance levels. These findings align with research by Cvejic and Ostojić (2018), which showed that structured PAPs effectively improve muscular endurance in school-aged children. The program adhered to FITT principles, focusing on the frequency and intensity of workouts, resulting in greater improvements than standard PE curricula.

Moreover, the experimental group demonstrated better flexibility than the control group, with a mean score difference of 1.87. This improvement is likely due to the targeted stretching exercise and dynamic and static stretching included in the PAP during warm-up and cool-down sessions, which focused on major muscle groups and joints. In contrast, the control group, following the standard PE curriculum, saw a modest change with a mean score difference of 1.43 due to limited flexibility training. Flexibility is essential for injury prevention and performance enhancement, yet it often receives insufficient attention in fitness programs. The PAP's targeted approach contrasts with the broader focus of typical PE classes. Supporting this, Ługowska et al. (2023) found that targeted stretching significantly improves adolescents' flexibility.

With the changes in body composition, the experimental group experienced a significant improvement with a mean score difference of 1.49. Such an enhancement is seen as a result of calorie-burning exercises incorporated in the PAP intending to increase the students' lean muscles. Conversely, the control group had a slight decrease in body mass index from a mean score difference of 0.79, which was sufficient to emphasize the non-physical impact of standard PE lessons on body composition. This is consistent with the findings of Swift et al. (2014), who found that supervised PAPs incorporating aerobic and resistance exercises were superior in improving body composition than general activity programs. Overload was a relevant concept in the PAP, as exercising with high- and low-intensity aerobic exercise with resistance training worked together to keep a calorie deficit while encouraging muscle expansion, thus improving overall body composition. It is acknowledged that to improve body composition, the two interventions of aerobic and resistance training should be encouraged and included in the PAPs, a prediction that is sometimes neglected in regular PE classes.

The study's results indicate that the PAP, designed with the FITT principles, was more effective than traditional PE in improving HRF among seventh-grade students. The PAP led to significant gains in cardiorespiratory endurance, muscular strength, muscular endurance, flexibility, and body composition through its organized approach with targeted exercises.

By applying the FITT principles, the program provided an optimal stimulus for enhancing fitness. These findings suggest that implementing structured PAPs in schools can lead to better fitness outcomes for children, promoting their overall health and well-being. Moreover, they highlight the inadequacies of the traditional PE curriculum, suggesting a need for a more integrated approach to PE.

Conclusions

The current study showed that with proper planning and application of the FITT principles, a PAP can significantly improve the HRF levels of school-aged children. The findings support implementing structured PAPs in schools to address all HRF components, helping children achieve lasting fitness and health benefits. Additionally, the study highlights the need for specific exercises, progressive overload, and appropriate intensities in PAP design to foster positive changes in fitness. These programs aim to combat the growing concerns of physical inactivity and its health consequences among children.

Recommendations

Recommendations for the Implications of the Study:

1. The study's findings can guide schools in Bhutan to adopt similar PAPs.
2. A structured PAP based on FITT principles can offer students a more effective fitness experience than traditional PE classes.

Recommendations for Further Research:

1. Future research should examine the long-term effects of PAPs on student fitness and health outcomes over extended periods.
2. Studies should also consider integrating nutritional guidance with PAPs to improve body composition.
3. Expanding research to include larger, diverse populations in Bhutan would provide valuable insights for policymakers in developing tailored health promotion programs.

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Conflict of interest

The authors declare that there is no conflict of interest.

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Аналіз впливу 8-тижневої структурованої програми фізичної активності на показники оздоровчого фітнесу учнів сьомих класів у Бутані

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 9 с., 5 табл., 2 рис., 37 джерел.

Мета дослідження. Мета цього дослідження полягала в проведенні аналізу впливу 8-тижневої програми фізичної активності (ПФА) на компоненти оздоровчого фітнесу (ОФ) учнів сьомих класів у Бутані. Основні напрямки дослідження включали оцінку впливу програми на показники кардіореспіраторної витривалості, м'язової сили, м'язової витривалості, гнучкості і композиції тіла.

Матеріали та методи. За методом простої випадкової вибірки 62 студенти було розподілено на дві групи: контрольну (n = 31), яка займалася за стандартною програмою фізичного виховання, та експериментальну (n = 31), яка брала участь у ПФА із застосуванням принципу FITT ("frequency", "intensity", "time", and "type" — частота, інтенсивність, час і тип). Перед впровадженням інтервенції з метою вимірювання показників ОФ використовували методику Fitness Gram. Для проведення порівняльного аналізу результатів між групами використовували t-критерії для незалежних вибірок, а для зіставлення результатів на перед- та післятестовому етапах дослідження — t-критерії для парних вибірок в межах зазначених груп.

Результати. В експериментальній групі помітно покращилися всі компоненти ОФ. Кардіореспіраторна витривалість зросла в середньому з 23,23 до 30,57 ($p < 0,05$), м'язова сила — з 7,47 до 12,37 ($p < 0,05$), м'язова витривалість — з 10,10 до 16,40 ($p < 0,05$), а гнучкість — з 27,98 до 29,85 ($p < 0,05$). Крім того, спостерігалося поліпшення показників композиції тіла, з істотним зниженням індексу маси тіла (ІМТ). Натомість у контрольній групі спостерігалося менш значне зниження показників гнучкості та ІМТ, водночас відзначалося виражене підвищення рівнів кардіореспіраторної витривалості, м'язової сили та м'язової витривалості.

Висновки. Дослідження вказує на ефективність застосування організованої ПФА щодо покращення компонентів ОФ порівняно зі стандартною навчальною програмою з фізичного виховання. Отримані дані свідчать про доцільність впровадження структурованих програм фізичної активності із застосуванням принципів FITT для підвищення показників фізичної підготовленості та оздоровчих результатів серед дітей та молоді.

Ключові слова: бутанський учень, оздоровчий фітнес, програма фізичної активності.

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