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Research Article

Impact of Nias Culture-Based Physical Training on Students' Cardiovascular Endurance

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Abstract

Background: Cardiovascular endurance among young adults is declining due to low engagement in conventional training. Culture-based physical training offers a promising alternative. However, empirical evidence remains limited. ***Objective***: This study aims to evaluate the effectiveness of a structured Nias culture-based physical training program incorporating *Fate'u* and *Fasukhu* activities in improving cardiovascular endurance among young adults. ***Methods***: A 12-week pre–post quasi-experimental study was conducted with 120 students (18–22 years) selected through purposive sampling and allocated into two groups: the Nias Culture-Based Physical Training (NCBPT) group and a conventional group (CG) that maintained their usual daily physical activities. Participants performed (NCBPT) three times per week (30–60 minutes/session). Cardiovascular endurance was assessed using the 20-m shuttle run test. Between-group differences in pre-post changes were analyzed using an independent samples t-test. ***Results***: Each group improved cardiovascular endurance, with the NCBPT group showing greater gains (Δ = 6.16, 21.6%, Cohen's d = 1.02) than the conventional group (Δ = 1.20, 4.2%, Cohen's d = 0.94). These results indicate that the NCBPT program was significantly more effective in enhancing aerobic capacity than conventional physical activities. ***Conclusions***: The NCBPT program demonstrated superior effectiveness in enhancing cardiovascular endurance compared to the control condition. This approach offers a practical and culturally relevant training strategy for improving aerobic fitness in sports and educational contexts.

Keywords: Aerobic fitness; Cardiovascular endurance; Nias culture; Young adults.

تأثير التدريب البدني القائم على ثقافة نياس على تحمل القلب والأوعية الدموية لدى الطلاب

الخلاصة

الخلفية: تتراجع قدرة تحمل القلب والأوعية الدموية بين الشباب بسبب انخفاض المشاركة في التدريب التقليدي. التدريب البدني القائم على الثقافة يقدم بديلا واعدا. ومع ذلك، لا تزال الأدلة التجريبية محدودة. **الهدف**: تقييم فعالية برنامج تدريب بدني منظم قائم على ثقافة نياس يدمج أنشطة فاتيو وفاسوكهو في تحسين تحمل القلب والأوعية الدموية بين الشباب. **الطرائق**: أجريت دراسة شبه تجريبية استمرت 12 أسبوعا قبل و بعد الدراسة شبه التجريبية مع 120 طالبا (18–22 سنة) تم اختيارهم من خلال أخذ عينات هادفة وتم توزيعهم إلى مجموعتين: مجموعة التدريب البدني القائم على ثقافة نياس (NCBPT) ومجموعة تقليدية (CG) التي حافظت على أنشطتها البدنية اليومية المعتادة. قام المشاركون بأداء (NCBPT) ثلاث مرات في الأسبوع (30–60 دقيقة لكل جلسة). تم تقييم قدرة التحمل القلبية الدموية باستخدام اختبار الجري لمسافة 20 مترا. تم تحليل الفروق بين المجموعات في التغيرات قبل وما بعد التغيير باستخدام اختبار t مستقل للعينات. **النتائج**: حسنت كل مجموعة من التحمل القلبي الوعائي، حيث أظهرت مجموعة NCBPT مكاسب أكبر مقارنة بالمجموعة التقليدية (Δ = 1.20، 4.2٪، كوهين d = 0.94). تشير هذه النتائج إلى أن برنامج NCBPT كان أكثر فعالية بشكل ملحوظ في تعزيز القدرة الهوائية مقارنة بالأنشطة البدنية التقليدية. **الاستنتاجات**: أظهر برنامج NCBPT فعالية أفضل في تعزيز التحمل القلبي الوعائي مقارنة بالحالة الضابطة. يقدم هذا النهج استراتيجية تدريب عملية وذات صلة ثقافية لتحسين اللياقة الهوائية في الرياضة والسياقات التعليمية.

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INTRODUCTION

Cardiovascular endurance is a fundamental component of physical fitness that plays a crucial role in sustaining prolonged physical activity and preventing non-communicable diseases such as hypertension, cardiovascular disease, and obesity [1,2]. However, recent studies have reported a concerning decline in aerobic fitness among young adults, largely attributed to sedentary lifestyles, increased screen time, and low participation in structured physical activity programs [3-5]. Empirical evidence indicates that a substantial proportion of university students exhibit low to moderate levels of cardiovascular endurance, leading to the need for more effective and engaging training interventions. Conventional exercise programs, while physiologically effective, often fail to maintain long-term adherence due to their repetitive and monotonous nature. Previous research has shown that motivation and enjoyment are key determinants of exercise participation and consistency, suggesting that training models should incorporate elements that enhance engagement [6-9]. In this context, integrating cultural values into physical activity has emerged as a promising approach. Studies have demonstrated that culturally relevant exercise not only improves participation rates but also strengthens psychological

attachment and intrinsic motivation, ultimately leading to better physiological outcomes [10-13]. Nias culture offers a unique and underexplored foundation for developing innovative training programs [14]. Traditional activities such as *fahombo* (stone jumping), war dances, and coordination-based games involve complex motor patterns, rhythmic movements, and high-intensity physical demands that align with modern principles of aerobic and plyometric training [15,16]. Specifically, the traditional activities *Fate'u* and *Fasukhu* incorporate dynamic jumping, running, and coordination elements that resemble interval training and circuit-based conditioning. Previous findings suggest that such movement patterns can effectively stimulate cardiovascular responses, improve oxygen uptake, and enhance overall aerobic capacity [17,18]. Despite the growing interest in culturally integrated training approaches, empirical studies examining their direct impact on cardiovascular endurance remain limited, particularly within the context of Indonesian local cultures [19-21]. Most existing research has focused on general physical activity interventions without considering cultural relevance as a key factor influencing effectiveness and adherence [22-24]. Therefore, there is a clear research gap in developing and scientifically validating culture-based training models that combine physiological effectiveness with cultural significance. Based on this rationale, the present study aims to evaluate the effectiveness of a structured Nias culture-based physical training program incorporating *Fate'u* and *Fasukhu* activities in improving cardiovascular endurance among young adults. It is hypothesized that this culturally grounded training approach will produce significant improvements in aerobic capacity while also offering a more engaging and sustainable alternative to conventional exercise programs.

METHODS

Study design

This study used a quantitative pre–post quasi-experimental design to assess the effects of Nias culture-based physical training on cardiovascular endurance. The intervention lasted 12 weeks, divided into three progressive phases.

Study participants

A total of 120 university students (mean age: 20.2 ± 0.76 years; height: 166.8 ± 5.1 cm; weight: 58.8 ± 7.4 kg; BMI: 20.2 ± 2.2 kg/m²) participated in this study and were divided into an intervention group (NCBPT, n= 60) and a conventional group (CG, n= 60). Participants were selected using a purposive sampling method.

Inclusion criteria

Subjects aged 18–22 years, physically healthy, actively engaged in academic activities, and with no history of cardiovascular or respiratory disorders.

Exclusion criteria

Included any medical condition or musculoskeletal injury that could limit participation in physical activity.

Sample size calculation

Sample size was determined a priori using G*Power, based on effect sizes from previous studies examining cardiovascular endurance responses to aerobic and interval training, with a targeted statistical power of 0.80 and an alpha level of 0.05.

Intervention and outcome measurement

The intervention group underwent a structured physical training program based on Nias cultural activities, specifically *Fate'u* (throw and catch coordination) and *Fasukhu* (dynamic jumping and endurance-based locomotor activity), which incorporate aerobic and plyometric characteristics essential for cardiovascular conditioning. Participants in the intervention group engaged in three training sessions per week throughout the study period. Meanwhile, the conventional group (CG) continued their usual daily activities without participating in the structured training program. Based on self-report during the initial screening, CG participants typically engaged in unsupervised jogging approximately 1–2 times per week, with each session lasting 20–30 minutes at a low to moderate intensity (self-reported RPE of 9–11 on the 6–20 Borg scale). No structured monitoring or progressive overload was applied to the CG. It is acknowledged that the lack of objective monitoring of CG activities represents a limitation of this study. The conventional group continued their usual daily activities without participating in the structured training program. Based on self-report, CG participants typically engaged in unsupervised jogging approximately 1–2 times per week, with each session lasting 20–30 minutes at low to moderate intensity (self-reported RPE 9–11 on the 6–20 Borg scale). No structured monitoring or progressive overload was applied to the CG.

NCBPT

The training program was conducted over a 12-week period and structured into three progressive phases: adaptation, development I, and development II. Each phase was designed to gradually increase training intensity and complexity to promote optimal cardiovascular adaptation. Training sessions were performed three times per week, with a duration ranging from 30 to 60 minutes per session. Exercise intensity was monitored using a percentage of the maximum heart rate (HRmax) and a rating of perceived exertion (RPE). During the adaptation phase (Weeks 1–4), participants performed moderate-intensity exercises at 60–70% HRmax (RPE 11–13) for 30–35 minutes per session (Table 1).

Table 1: Structure of the Nias culture-based training program

Phase	Duration & Frequency	Intensity	Main Training Components
Adaptation (Weeks 1–4)	30–35 minutes, 3×/week	60–70% HRmax (RPE 11–13)	Dynamic Faluaya steps (forward–backwards, arm swings); low rhythmic jumps (30–40 cm); 6-post light circuit (jumping jacks, squats, skipping, plank steps, side shuffles, high knees)
Development I (Weeks 5–8)	35–40 minutes, 3×/week	70–80% HRmax (RPE 15–17)	Interval Faluaya steps; medium rhythmic jumps (40–50 cm); 8-post circuit including burpees and mountain climbers
Development II (Weeks 9–12)	40–60 minutes, 3×/week	75–85% HRmax (RPE 15–17)	High rhythmic jumps (50–60 cm); 8-post HIIT circuit (jump squat, burpee, push-up clap, speed skipping, plank jack, mountain climber, jumping lunges, side shuffle)

The activities included dynamic Faluaya movement patterns (forward–backward steps with coordinated arm swings), low-intensity rhythmic jumps (30–40 cm), and a six-station light circuit consisting of jumping jacks, squats, skipping, plank steps, side shuffles, and high knees. This phase aimed to prepare participants physiologically and reduce injury risk. In the development I phase (Weeks 5–8), training intensity increased to 70–80% HRmax (RPE 15–17), with session durations of 35–40 minutes. Exercises incorporated interval-based Faluaya movements, medium-intensity rhythmic jumps (40–50 cm), and an eight-station circuit that included higher-intensity movements such as burpees and mountain climbers. This phase focused on improving aerobic capacity and muscular endurance. During the development II phase (Weeks 9–12), participants trained at 75–85% HRmax (RPE 15–17) for 40–60 minutes per session. The program included high-intensity rhythmic jumps (50–60 cm) and an eight-station high-intensity interval training (HIIT) circuit comprising jump squats, burpees, push-up claps, speed skipping, plank jacks, mountain climbers, jumping lunges, and side shuffles. This final phase aimed to maximize cardiovascular endurance and enhance overall physiological performance. Overall, the progressive structure of the program, combined with culturally based movement patterns and interval training principles, was designed to optimize cardiovascular adaptation while maintaining participant engagement.

Cardiovascular endurance measurement

Cardiovascular endurance was assessed indirectly using the 20-metre multistage fitness test (beep test) [25], a validated field-based measure of estimated maximal oxygen consumption (VO_2max). Participants ran continuously between two 20-meter markers in time with auditory beeps that progressively increased in speed. The test ended when a participant failed to reach the end line before the beep on two consecutive occasions. The final completed stage and shuttle number were recorded and converted to an estimated VO_2max value using standardized prediction equations. It is important to acknowledge that this test provides an indirect estimate of cardiovascular endurance. Direct measurement using expired gas analysis during a graded exercise test would offer greater physiological precision.

Ethical considerations

Prior to data collection, all participants were informed about the study procedures and provided written informed consent. The study was conducted in accordance with the principles of the Declaration of Helsinki [26].

Statistical analysis

All statistical analyses were performed using SPSS version 22 (IBM Corp., Armonk, NY, USA) with a significance level set at $p< 0.05$. Data normality was assessed using the Shapiro–Wilk test, and homogeneity of variance was evaluated using Levene's test. Differences within groups (pretest *vs*. posttest) were analyzed using paired sample t-tests. To compare the effectiveness between groups, independent samples t-tests were performed on the change scores (posttest - pretest). Effect sizes were calculated using Cohen's d for within-group comparisons and for between-group differences using pooled standard deviations. Statistical significance was set at $p< 0.05$.

RESULTS

A total of 120 university students (mean age: 20.2 ± 0.76 years; height: 166.8 ± 5.1 cm; weight: 58.8 ± 7.4 kg; BMI: 20.2 ± 2.2 kg/m²) participated in this study and were divided into an intervention group (n= 60) and a conventional group (n= 60). All participants were in good health and actively engaged in academic activities. Baseline characteristics were within normal ranges, indicating a relatively homogeneous sample. No significant differences were observed between groups at baseline, confirming comparability for subsequent analysis. The results show an increase in cardiovascular endurance from pre-test to post-test in both groups: NCBPT (28.57 ± 1.28 to 34.73 ± 1.63) and CG (28.60 ± 1.30 to 29.80 ± 1.26). Both groups demonstrated statistically significant improvements. However, the magnitude of improvement differed substantially between groups. The NCBPT group showed a large improvement of 21.56% (Δ= 6.16), while the CG group showed a modest improvement of 4.2% (Δ= 1.20). Thus, although both groups improved, the NCBPT group exhibited a substantially greater gain in cardiovascular endurance compared to the control group. Further details are presented in Table 2.

Table 2: The mean differences, standard deviations, and percentage improvements in pretest and posttest Cardiovascular Endurance for each treatment group

Training Method	Pre-test	Post-test	Δ	%
NCBPT	28.57±1.28	34.73±1.63	6.16	21.56
CG	28.60±1.3	29.8±1.26	1.20	4.2

Values are presented as mean±SD. NCBPT: Nias culture-based physical training; CG: conventional group; Δ= change in values.

Table 3 shows that the data met assumptions of normality and homogeneity (p> 0.05). The Shapiro–Wilk test indicated that the data were normally distributed (W= 0.973, n= 60, p= 0.979), as the p-value exceeded the threshold of 0.05. Furthermore, Levene's test showed that the variances were homogeneous (p= 0.142), indicating no significant differences in variance across groups. These results demonstrate that the assumptions of normality and homogeneity of variance were satisfied, thereby justifying the use of parametric statistical tests in subsequent analyses.

Table 3: Testing for normality and homogeneity

Normality test		Homogeneity test	
Shapiro Wilk		Levene's	
Statistic	*p*-value	F	*p*-value
0.973	0.979	2.36	0.142

Note. The data are normally distributed and homogeneous (p> 0.05).

Table 4 presents the results of paired sample tests and within-group Cohen's d. Both groups experienced statistically significant improvements from pretest to posttest. In the NCBPT group, the p-value (p< 0.0001) demonstrates a highly significant improvement in cardiovascular endurance following the intervention. This is further supported by a large effect size (Cohen's d= 1.02), indicating a strong and practically meaningful impact of the training program. The control group also showed a statistically significant improvement (p= 0.021) with a large effect size (Cohen's d= 0.94). However, it is important to interpret this finding cautiously. The large effect size in the CG group is partly attributable to the low standard deviation of the change scores rather than a large absolute improvement (Δ= 1.20, 4.2%). In contrast, the NCBPT group's large effect size corresponded to a substantially larger absolute gain (Δ= 6.16, 21.6%). Overall, while both groups demonstrated significant within-group changes, the combination of a lower p-value and a higher effect size in the NCBPT group highlights the greater effectiveness of the intervention in enhancing cardiovascular endurance.

Table 4: Within-group comparisons of cardiovascular endurance using paired t-tests

Origin	95% CI	*p*-value	Cohen's d
Pretest NCBPT-Posttest NCBPT	5.70 - 6.62	<0.0001	1.02
Pretest CG-Posttest CG	0.82 - 1.58	0.021	0.94

NCBPT: Nias culture-based physical training; CG: conventional group. The difference is statistically significant (p< 0.05).

To directly compare the effectiveness of the two conditions, an independent samples t-test was conducted on the change scores (post-test minus pre-test) between the NCBPT and CG groups. As shown in Table 5, the NCBPT group demonstrated a significantly greater improvement in cardiovascular endurance (Δ= 6.16 ± 1.78) compared to the CG group (Δ= 1.20 ± 1.48); t(118)= 14.82, p< 0.001. The between-group effect size was very large (Cohen's d= 1.64), confirming that the Nias culture-based training was substantially more effective than conventional physical activities in enhancing aerobic capacity.

Table 5: Between-group comparison of change scores (post-test minus pre-test)

Origin	Mean Δ±SD	95% CI of Δ	p-value	Cohen's d
NCBPT	6.16±1.78	5.70-6.62	<0.001	1.64
CG	1.20±1.48	0.82-1.58		

Note: Independent samples t-test comparing the mean change scores (post-test minus pre-test) between NCBPT and CG groups. Cohen's d represents the between-group effect size.

DISCUSSION

The present study aimed to examine the effectiveness of a Nias culture-based physical training program in improving cardiovascular endurance among early adult students. The findings clearly demonstrate that the intervention group experienced a significantly greater improvement in cardiovascular endurance compared to the conventional group. Although the CG group showed a modest but statistically significant improvement (4.2%, p= 0.021), the NCBPT group's gain was substantially larger (21.6%, p< 0.001). The between-group comparison confirmed that the NCBPT program was superior (t(118)= 14.82, p< 0.001, Cohen's d= 1.64). This contrast indicates that the structured, culture-based training program produced markedly greater physiological adaptations than unstructured conventional activities. However, these findings are based on an indirect measure of cardiovascular endurance (20-m shuttle run test). While this test is widely used and validated for field settings, direct measurement of VO_2max using expired gas analysis would provide a more precise assessment of aerobic capacity. These results are consistent with previous studies reporting that cardiovascular endurance among university students is often influenced by lifestyle patterns and levels of physical activity [27,28]. The significant improvement observed in the intervention group supports existing evidence that dynamic, rhythmic, and progressively overloaded aerobic training can effectively enhance cardiopulmonary function, including increased stroke volume, oxygen uptake, and overall aerobic capacity [29]. In contrast, the modest improvement observed in the conventional group suggests that unstructured, low-intensity physical activities such as occasional jogging may produce minimal physiological benefits. This finding reinforces the importance of structured, progressive, and adequately dosed exercise stimuli in eliciting meaningful improvements in cardiovascular

endurance. Furthermore, the findings align with research highlighting the effectiveness of integrating traditional movement patterns such as jumping, coordination tasks, and circuit-based activities in improving endurance and motor performance [30,31]. The incorporation of *Fate'u* and *Fasukhu* movements, which inherently combine aerobic and plyometric elements, appears to have provided sufficient training stimulus to drive significant improvements in cardiovascular endurance. Importantly, the effectiveness of the program was not limited to physiological outcomes but was also reflected in high participant adherence (92.5%), suggesting strong engagement and motivation. This supports previous findings that culturally relevant physical activities can enhance intrinsic motivation, emotional involvement, and long-term exercise adherence [32-34]. The integration of culturally meaningful movements likely created a sense of identity and enjoyment, which contributed to consistent participation and amplified the overall training effect [35-37]. In contrast, the conventional group, which did not receive structured or culturally engaging training, demonstrated only modest improvements (4.2%) despite showing statistical significance. This further highlights the added value of culturally based structured interventions in producing large and practically meaningful physiological adaptations. From a practical perspective, these findings support the implementation of culture-based training models within physical education curricula, university wellness programs, and community health initiatives. The structured combination of interval, rhythmic, and circuit-based training principles ensures alignment with established aerobic conditioning standards, while the integration of local cultural elements enhances accessibility, engagement, and sustainability [38-41]. This approach is particularly relevant in contexts with limited access to modern fitness facilities, as it provides an effective and culturally meaningful alternative.

Study limitations

Despite the promising findings, several limitations should be acknowledged. First, the primary outcome measure (20-m shuttle run test) provides an indirect estimate of cardiovascular endurance rather than a direct physiological measurement. Although this test is widely used and validated for field-based research, direct assessment of maximal oxygen consumption (VO_2max) using gas exchange analysis during a graded exercise test would offer greater precision and allow for more definitive conclusions about aerobic capacity. Second, the physical activities performed by the conventional group were not objectively monitored or standardized. Based on self-report, participants engaged in occasional, low-intensity jogging (approximately 1–2 times per week, 20–30 minutes per session), but the exact frequency, duration, and intensity may have varied. This lack of monitoring may have introduced variability and limits the internal validity of comparisons between groups. Third, although the inclusion of a conventional group strengthens the study design, future research should incorporate randomized controlled trials to further enhance causal inference. Fourth, long-term follow-up studies are also needed to evaluate the sustainability of cardiovascular improvements. Fifth, future studies could explore psychological variables such as motivation and cultural identity, as well as physiological markers such as direct VO_2max and lactate thresholds, to better understand the mechanisms underlying the observed adaptations. Overall, the findings highlight that Nias culture-based physical training is not only effective in improving cardiovascular endurance but also offers significant motivational and cultural benefits. This reinforces the potential of integrating local wisdom into modern training programs as an innovative, effective, and sustainable strategy for enhancing physical fitness.

Conclusion

The 12-week Nias culture-based physical training program effectively improved cardiovascular endurance among early adult students, as evidenced by substantial performance gains and a large effect size. Although the conventional group also showed modest improvement, the NCBPT group demonstrated significantly larger gains, confirming the superior effectiveness of the culture-based approach. The integration of *Fate'u* and *Fasukhu* activities within a structured aerobic framework, combined with progressive intensity and rhythmic movement patterns, provided an optimal stimulus for cardiopulmonary adaptation. The high adherence rate further suggests that the cultural relevance of the program supported sustained participation. These findings highlight the potential of culturally grounded training approaches as effective, engaging, and contextually relevant strategies for enhancing cardiovascular endurance, with practical applications in physical education and health promotion settings.

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Conflict of interests

The authors declared no conflict of interest.

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Data sharing statement

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

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