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Integrated Approach: Examining the Impact of Endurance and Circuit Training on Vital Capacity in School-Going Obese Children

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Abstract: Childhood obesity is a global health concern associated with various complications, including impaired lung function. This study investigates the effects of structured training interventions on vital capacity in obese boys attending CBSE schools in Thrissur district, Kerala, India. The aim of this study was to assess the impact of Endurance Training, Circuit Training, and a Control Group on vital capacity in obese school-going boys. A sample of 120 boys (10-14 years) from three CBSE schools underwent specific training regimens for 18 weeks. Vital capacity was measured using the Helios 401 spirometer. The analysis included descriptive statistics, ANCOVA, and pairwise comparisons with Bonferroni adjustment. Both training groups showed improved vital capacity post-treatment. ANCOVA revealed significant effects of pre-treatment vital capacity and treatment groups on post-treatment vital capacity (R Squared = 0.944). Pair-wise comparisons indicated distinct vital capacity levels between the training groups and the control group. Endurance and circuit training positively impact vital capacity in obese school-going boys. Tailored interventions are crucial for enhancing specific physical parameters. Future research should explore underlying mechanisms and long-term effects across diverse populations.

Keywords: Childhood obesity, Vital capacity, Structured training, Lung function

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Introduction

Childhood obesity is a growing concern globally, contributing to various health issues, including impaired lung function. Many governments and foundations are currently investigating the potential of interventions to prevent juvenile obesity, which has reached a high global prevalence. The purpose of these scientific investigations is to pinpoint the critical elements that must be integrated into public health initiatives in schools and communities. Regrettably, the outcomes of preventive intervention trials have been inconsistent, with numerous well-designed trials failing to demonstrate a clear and definitive positive impact on the indices of adiposity that were used as outcomes. The entire enterprise of obesity prevention is called into question when a significant amount of time and money is invested in trials that do not yield evidence of success. Consequently, it is crucial to meticulously evaluate the assumptions that underpin the experimental trials (Rey *et al*., 2017).

The typical paradigm for examining pediatric obesity is predicated on the common-sense knowledge that has been derived from adult experience. This knowledge posits that weight loss is a direct result of reducing energy intake and that the energy deficit and resulting weight loss are exacerbated by the addition of physical activity (PA) to the lifestyle. A consequence of this paradigm is that adolescents who gain weight faster than their peers consume more energy. Nevertheless, recent evidence and theory indicate that this paradigm may be misleading when applied to the prevention of pediatric obesity (Seo *et al*., 2012).

The initiatives can be interpreted as obesity treatment or secondary prevention, rather than primary prevention, as the youths were selected to be obese at baseline. Behavioral interventions that emphasize both diet and physical activity have been effective in reducing the relative weight of obese adolescents. Consequently, the energy balance paradigm and the restriction of energy intake are suitable methods for assisting obese adolescents in reducing their relative weight. Nevertheless, the extent to which the change in relative weight was attributed to changes in adipose mass and how much to fluctuations in body composition is unclear, as numerous of these studies did not assess body composition. Physical activity is merely one of the numerous potential solutions required to mitigate the pediatric obesity epidemic (Bernard Gutin, 2008).

This study contributes valuable insights into the positive effects of endurance and circuit training on vital capacity in obese school-going boys, offering practical implications for health professionals, coaches, and educators working with this demographic.

Materials and Methods

For this study, 120 obese children (boys) were selected randomly from CBSE schools, namely Chinmaya Vidyalaya, Thrissur; S N Vidyabhavan, Chenthrapinni; HIRA English School, Kaipamangalam; and these schools were located in the northern part of the Thrissur district, Kerala, India. Their age ranged from 10 to 14 years. The subjects were divided into three equal groups such as two treatment group, Group I (Endurance Training Group n = 40) Group II (Circuit training group n = 40), and Group III (control group, n = 40).

Table 1 displays the well-organized training schedules for the first group, known as Endurance Training Group (ETG), the second group, known as Circuit Training (CTG), and the third group, known as Control Group (CG). Group I received three days of Endurance Training Group (Monday, Wednesday, and Friday). Group II received circuit training three days a week on Tuesdays, Thursdays, and Saturdays. For eighteen weeks, three days a week, each of the experimental groups received the appropriate training regimen, which included 1.5 h of evening and morning sessions each day. Every three weeks, load progression procedures were modified. The three groups' pre-test mean differences had to be taken into consideration when analyzing the post-test mean differences. The data was gathered from each group both before and after the experimental period, and the results were statistically analyzed using the ANCOVA to determine whether there had been a significant improvement. The Bonferroni post-hoc test was used to determine the paired means difference; the adjusted post-test means were determined to be significant.

Selection of Criterion Measures Test

After reviewing the available literature, the following standardized tests were selected and used to collect the relevant data on the selected

Table 1: Research Design Structure

Group	Treatment
Experimental Group I	Endurance Training Group (ETG)
Experimental Group II	Circuit Training Group (CTG)
Control Group	Not engaged in any specific training program
Training Duration: 90 min	Warm-up, Instruction, Treatment (training) Cool Down, Correction, and Clarification (90 minutes)
Training session Per week	Three days per week session in the evening
Total Length of Training	Eighteen weeks
Training Load Progression	Every Three weeks

Table 2: Selection of tests

Variables	Test/Method/Instrument	Unit of Measurement
Vital Capacity	Helios 401spirometer	Liters

dependent variables and they are detailed in Table 2.

Test Administration:

To calculate VC or vital capacity

A Windows-based PC and the spirometer Helios 401 are used together. By taking a vital capacity measurement, it is possible to ascertain the dynamic lung function (VC). A turbine transducer is housed in a handpiece on it. A USB interface cable is used to connect this handpiece to a computer. The software that comes with the device is used to document spirometry maneuvers and provide a diagnosis recommendation. Informational and user guide messages, device parameters, and Spirometry parameters are all displayed on the computer monitor. A physical copy record of the maneuvers and the associated parameter values can be obtained by connecting the printer to the computer. A basic explanation of how to install the RMS Helios spirometer is- (i) Unpack the accessories and spirometer, (ii) Secure the transducer within the handpiece's housing, (iii) Secure the mouthpiece to the handpiece and transducer, (iv) Attach the spirometer to the USB-Serial connector of the USB-Serial cable, (v) Attach the USB-Serial cable to the computer using its USB port, (vi) Turn on the computer and (vii) Put the installation CD for the spirometer software into the computer.

At the start of the test, the Helios spirometer was positioned so the participant could stand straight. Before the test, the individual twice forcefully inhaled and exhaled. The participant was advised not to let air escape around the mouthpiece or via their nose. After finishing, the individual should slant forward a little bit to breathe as much air as they can into the spirometer. The outcome was recorded in liters and the reading is displayed on the Helios spirometer graph.

Results and Discussion

In Table 3, the unadjusted and covariate- adjusted descriptive statistics for vital capacity are

Table 3: Unadjusted and Covariate Adjusted Descriptive Statistics for Vital Capacity

Group	Before Treatment			After Treatment (Unadjusted)		After Treatment (Adjusted)	
	n	Mean	SD	Mean	SD	Mean	SE mean
Endurance Training Group	40	1.894	0.3158	2.722	0.2906	2.716	0.017
Circuit Training Group	40	1.886	0.1435	2.280	0.1492	2.280	0.017
Control Group	40	1.880	0.4322	1.900	0.4322	1.906	0.017

N represents the number of participants, Mean is the mean agility score, and SE Mean is the standard error of the mean

Table 4: Analysis of Covariance of Agility by Treatments with Pre-treatment Vital Capacity as Covariate

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Vital Capacity Pretest	10.042	1	10.042	829.796	<0.001	0.877
Groups	13.131363	2	6.566	542.520	<0.001	0.903
Error	1.403854	116	0.012			

R Squared = 0.944 (Adjusted R Squared = 0.942)

presented across three groups: Endurance Training Group, Circuit Training Group, and Control Group. Before treatment, each group consisted of 40 participants. After treatment, the mean vital capacity for the Endurance Training Group increased from 1.894 to 2.722 (unadjusted), and after adjusting for covariates, it remained high at 2.716. The standard deviation (SD) of the vital capacity decreased slightly from 0.3158 to 0.2906 after adjustment, indicating a more stable measure.

For the Circuit Training Group, the mean vital capacity increased from 1.886 to 2.280 (unadjusted), and the adjusted mean remained the same at 2.280. Similar to the Endurance Training Group, the SD decreased after adjustment, suggesting increased precision in the measurement.

In contrast, the Control Group showed minimal change in mean vital capacity from 1.880 to 1.900 (unadjusted), and the adjusted mean was 1.906. The SD remained constant after adjustment. These findings suggest that both training groups experienced improvements in vital capacity after treatment, with adjustments accounting for potential covariates. The Control Group, however, exhibited marginal changes. The standard error of the mean (SE Mean) provides an estimate of the variability of the sample means, with lower values indicating greater precision in the estimation of the population mean.

Table 4 presents the results of an Analysis of Covariance (ANCOVA) examining the impact of different treatments on vital capacity, with pretreatment vital capacity serving as a covariate.

Table 5: Pair-wise Comparison for vital capacity in training groups within and between control

(I) Group	(J) Group	Mean Difference (I-J)	95% Confidence Interval for Difference		p
			Lower Bound	Upper Bound	
Endurance Training Group	Circuit Training Group	0.435*	0.375	0.495	<0.001
	Control Group	0.810*	0.750	0.869	<0.001
Circuit Training Group	Endurance Training Group	-0.435*	-0.495	-0.375	<0.001
	Control Group	0.374*	0.315	0.434	<0.001
Control Group	Endurance Training Group	-0.810*	-0.869	-0.750	<0.001
	Circuit Training Group	-0.374*	-0.434	-0.315	<0.001

Based on estimated marginal means; *The mean difference is significant at the 0.05 level; Adjustment for multiple comparisons: Bonferroni

The analysis reveals significant effects for both the vital capacity pretest and treatment groups. The vital capacity pretest (a covariate) contributes significantly to the model, with a large Type III Sum of Squares (10.042), a high F-statistic (829.796), and a very low p-value (<0.001). This indicates that pre-treatment agility has a substantial influence on the dependent variable (agility).Similarly, the treatment groups show a significant effect, as evidenced by the Type III Sum of Squares (13.131363), F-statistic (542.520), and p-value (<0.001). The Partial Eta Squared values for both the vital capacity pretest (0.877) and groups (0.903) suggest that a substantial proportion of the variability in agility is explained by these factors.The Error term, representing unexplained variability, has a relatively small Mean Square (0.012), indicating that the model accounts for a significant portion of the variance in vital capacity.

The R-squared value of 0.944 indicates that the model explains 94.4% of the variance in vital capacity, while the Adjusted R-squared value of 0.942 considers the number of predictors in the model, suggesting a high level of explanatory power.

Table 5 presents pair-wise comparisons for vital capacity in the training groups (Endurance Training, Circuit Training) within and between the Control Group. Mean differences (I-J) along with their 95% confidence intervals and p-values are reported.

Endurance Training vs. Circuit Training:

The mean difference is 0.435; with a 95% confidence interval ranging from 0.375 to 0.495.This difference is statistically significant (p < 0.001).

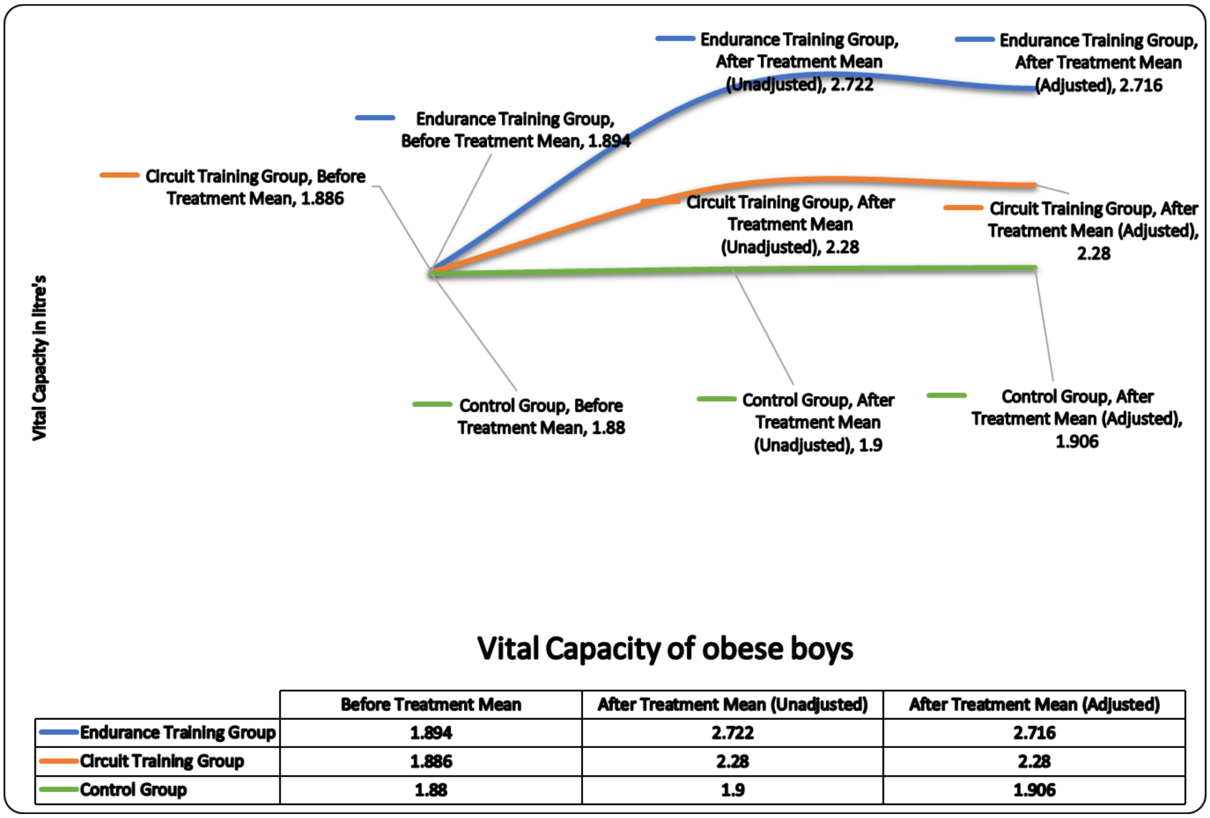
Endurance Training vs. Control Group:

The mean difference is 0.810; with a 95% confidence interval ranging from 0.750 to 0.869.This difference is statistically significant (p < 0.001).

Circuit Training vs. Control Group:

The mean difference is -0.435, with a 95% confidence interval ranging from -0.495 to -0.375.This difference is statistically significant at the 0.05 level (p < 0.001).

The results indicate significant differences in vital capacity between all pairs of groups. These findings suggest that the training groups (Endurance and Circuit) exhibit distinct vital capacity levels compared to each other and the Control Group. The significance levels are



	Before Treatment Mean	After Treatment Mean (Unadjusted)	After Treatment Mean (Adjusted)
Endurance Training Group	1.894	2.722	2.716
Circuit Training Group	1.886	2.28	2.28
Control Group	1.88	1.9	1.906

Fig. 1: Representing means vital capacity for three groups.

adjusted for multiple comparisons using the Bonferroni method to control for Type I errors.

In summary, the results (Fig. 1) suggest that both pre-treatment agility and treatment groups significantly contribute to the observed variability in agility, providing valuable insights into the effects of different treatments while controlling for pre-treatment differences.

The present study's findings underscore the effectiveness of endurance and circuit training interventions in modifying vital capacity among CBSE School-level obese boys. The unadjusted and adjusted descriptive statistics highlight distinct patterns in vital capacity changes post-treatment, emphasizing the impact of structured training programs.

The ANCOVA results further validate these findings, indicating that both pre-treatment vital capacity levels and the type of training intervention significantly influenced post-treatment vital capacity scores. Considering participants' initial vital capacity levels is crucial when interpreting the effects of different training methods. In past, few investigators noticed similar results which support the findings of the present study (Neranoch *et al*., 2023; Chen *et al*., 2023).

Conclusion

In conclusion, this study provides evidence supporting the positive impact of endurance and circuit training on vital capacity in school-going CBSE obese boys, when we see deeply in endurance workouts given much higher capability. These findings have practical implications for coaches and sports professionals, suggesting the importance of tailoring training interventions to enhance specific physical parameters.

Future research avenues may explore the underlying mechanisms of observed changes and investigate the long-term effects of diverse training modalities on vital capacity across various boys' and children's populations.

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