

Effect of Core Strength Training on Posture, Balance, and Cardiovascular Endurance

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Abstract— Core strength training is often used to enhance trunk stability, body alignment, movement efficiency, and physical fitness. The purpose of the study was to examine its impact on posture, balance, and cardiovascular endurance. Specifically, the study focused on schoolgirls. A pre-test and post-test experimental design was adopted for an experimental group (n=12) and a control group (n=8). 20 school girls aged 11-15 years participated. The control groups are requested to carry out their regular physical activities while the experimental groups are subjected to a four-week core strength training program. The Wall Test was used to measure posture, the Stork Stand Test for balance, and the 600-m run test for cardiovascular endurance. At the 0.05 significance level the SSA and ANCOVA were applied. The change in cardiovascular endurance was not statistically significant but experimental group did show statistically significant improvement in posture. According to the results, the short-term core strength program improves body alignment, stability, and neuromuscular control in adolescent girls. However, a long-term intervention or greater aerobic stimulus may induce a marked change in cardiovascular endurance. Therefore, school physical education programs may include core exercises to prevent postural misalignment and functional fitness.

Keywords—Balance, cardiovascular endurance, core strength, posture, schoolgirls.

I. INTRODUCTION

The musculoskeletal health, functional capacity and future well-being can be well determined by physical fitness during early childhood and adolescence. The trunk and pelvis muscles, diaphragm, lumbar, and hip muscles work together to stabilize the trunk and pelvis as one unit. For the proper functioning of the spine, to remove and transmit forces between the upper & lower limbs and to get the maximum efficiency of movement sufficient stability is important. The inadequate stability may relate to altered posture, early fatigue, inefficient movement pattern and an increased chance of musculoskeletal disorders. [14], [15], [17].

As more school-age girls engage in sedentary time – either doing formal academic work or participating in screen-based activities – they may find less time to engage in outdoor play and organized exercise. The forward head posture, rounded shoulders, altered thoracic and lumbar curves, and reduced postural control are due to repetitive sedentary postures, heavy school bags and less muscular activity. Not only appearance-related changes, but also changes in spinal loading,

respiratory mechanics, mobility, and future pain-risk are relevant. [14], [17], [18].

Balance is dependent on the interplay between sensory information, muscular coordination, and the ability to control the body's center of mass over its base of support. It is important for performance postures such as standing, walking, running, and sporting movement. Cardiovascular endurance is a major component of health-related to fitness because it reflects the capacities of the circulatory and respiratory systems to perform sustained work. A lack of fitness in youth can lead to reduced performance in adulthood and a poor health trajectory. [12], [17], [19].

The purpose of core training is to improve activation of trunk musculature that is anticipatory and coordinated. In their study, Hodges and Richardson showed that the transverses abdominis activates before the arm moves, which means that the trunk keeps stable when we do things. Further endeavors associated with core exercises have improved postural alignment, mobility, balance, and most notably athletic performance in varied populations [2]– [4], [15].

Earlier studies demonstrate beneficial effects of core or suspension training on balance and postural deficits in adolescents and young adults. Depending on the athlete's training status, participant characteristics, and the intervention period, outcomes varied among recreational players and school-age athletes but were generally positive. [5], [7], [9], [10]. Despite this evidence, there have been relatively few controlled studies on the posture, balance, and cardiovascular endurance of schoolgirls in an educational setting. So, the current study assessed a core strength programme that was brief and feasible to deliver, which could be

integrated into school PE without special equipment. [11], [13], [20].

II. AIM & OBJECTIVES

The objective of the study was to assess the impact of core strength training on the posture, balance, and cardiovascular endurance of schoolgirls. these were the specific objectives.

- 1) To investigate the impact of core strength training on the posture of school girls.
- 2) To assess the influence of core strength training on balance in schoolgirls.
- 3) To estimate the sufficiency of core strength training on the cardio-respiratory endurance of school girls.

III. METHODOLOGY

A. Study Design: An experimental design with pre-tests and post-tests was used. Two groups were formed; an experimental group which participated in structured core strength program and a control group which carried out regular school time activities without the provision of an additional training intervention. The aforementioned design makes it possible to compare the changes recorded before and post four-week period. [10], [13].

B. Participants: The target population consisted of schoolgirls aged 11 to 15 years. Twenty participants were selected by using purposive sampling. The psychologist allocated them to the experiment and control groups according to availability and institutional constraints. The experimental group (n = 12) and control group (n = 8) were appropriately used for the purpose of the study. [16], [17].

C. Training Protocol: The participants in the experimental group engaged in running and various exercises. The sessions were conducted every 4-5

days and lasted for about 30-40 min. The exercise volume and complexity were increased according to the participants' adaptation. Retention of Sequence and Dosage from the Original Training Plan (15 words) The sequence and dosage retained from the original training plan are presented in Table I. [5], [13], [15].

TABLE I
PROGRESSIVE CORE STRENGTH
TRAINING SCHEDULE

Exercise	Sets	Repetition/Duration	Interval
Running	1	3 min	5 min
Short sprints	2	2	5 min
Heel-to-toe walk	2	10	5 min
High knees	2	10	5 min
Jumping jacks	2	10	5 min
Squats and lunges	2	10	5 min
Glute bridge	2	10	5 min
High plank	2	10 s	5 min
Running	3	5 min	5 min
Shuttle run	3	4	5 min
Heel-to-toe walk/run	3	4	5 min
Hopping on one leg (both sides)	3	10	5 min
Jump squats	3	15	5 min
Jump lunges	3	15	5 min
Crunches	3	15	5 min
Plank	3	20 s	5 min
Noka hold	3	15 s	5 min
Running	1	10 min	2 min
Short sprints	4	4	2 min
Burpees	4	20	2 min
Side leg raises	4	20	2 min
One-leg balance on toes (both sides)	2	30 s	2 min
Mountain climbers	4	20	2 min
Crunches	4	20	2 min
Forearm plank	2	30 s	2 min
Running	1	15 min	2 min
Short sprints (backward/forward)	6	6	2 min

D. Procedure: In the before training, pre-tests were administered to all participants for posture, balance and aerobic endurance under uniform conditions. The four-week program was then completed by the experimental group and control group continued their regular physical education program. At the end of the intervention, post-tests were conducted using the same procedures, equipment, environment, and testing sequence. [10], [19].

E. Measures and Data Collection: Posture was examined using the Wall Test for identification of alignment and postural deviations. Static balance was evaluated using the Stork Stand Test which involves the control of the body over a reduced base of support. The 600-m run test assessed participants' cardiovascular endurance and a lower completion time represents better performance. Timing measurements were taken at two points. [12], [14], [19].

F. Statistical Analysis: The researchers summarized the results using means, medians, standard deviations, variance, skewness, and kurtosis. The analysis of covariance shows that the group and test effects were compared at the level 0.05. Partial eta squared (η^2) will be retained in order to describe the magnitude of reported effects.

G. Ethical Considerations: Following approval from the appropriate school officials, written informed consent was obtained from both parents and guardians. The exercise programs will be supervised and participation is voluntary; members can withdraw at any time. The identity of the participant and test results were kept confidential. [17], [19].

IV. RESULTS

A. Posture

TABLE II
DESCRIPTIVE STATISTICS FOR POSTURE

Statistic	Experimental Pre-test	Experimental Post-test	Control Pre-test	Control Post-test
N	12	12	8	8
Missing	0	0	0	0
Mean	81.30	98.30	77.50	79.40
Median	82.50	100.00	75.00	80.00
Standard deviation	6.44	2.46	8.02	4.17
Skewness	-1.47	-0.812	1.66	0.277
SE skewness	0.637	0.637	0.752	0.752
Kurtosis	3.12	-1.65	3.42	-1.39
SE kurtosis	1.23	1.23	1.48	1.48

At baseline, the experimental and control groups recorded mean posture scores of 81.30 and 77.50, respectively. Following training, the experimental-group mean increased to 98.30, whereas the control-group mean rose only to 79.40. The reduction in the experimental-group standard deviation from 6.44 to 2.46 indicates greater consistency after the intervention (Table II).

The reported ANCOVA results showed a significant group effect, $F(1, 37) = 27.80$, $p < .001$, $\eta^2 = .302$, and a significant test effect, $F(1, 37) = 27.10$, $p < .001$, $\eta^2 = .295$. The reported effect sizes

indicate a substantial practical effect on posture (Table III).

TABLE III
REPORTED ANCOVA RESULTS FOR POSTURE

Source	Sum of squares	df	Mean square	F	p	η^2
Overall model	2448	2	1223.8	27.4	< .001	—
Group	1238	1	1237.6	27.8	< .001	.302
Test	1210	1	1210.0	27.1	< .001	.295
Residuals	1650	37	44.6	—	—	—

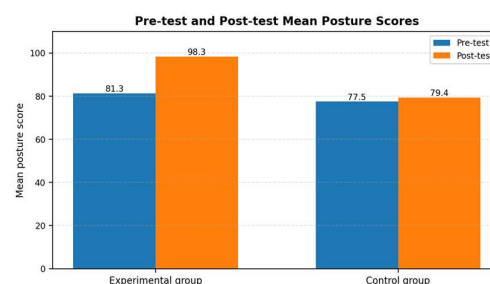


Fig. 1. Pre-test and post-test mean posture scores based on the values reported in Table II.

B. Balance:

TABLE IV
DESCRIPTIVE STATISTICS FOR BALANCE

Statistic	Experimental Pre-test	Experimental Post-test	Control Pre-test	Control Post-test
N	12	12	8	8
Mean	1.99	4.71	1.47	2.62
Median	1.77	4.73	1.25	2.30
Standard deviation	1.01	2.12	1.40	2.45
Variance	0.745	0.0601	1.64	0.254
Skewness	0.637	0.637	0.752	0.752
SE skewness	0.238	-1.14	3.05	-2.06
Kurtosis	1.23	1.23	1.48	1.48

The experimental-group mean balance score increased from 1.99 to 4.71, while the control-group mean increased from 1.47 to 2.62. The medians showed the same direction of change,

indicating that the improvement was not confined to a small number of participants (Table IV). The reported analysis indicated a significant group effect, $F(1, 37) = 4.96$, $p = .032$, $\eta^2 = .090$, and a significant test effect, $F(1, 37) = 13.26$, $p < .001$, $\eta^2 = .240$. These results support a moderate group-related effect and a larger pre-test–post-test effect on balance (Table V).

TABLE V
REPORTED ANCOVA RESULTS FOR
BALANCE

Source	Sum of squares	df	Mean square	F	p	η^2
Overall model	60.3	2	30.15	9.11	< .001	—
Test	43.9	1	43.89	13.26	< .001	.240
Group	16.4	1	16.42	4.96	.032	.090
Residuals	122.4	37	3.31	—	—	—

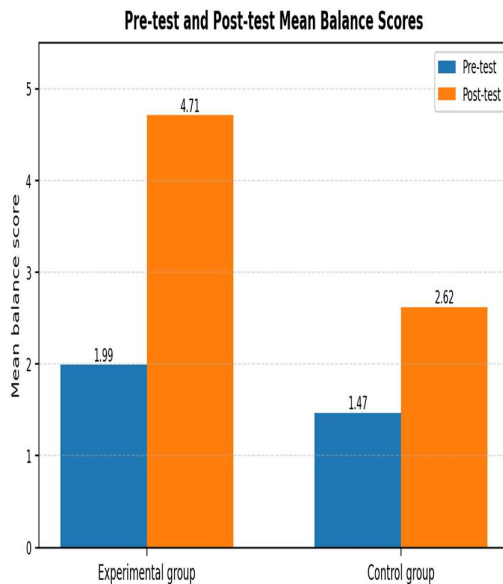


Fig. 2. Pre-test and post-test mean balance scores based on the values reported in Table IV.

C. Cardiovascular Endurance

TABLE VI
DESCRIPTIVE STATISTICS FOR
CARDIOVASCULAR ENDURANCE

Statistic	Experimental Pre-test	Experimental Post-test	Control Pre-test	Control Post-test
N	12	12	8	8
Mean	3.54	3.14	3.51	3.46
Median	3.48	3.16	3.42	3.26
Standard deviation	0.428	0.232	0.405	0.874
Variance	0.183	0.0536	0.164	0.765
Skewness	1.30	-2.00	2.58	1.23
SE skewness	0.637	0.637	0.752	0.752
Kurtosis	1.23	5.93	6.96	1.45
SE kurtosis	1.23	1.23	1.48	1.48

The experimental-group mean 600-m run score decreased from 3.54 to 3.14, while the control-group mean changed from 3.51 to 3.46. Because lower time reflects faster completion, the descriptive pattern suggests improvement in the experimental group; however, the inferential result did not reach statistical significance (Table VI).

TABLE VII
REPORTED ANCOVA RESULTS FOR
CARDIOVASCULAR ENDURANCE

Source	Sum of squares	df	Mean square	F	p	η^2
Overall model	0.861	2	0.431	1.700	.197	—
Group	0.201	1	0.201	0.792	.379	.020
Test	0.660	1	0.660	2.607	.115	.065
Residuals	9.374	37	0.253	—	—	—

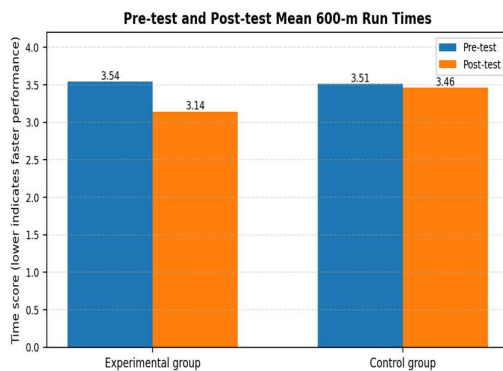


Fig. 3. Pre-test and post-test mean 600-m run scores based on the values reported in Table VI; a lower score indicates faster performance.

V. DISCUSSIONS

Research indicated the outcome variables responded differently. There was a significant improvement in posture and balance changes, while no cardiovascular endurance change. The pattern is physiologically plausible because the program contained repeated trunk-stability, balance, and lower-limb control tasks, whilst the aerobic dose was relatively brief. [12], [15], [19].

The improvement in posture may result from better activation and coordination of the abdominal, lumbar, pelvic and hip musculature. When you anticipate a movement of an arm or leg, the deep abdominal muscles activate to support the stability of the spine. Repeated stabilization exercises will help in alignment and prevent unnecessary movement of the trunk. The current study findings are consistent with investigations showing positive postural effects following core training. [3], [4], [10], [15].

The findings, on balance, are consistent with evidence indicating that core training improves control of proximal body segments and enhances the regulation of the center of mass. Exercises that challenge neuromuscular coordination and postural adjustments: planks, bridges, unilateral stance, lunges, and hopping. After activities focusing on core instability training, TRX activities, and balance training, similar improvements have been reported. [2], [7], [9], [10], [19].

Although the experimental group completed the 600-m run faster after training, the change was not significant. Sufficient exercise intensity, duration, and total training volume are necessary for cardiovascular adaptation. A four-week trunk

stabilizing intervention may not be sufficient to produce a cardiorespiratory effect, as it may not have a sustained aerobic overload. [12], [17], [20]. Looking at it practically, the program is low-cost, requires little equipment, and can be delivered throughout the school day within regular physical education. It seems to have the development of postural control and balance as its strongest immediate value. When running or circuit-based aerobic work is another primary goal, schools could combine the core program with these forms of exercise. [11], [13], [15]

VI. LIMITATIONS & FUTURE DIRECTIONS

A four-week core strength training program significantly improved posture and balance in schoolgirls aged 11–15 years. It seems that the program has improved trunk stability, neuromuscular coordination, and postural control. The lack of a gain in cardiovascular endurance suggests that a longer program is necessary or a more specific aerobic component. A useful method for developing musculoskeletal fitness and functional movement is by developing the core exercises that can be integrated into the physical education of schools. [13], [15], [17].

Because of the small purposively chosen sample, unequal group sizes, brief intervention period and lack of follow-up, the findings must be interpreted cautiously. The research used field-based outcome measures and did not quantify training intensity with heart-rate or workload monitoring. Further research should include more substantial randomized samples, balanced groups, longer interventions, designs that are sensitive to maturation, and objective measures of trunk strength and cardiorespiratory fitness. [12], [17], [19].

VII. CONCLUSION

A core strength training program for 4 weeks showed beneficial effects of improving posture and balance in schoolgirls. The implementation of the program seems to improve trunk stability, neuromuscular coordination, and postural control. The lack of significant improvements in cardiovascular endurance indicates that a longer program or one with more of an aerobic component is necessary. Incorporating core exercises into school physical education is thus a realistic strategy

for improving their musculoskeletal fitness and functional movement. [13], [15], [17].

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