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Multivariate Structural Equation Modeling of the Influence of Screen Time on Physical Fitness and Academic Achievement Among Students

ASHA DEVI T.[1*], UMA V.[2], SURESH KUMAR M.[3]

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ABSTRACT. *Introduction:* Screen time plays a critical role in students' life impacting their physical fitness and academic achievement is the ubiquitous contemporary concern that covers all nationalities irrespective of race, ethnicity and socio-economic status. Exploring the direct effects and their cause and effect individual studies have shown their linear effects and impacts, the review of literature shows a gap in multivariate modeling of the variables which requires the path analysis as well studying the direct and indirect effects simultaneously. *Objectives:* The present study was conceptualized with hybrid experimental design coupled with Sequential equation modeling. *Methods:* The research design showed its fitness for the study through the fit indices of the model. The sample was drawn from 40 girls' students in the age group of 15-17 and assigned to experimental and control group using random number table. During pre-test data collection screen time data was collected from the sample as self-reporting data and was used as baseline data at analysis and though it was the independent variable as the structural equation modeling allowed the intervention through Fartlek training and no manipulation of screen time and the same was not measured for post-test. The intervention was given to the experimental group through Fartlek training for a period of 40 min/day for six weeks duration. The interventional protocol consists of warm-up 10 min Speed play with Intervals of varying intensities of Moderate run, Fast run, Slow jog, Sprint, Moderate run, Sprint, Jog recovery, Fast run, Sprint, Slow jog for 40 min/day. The data were

[1] Ph.D. Research Scholar, Ganesar College of Arts & Science (Affiliated to Bharathidasan University, Tiruchirappalli), Ponnamaravathy, Pudukkottai, Tamil Nadu, India.
[2] Research Supervisor, Director of Physical Education, ADM College for Women (Affiliated to Bharathidasan University, Tiruchirappalli), Nagappattinam, Tamil Nadu, India.
[3] Co-Supervisor, Director of Physical Education, Ganesar College of Arts & Science (Affiliated to Bharathidasan University, Tiruchirappalli), Pudukkottai, Tamil Nadu, India.
* Corresponding author: kbhas81@gmail.com

collected for the variables VO_2 max, Pushups, Sit-ups, Flexibility, BMI and academic achievement adopting due standard procedures aligned with directions of Committee on Publication ethics (COPE). *Results:* Descriptive statistics shows the status of the groups of between groups and within group in Pre-test and Post-test to elucidate effectiveness of the intervention. The independent t test shows the between group effectiveness in post-test. The experimental group significantly stands better than the control group in VO_2Max, push-ups, sit ups, flexibility and academic achievement. Yet the BMI is not significant between the groups but showed and improvement within the group level. The paired t test at $p<0.01$ shows that both the groups have attained statistically significant improvement. The higher t values of experimental group show the effect strength. The Pearson matrix showed the meaningful pattern of relationship among the variables, it shows two Positive performances cluster VO_2Max, push-ups, sit ups, flexibility and academic achievement. Negative performance cluster includes Screen time and partially BMI. *Conclusion:* The direct effects and indirect effects were studied comprehensively with structural equation modeling. The direct effect of model stands with (β =.-.38) whereas the indirect effects exerted strong impact on academic achievement with (β =-.738), mediation shows that physical fitness is the primary mediator and BMI is the secondary mediator.

Keywords: *screen time, Fartlek training, Structural Equation Modeling (SEM), Direct effects, Indirect effects, Variable mediation*

INTRODUCTION

The digital era provides digital ambience to all people on all walks of life while so the timing of occupancy by digital screen to an individual is conceptualized as screen time. As the digital divide denotes the screen time finds a place in every individual's life. Being ubiquitous it has influences on all aspects of life, the present study delimits to study its influence on physical fitness and academic achievement among students. The sedentary lifestyles, cognitive distractions and reduced physical activity are direct markers of screen time among students that in turn determines the physical fitness and academic achievement. Excessive screen time has many negative health effects caused by a multitude of mechanisms (Nikos Prefitis & Demosthenes Panagiotakos, 2023). The independent explorations of cause and effect and correlational analysis are prevalent literature, while the multivariate modeling to study the simultaneous analysis of interrelations are limited and to contribute for the research gap the present study was undertaken. Structural equation modeling (SEM) was adopted to study the direct and indirect effects in a robust approach to evaluate them. The relationship between screen time and digital device usage

precisely during night hours has deleterious effects in individuals (Nakshine et al., 2022). The studies have shown that there is a steady decline in physical fitness in consequent of screen time.

Academic achievement is the core to schooling, its success depends on the physical fitness whereas the physical fitness is negatively correlated with BMI. Academic achievement is negatively associated with screen time whereas BMI is positively associated with screen time that ultimately negatively correlated with physical fitness that positively correlated with academic achievement. Thus, the phenomenal direction and magnitude of correlation is explored by structural equation modelling. The screen time is inevitable to students' life, yet it has deleterious effects on academic achievement as well physical fitness.

The Physical Education and sports events have also witnessed drastic shift in the advent of digital sports wearables and equipment's. So, there is an attention required to focus on physical fitness rather than physical education and sports pedagogy of the students. In other words, it can be elucidated that though the students are engaged in physical education and sports pedagogy it is not warranted to their physical fitness. Interestingly students' mental health depends on physical health that is shaped by physical fitness. The object of schooling is the all round personality development that includes the physical fitness, physical health, mental health and academic achievement. The crux of the schooling ambience with the digital dependency is conceptual corridor of the study. Fartlek training is a kind of fast play activities combined with speed and slow accelerated activities without definite resting period was the interventional strategy. As the Fartlek training contributes for aerobic and anaerobic capacity, the intervention was preferred through Fartlek training. The effect of Fartlek training also studied through the experimental design in terms of direct effects and indirect effects of reduction of screen time on physical fitness and academic achievement. The study has extensively studied the role of training on academic achievement, roles of training to reduce the screen time and its influence on physical fitness variables and academic achievement with path analysis.

OBJECTIVES OF THE STUDY

1. To investigate the effect of screen time on physical fitness.
2. To study the influence of screen time on academic achievement.
3. To analyze the relationship between physical fitness and academic achievement.
4. To study the multivariate modeling of screen time influence on physical fitness and academic achievement.

HYPOTHESIS

Ha1: The screen time has a significant negative effect on physical fitness.

Ha2: The screen time has a significant negative effect on academic achievement.

Ha3: The physical fitness variables significantly improve academic achievement.

Ha4: The physical fitness significantly mediates the relationship between the screen time and academic achievement direct and indirect effects.

CONCEPTUAL FRAMEWORK OF THE STUDY

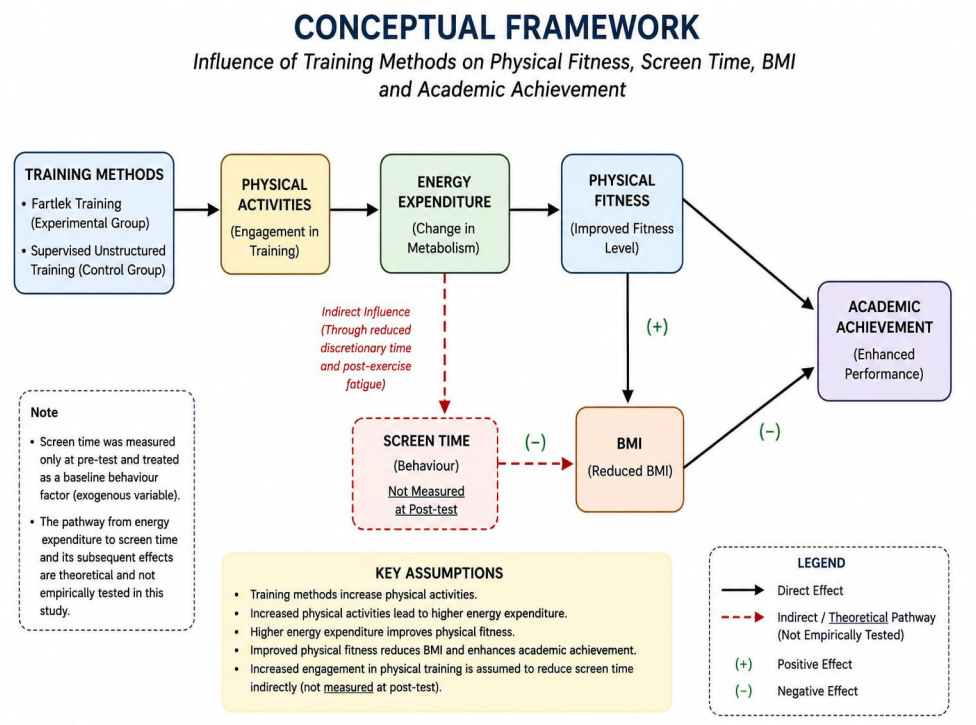


Fig. 1. Conceptual Framework

The training methods influence physical activities that brings changes in energy expenditure. The energy expenditure is diffectly effecting the physical fitness and indirectly effects screen time behaviour (not measured at post-test level) that negatively influences BMI and academic achievement. Increased

engagement in physical training indirectly influences screen time through reduced discretionary time and post exercise fatigue. This pathway is not empirically tested as no screen time measurement was done at post-test it is included as baseline behaviour factor in the study.

MATERIAL AND METHODS

Participants and sampling

The sample of 40 girls' students in the age range of 15-17 years studying in class XI were taken for the study. The sample group was randomly assigned to group A and B using random number table and one group with odd numbers constituted the experimental group whereas the other group with even number constituted the control group.

Inclusion criteria

The participants were included in the study with their consent of oral announcement about the study paradigm. The consented individuals with regular device users for <4 hrs./day were included using 4G internet connection.

Exclusion criteria

The participants who did not submit the consent, having injuries and chronic illness and who is unable to have 4G Internet connection were excluded from the study.

Variables

The variables and their interrelations are shown in Figure 2. Independent, mediator and dependent variables are summarized hereunder.

Data collection

The data were collected at two phases namely pre-test that was prior to the intervention and post-test that was followed by the intervention. Pre-test was administered to both the control and experimental groups on screen time, Physical fitness components adopting standard procedures. After the intervention period post-test was administered on Physical fitness and academic achievement.

Data analysis

The collected data were processed for correctness and coded for SPSS analysis. The data analysis was planned to include descriptive statistics and paired 't' test, independent 't' test, Pearson correlation matrix and Structural Equation Modelling for direct effects and indirect effects. The findings are interpreted and discussed in the light of objectives and Hypothesis.

Independent variable: Fartlek training

Mediator variable:

1. Physical fitness,
2. VO_2 max (endurance),
3. Push up (Strength),
4. Sit and reach (flexibility)
5. BMI.

Dependent variable: Academic achievement (Test scores)

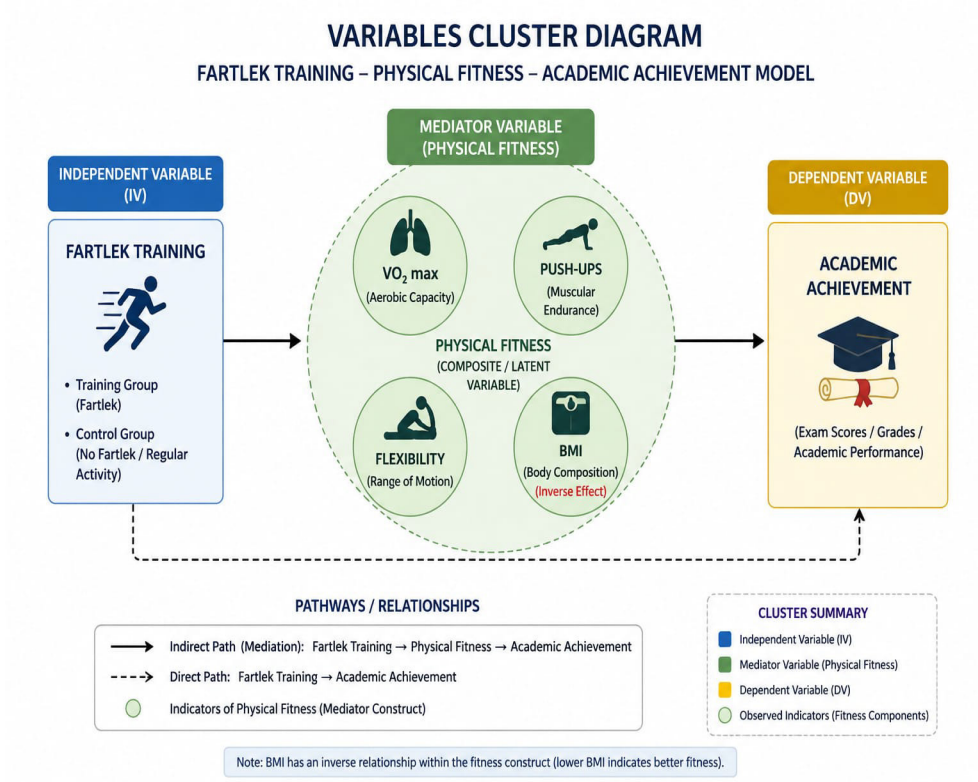


Fig. 2. Variables Cluster

Methodology

True experimental design with randomized control two group designs was employed.

Research design

Experimental design with Structural Equation Modeling (SEM).

Pre-test -intervention-post-test with Structural Equation Modeling (SEM)was adopted. The structural equation modeling was adopted to simultaneously study the relationship (Haier et al., 2019; Kline 2016) between the selected variables. The structural equation modeling studied the direct effects of intervention on Physical fitness and academic achievement. Indirect effects were also studied through the mediator variable physical fitness on dependent variable (academic achievement) by independent variable (Fartlek training).

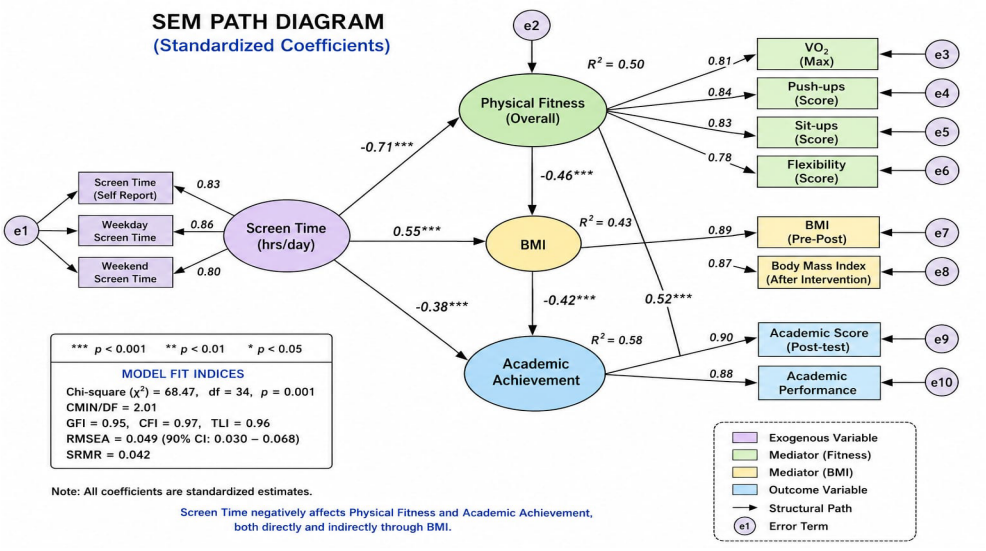


Fig. 3. SEM PATH

Experimental protocol of intervention

The experimental protocol of Fartlek training was planned and tailored by the investigator for 40 min/day for 6 weeks. The components of training include warm-up 10 min followed by Speed play with Intervals of varying intensities of Moderate run, Fast run, Slow jog, Sprint, Moderate run, Sprint, Jog recovery, Fast run, Sprint, Slow jog and cool down for 30 min/day. The control group was not given any specific training during the period of study. The intervention

training methods were planned and executed to effectively reduce the screen. The training period was arranged at the participants maximum screen engagement time assessed from participants self-reporting data.

Table 1 depicts the descriptive statistics of pre-test and post -test scores. The table explains the substantial improvement in all physical fitness variables and academic achievement. The table shows both the groups have improved in all the variables but the higher mean difference between the present test and post -test scores demonstrate the substantial improvement of the experimental group ahead of the control group.

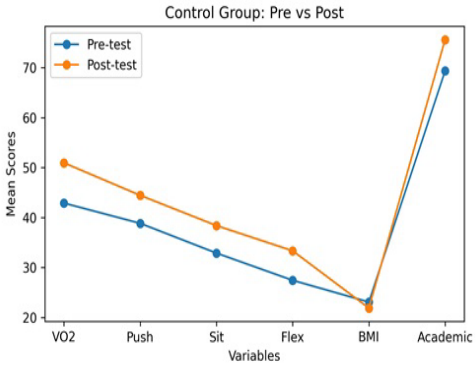
Table 1. Descriptive statistics of Pre-test and Post-test scores

Variable	Group	Pre-test (M ± SD)	Post-test (M ± SD)
VO_2 Max	Experimental	43.55 ± 4.62	57.65 ± 2.68
	Control	42.90 ± 4.10	50.95 ± 4.95
Push-ups	Experimental	39.55 ± 3.60	49.65 ± 2.88
	Control	38.85 ± 3.50	44.45 ± 3.80
Sit-ups	Experimental	31.10 ± 5.74	41.55 ± 4.87
	Control	32.90 ± 4.90	38.40 ± 4.90
Flexibility	Experimental	28.05 ± 3.86	35.95 ± 4.87
	Control	27.45 ± 3.80	33.35 ± 3.60
BMI	Experimental	23.95 ± 2.77	22.10 ± 2.94
	Control	23.10 ± 2.60	21.90 ± 2.80
Academic Achievement	Experimental	69.80 ± 8.20	79.95 ± 6.58
	Control	69.35 ± 7.90	75.60 ± 7.10

The table 2 stands for paired t test results of pre-test and post -test scores within the groups. The paired t test at $p<0.01$ shows that both the groups have attained statistically significant improvement. The higher t values of experimental group show the effect of strength to confirm the effectiveness of the intervention.

Table 2. Paired t-test Results (Pre vs Post)

Variable	Group	Mean Diff	t	p
VO_2 Max	Experimental	14.10	14.85	< .001
	Control	8.05	6.20	< .001
Push-ups	Experimental	10.10	12.40	< .001
	Control	5.60	5.40	< .001
Sit-ups	Experimental	10.45	11.75	< .001
	Control	5.50	5.10	< .001
Flexibility	Experimental	7.90	9.60	< .001
	Control	5.90	5.80	< .001
BMI	Experimental	-1.85	6.10	< .00 1
	Control	-1.20	3.90	< .01
Academic Achievement	Experimental	10.15	10.20	< .001
	Control	6.25	5.00	< .001



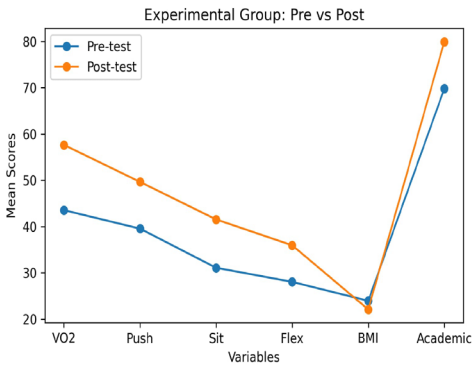


Fig. 4. Control Group: Pre vs Post

Fig. 5. Experimental Group: Pre vs Post

Figure 4 shows the within group status in pre-test and post-test. The graph evidence that all the variables have attained a gain in the post-test compared to pre-test in exception of BMI. Figure 5 represents the status of experimental group gain in variables at post-test against pre-test. The comparative view of Figure 4 and 5 shows that the gap between the intersect of pre and post -test line is wider in Figure 5 and narrower in Figure 4. The wider intersect gap shows the significant effect of intervention.

Table 3. Independent t-test (Post-test: Experimental vs Control)

Variable	Experimental (M ± SD)	Control (M ± SD)	t	p
VO_2 Max	57.65 ± 2.68	50.95 ± 4.95	4.85	< .001
Push-ups	49.65 ± 2.88	44.45 ± 3.80	4.20	< .001
Sit-ups	41.55 ± 4.87	38.40 ± 4.90	2.45	< .05
Flexibility	35.95 ± 4.87	33.35 ± 3.60	2.10	< .05
BMI	22.10 ± 2.94	21.90 ± 2.80	0.25	> .05
Academic Achievement	79.95 ± 6.58	75.60 ± 7.10	2.35	< .05

The table 3 illustrates the independent t test results of post-test of control and experimental groups. The independent t test shows the between group effectiveness in post-test. The experimental group significantly stands better than the control group in VO_2Max, push-ups, sit ups, flexibility and academic achievement. Yet the BMI is not significant between the groups but showed and improvement within the group level.

Figure 6 depicts the post-test comparison of experimental and control groups. The bar diagram shows the gain in all variables except BMI.

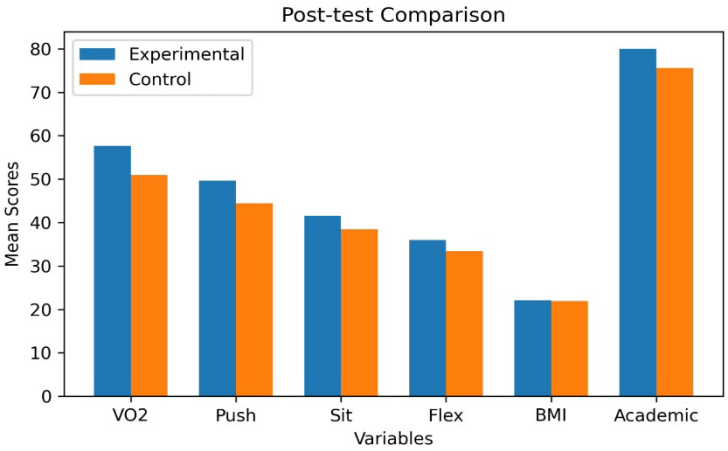


Fig. 6. Post-test Comparison

The table 4 depicts the Pearson correlation matrix of post -test scores of variables. The paired t test at $p<0.01$ shows that both the groups have attained statistically significant improvement.

Table 4. Pearson Correlation Matrix (Post-test Variables)

Variable	1	2	3	4	5	6	7
1. VO_2 Max	1.00						
2. Push-ups	.78**	1.00					
3. Sit-ups	.72**	.75**	1.00				
4. Flexibility	.69**	.70**	.68**	1.00			
5. BMI	-.52**	-.48**	-.45**	-.40*	1.00		
6. Academic Achievement	.66**	.64**	.60**	.58**	-.50**	1.00	
7. Screen Time	-.61**	-.58**	-.55**	-.52**	.55**	-.63**	1.00

Note. p < .05**

The higher t values of experimental group shows the effect of strength The correlation matrix reveals a well structured pattern of relationship among physical fitness, academic achievement and screen time. There are two distinct clusters observed in the correlation matrix.

Positive performance cluster: VO_2 Max, push-ups, sit ups, flexibility and academic achievement

Negative performance cluster: Screen time and partially BMI

Table 5. Standardized Direct Effects (β)

Path	β	p	Interpretation
Screen Time → Physical Fitness	-0.71	< .001	Strong negative
Screen Time → BMI	0.55	< .001	Moderate positive
Screen Time → Academic	-0.38	< .001	Negative
Physical Fitness → Academic	0.52	< .001	Positive
Physical Fitness → BMI	-0.46	< .001	Negative
BMI → Academic	-0.42	< .001	Negative

The table 5 illustrates the path analysis observed as direct effects of the study. The table shows the multiple paths of studying the direct effects of the variables. The screen time with physical fitness showed a strong negative effect. Physical fitness with academic achievement, Screen time with BMI paths have shown positive and moderate positive effects respectively. The other three paths such as screen time with academic achievement, physical fitness with BMI and BMI with academic have shown negative effects.

Table 6. (SEM Model Fit Indices)

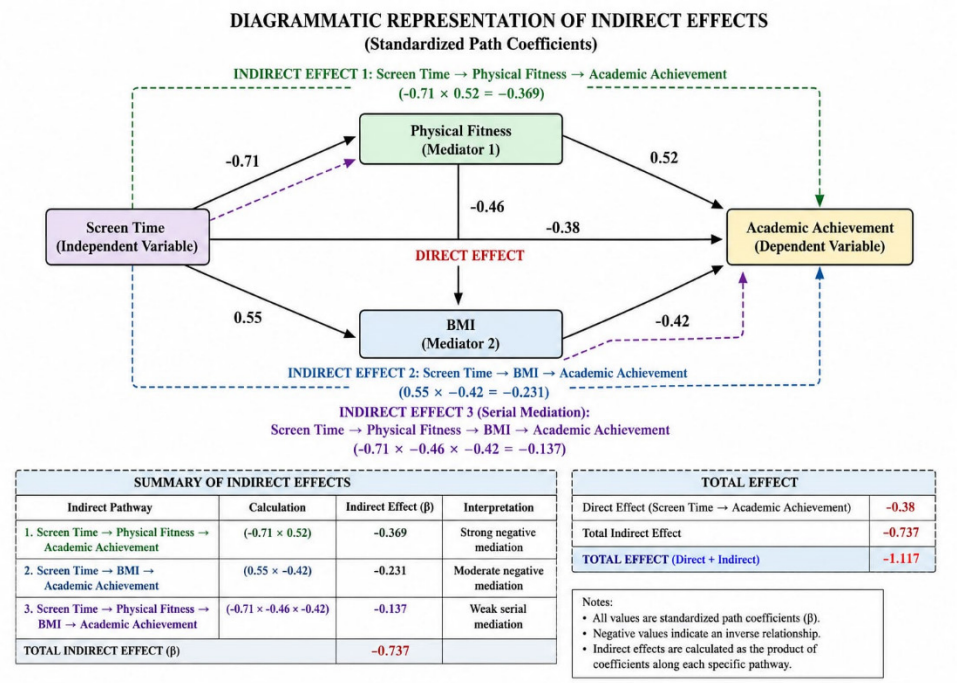
Fit Index	Value	Recommended	Interpretation
χ^2	68.47	—	Acceptable
df	34	—	—
χ^2/df	2.01	< 3	Good
GFI	0.95	> 0.90	Good
CFI	0.97	> 0.90	Excellent
TLI	0.96	> 0.90	Excellent
RMSEA	0.049	< 0.08	Good
SRMR	0.042	< 0.08	Good

The table 6 shows the fit indices of SEM model. The fit indices showed a good fit of the paths studied.

Table 7. standardized direct effects of variables on academic achievement

Predictor Variable	Outcome Variable	Standardized β	Interpretation
Screen Time	Academic Achievement	-0.38	Moderate negative effect
Physical Fitness	Academic Achievement	0.52	Strong positive effect
BMI	Academic Achievement	-0.42	Moderate negative effect

The table 7 shows standardized direct effects of variables on academic achievement. Physical fitness showed a strong positive direct effect on academic achievement (Byrne, 2016). The magnitude of the coefficient (β=0.52) suggests that physical fitness is the most influential direct predictor in the model. The screen time shows moderate negative direct effect on academic achievement, it implies that increases screen time reduces the academic achievement, whereas the BMI exerted moderate negative direct effect on academic achievement. Higher BMI values are corroborated with lower academic achievement. The figure 7 shows the figurative representation of indirect effects of the model with computed standardized path coefficients.



SUMMARY OF INDIRECT EFFECTS			
Indirect Pathway	Calculation	Indirect Effect (β)	Interpretation
1. Screen Time → Physical Fitness → Academic Achievement	(-0.71 × 0.52)	-0.369	Strong negative mediation
2. Screen Time → BMI → Academic Achievement	(0.55 × -0.42)	-0.231	Moderate negative mediation
3. Screen Time → Physical Fitness → BMI → Academic Achievement	(-0.71 × -0.46 × -0.42)	-0.137	Weak serial mediation
TOTAL INDIRECT EFFECT (β)		-0.737	

TOTAL EFFECT	
Direct Effect (Screen Time → Academic Achievement)	-0.38
Total Indirect Effect	-0.737
TOTAL EFFECT (Direct + Indirect)	-1.117

Notes:
- All values are standardized path coefficients (β).
- Negative values indicate an inverse relationship.
- Indirect effects are calculated as the product of coefficients along each specific pathway.

Fig. 7. Diagrammatic representation of indirect effects

Table 8 illustrates standardized indirect effects of screen time on academic achievement. Through the indirect effects three possible paths were studied that affect the academic achievement, out of the three, Screen time→ Physical fitness→Academic achievement (β =-.369), this strong negative indirect effect shows that the screen time reduces academic achievement through lowering physical fitness. The second path Screen time →BMI→Academic achievement

(β=-.231), this path shows a moderate negative effect indicates that Screen time increases BMI and consequent BMI reduces academic achievement. The third one is serial mediation path: Screen time→Physical fitness→BMI→Academic achievement (β =-.137), the serial mediation path way shows weaker yet meaningful indirect effect accommodating both mediators in sequence. The findings are similar to the studies of Trembly et al. (2011) and Carson et al. (2016).

Table 8. standardized indirect effects of screen time on academic achievement

Pathway	Calculation	Indirect Effect (β)	Interpretation
Screen Time → Physical Fitness → Academic Achievement	(-0.71 × 0.52)	-0.369	Strong negative mediation
Screen Time → BMI → Academic Achievement	(0.55 × -0.42)	-0.231	Moderate negative mediation
Screen Time → Physical Fitness → BMI → Academic Achievement	(-0.71 × -0.46 × -0.42)	-0.137	Weak serial mediation

Table 9. Total effects of screen time on academic achievement

Effect Type	Value (β)
Direct Effect	-0.38
Total Indirect Effect	-0.737
Total Effect	**-1.117**

Table 9 shows that the total indirect effect (β =-.737) is quite larger than the direct effect (β=-.38). The values indicate that most of the impact on academic achievement occurs through mediators, whereas the direct effect (β =-.38) suggests that the relationship in the model does not fully explained by direct effect alone. Hence the effects of mediating are empirical and the model fits for sequential equation modelling.

DISCUSSION

The research gap shows a quite number of studies available on cause and effect and correlational analysis of the variables involved in the study in the nature of independent exploratory studies to delimit the interaction between the selected variables. To contribute for simultaneous analysis of interrelations

among the variables in the present study multivariate modelling was adopted. The direct effects and indirect effects were studied comprehensively with structural equation modelling. True experimental two group pre-test intervention post-test design was adopted. The structural equation modelling (SEM)was integrated with experimental design.

The descriptive statistics showed with the group analysis and showed the effect of intervention among the experimental group participants with higher mean difference. The paired t test within groups showed effectiveness of intervention from the higher t value of experimental group. The paired t test shows the strength effect of the intervention through Fartlek training. The independent t test results showed the between group performance in post-test. The post-test performance between groups effectiveness asserts the effectiveness of Fartlek training in VO_2max, push-ups, sit-ups, flexibility and academic achievement. In respect of BMI the effect of training is not significant between the groups whereas it showed improvement within the groups. The insignificant effect of Fartlek training is inferred from the limited period of six weeks interventional period that is not enough period to yield effectiveness of Fartlek training among experimental group participants (Martin et al,2018).

The Pearson correlation matrix and correlation heat map were computed to study the relationship among the variables in multiple paths. Figure 7 illustrates the correlation heatmap of the variables relationship magnitude in terms of correlation coefficient(r).

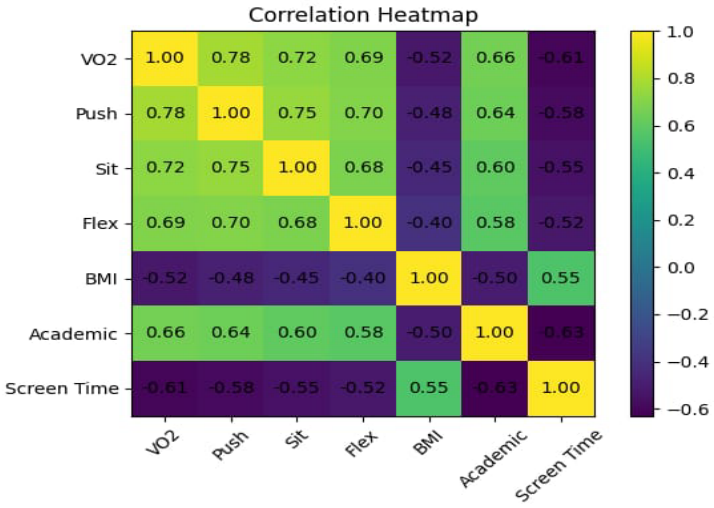


Fig. 8. Correlation Heatmap

The Correlation heatmap in figure 8 aids to interpret the interrelationship of variables. All the Physical fitness variables VO_2max, push-ups, sit-ups and flexibility showed strong positive correlation with each other. The observed pattern viz VO_2 max and push-ups (r=0.78), VO_2 max and sit-ups (r=0.72), Push-ups and Sit-ups (r=0.75), VO_2Max with flexibility (r=0.69), push-ups with flexibility (r=0.70), sit-ups with flexibility (r=0.68). The association among the various pairs showed moderate to strong correlations. The Pearson matrix for Physical fitness components showed the interdependence among them. The interdependency has been in confirmatory to the individual exploratory correlational studies.

Physical fitness vs academic achievement

All the physical fitness variables where positively quadrilateral with the academic achievement. The correlation coefficient of academic achievement with physical fitness variables such as VO_2 max (r=0.66), push-ups (r=0.64), sit-ups (r=0.60) and Flexibility (r=0.58). The range of association indicates that higher the physical fitness higher in the academic achievement. The correlation analysis of physical fitness and academic achievement is supported by large number of individual exploratory studies. The findings are in corroboration with higher levels of physical fitness tend to exhibit better academic outcomes (Donnelly et al., 2016; Singh et al., 2012)

Screen time relationships

The screen time is the hours /day and individual is sitting before the digital screen including online, off-line and app based actions actively or passively performed by individuals(Adelantado Renau et al.,(2019).The correlation matrix revealed that the screen time possess a strong negative association with all the physical fitness variables such as VO_2 max (r= -0.62),push ups (r= -0.58), sit-ups (r= -0.55)and Flexibility (r= -0.52).The range of association indicates that higher the screen time lower the physical fitness, reduced in flexibility and poor in endurance. Further the higher screen time causes poor academic achievement performance. The negative correlates of screen time evidences the adverse effects on Physical fitness and educational outcome. The studies of Trembly et al. (2011) and Le Blanc et al. (2017) supports the findings of screen time direct relationship with academic achievement.

BMI relationships

The BMI stands for a mixed yet meaningful pattern of relationship among the variables. BMI is negatively correlated with VO_2Max (r=-.52), Push-ups (r=-.48), Sit-ups (r=-.45), Flexibility (r=-.40) and academic achievement (r=-.50). The BMI

correlation shows that it can act as mediating health indicators influencing screen time and academic achievement is in line with the studies of Santana C.C.A. et al. (2017) and Martin et al. (2018). The negative association of BMI with physical fitness variables show lower physical fitness and lower academic achievement. Whereas the screen time has positive correlation with BMI (r=.50). The findings are in congruent with the study of Sanders et al. (2019). Similar effect of screen time on obesity was reported by Hongsengh Quian et al. (2025).

The direct and indirect effects

The direct effects analysis showed that physical fitness has a strong positive effect on academic achievement (β =0.52), whereas the screen time (β =-0.38) and BMI (β=-.0.42) has negative effects. The computed values of indirect effects revealed screen time significantly influenced academic achievement through physical fitness and BMI (β =-0.737). The indirect effects overweigh the direct effects (β =-0.38< β -0.737) suggest the strong mediation.

Limitations and furtherance

The present study employed a small sample of 40 girls' students (N=40), when included larger sample and with all gender groups, the generalizability of the findings will be more authentic to ensure the external validity of the research design.

The longitudinal and cross sectional studies may be conducted to test the concurrent validity of the structural equation modelling. The interventional period may be extended beyond six weeks to test the lasting effect of the intervention.

The future studies may incorporate more mediators such as sleep quality and mental health.

Implications

The study empirically validates that academic achievement is strongly influenced by physiological factors that can be manipulated through physical training Paradigms in general and through Fartlek training is particular.

The strong mediation effect shows that screen time operates through many underlying factors.

The serial mediation implies that the academic achievement is interconnected through pathways rather than by individual variables to show linearity.

The schools could re plan their academic activities with structures physical education activities. It extends that physical education is not supplementary rather it is essential for conducive academic environment.

BMI and Physical fitness should be made part of students' performance assessment systems with required follow up activities.

The study contributes as an empirical sequential equation modelling in exploring the complex direct and indirect effects of variables. Hence the study acts as a significant reference guide for designing hybrid experimental designs.

CONCLUSION

The study contributes for design hybrid approach to experimental research that allows to study the direct and indirect effects of modeling. The structural equation modeling path indicates that screen time has direct effects with academic achievement; also it has indirect effects through meditation model. The homogeneity between the groups were established prior to the intervention. The screen time was measured for baseline analysis and not manipulated through the model is empirical from the structural equation modeling hybridization with experimental design. The higher t values of experimental group shows the effect strength. The correlation matrix reveals a well-structured pattern of relationship among physical fitness, academic achievement and screen time. The structural equation modeling shows that total indirect effect (β =-0.737) is quite larger than the direct effect (β =-0.38). The values indicate that most of the impact on academic achievement occurs through mediators, whereas the direct effect (β =-0.38) is marginal. The direct effects shows that the relationship can not be exhaustively explained by the direct effects alone rather the indirect effects play a significant relationship and so the selection of research design with Sequential Equation Modelling is aptly justified by the observed results. The BMI has not attained statistically significant effect through the training intervention is due to the limitation of training duration. The requirement of minimum 12 weeks intervention was studied by Zhen Li et al. (2025) supports the limitation of limited period of intervention on BMI. The other mediating and dependent variables have shown typical effect of intervention to confirm the soundness of the study that substantiates the generalizability of the findings.

AUTHORS CONTRIBUTION STATEMENT

Asha Devi contributed to conceptualization of the paper and field work done by her on implementation of the intervention and measurement of variables and drafted the manuscript. Uma provided the hybrid experimental design with Sequential

Equation Modelling to test the variables simultaneously. Suresh Kumar assisted in data analysis, interpretation and revised the manuscript. All authors reviewed the paper and approved the final version for submission.

CONFLICT OF INTEREST

The authors declare that no conflict of interests.

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ETHICAL STATEMENT

The procedures followed for the study adheres to the ethical established by the Committee on Publication Ethics (COPE) ensuring transparency, integrity and respect for participants.

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