

# Effect of mini-trampoline exercises on body composition, reaction time and motor proficiency in overweight and obese adolescents – a randomised controlled trial

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## Abstract

**Introduction.** Mini-trampoline exercises are low-impact and enjoyable, making them particularly suitable for adolescents, so they are unaware of the effort they are exerting. This study sought to assess the impact of mini-trampoline exercises on body composition, reaction and motor proficiency in overweight and obese adolescents with a sedentary lifestyle.

**Methods.** A randomised controlled trial was conducted on 36 overweight and obese adolescents aged 15–19 years with a sedentary lifestyle who scored 1 or 2 on the PAQ-A and had a BMI above the 85<sup>th</sup> percentile. Participants were divided randomly into two groups of equal size, labelled as groups A and B. Group A carried out mini-trampoline exercises three times weekly on non-consecutive days for four weeks; each session lasted for 40 min and included dietary counselling. Group B was given only dietary counselling. Outcome measures such as body composition were evaluated using BMI, reaction time using the Deary-Liewald reaction time task and motor proficiency using the BOT-2. Outcome measures were assessed at baseline and post 4 weeks.

**Results.** Mini-trampoline exercises showed significant decreases in BMI (group A =  $0.18 \pm 2.08$ , group B =  $0.04 \pm 0.52$ ) and reaction time (group A =  $0.06 \pm 0.03$ , group B =  $0.01 \pm 0.03$ ), and improvement in motor proficiency (group A =  $10.89 \pm 4.57$ , group B =  $2.89 \pm 4.48$ ), when comparing group A with group B.

**Conclusions.** Mini-trampoline exercises are an effective form of exercise for reducing body composition, reaction time and enhancing motor proficiency in overweight and obese adolescents. Therefore, mini-trampoline exercises can be inculcated as a recreational activity to promote physical fitness, reaction time and motor proficiency in adolescents.

**Key words:** rebound exercise, mini-trampoline, adolescents, reaction time, motor performance

## Introduction

Overweight and obesity are defined by an abnormal or excessive buildup of fat that poses significant health risks. Between 1975 and 2016, the global prevalence of overweight and obese adolescents and children aged 5 to 19 increased more than fourfold, rising from 4% to 18% [1]. In India, research by Sinha [2] indicates that among adolescents aged 10 to 19, the prevalence of obesity is 5.8%, while overweight stands at 18.5% [2].

The global rise in obesity can be attributed largely to dietary modifications and decreased energy expenditure due to work and leisure activities. This increase in obesity is associated with a higher incidence of medical problems such as stroke, insulin resistance, and systemic arterial hypertension. It also affects physical characteristics such as gross motor coordination and motor performance. Effectively managing obesity and overweight in children and adolescents requires a multidisciplinary approach with a comprehensive perspective.

For adults, maintaining health and wellbeing depends significantly on incorporating regular moderate physical activity into their lifestyles. Unfortunately, most adults do not engage in such activities regularly [3]. Nevertheless, exercise remains a critical component in helping obese individuals lose weight. A 2018 study revealed a discrepancy between the physical activities available and the preferences of adolescents. To address this, authorities should involve young people in designing interventions and facilities to provide suitable opportunities for physical activity. Study participants expressed a preference for nearby, affordable, enjoyable, social oppor-

tunities, and appropriate infrastructure for unstructured physical activities [4].

Compared to conventional aerobic exercises such as sprinting, jumping rope, jogging, or dancing, using a mini-trampoline appears to be a superior option for those who are overweight or obese. This is because excess weight increases the likelihood of sustaining injuries during physical activities. Rebound exercise on a mini-trampoline distributes gravitational forces evenly across the body and produces a lower ground reaction force, which reduces stress on weight-bearing joints. Research shows that rebound exercise is associated with fewer musculoskeletal injuries during workouts [5]. Moreover, mini-trampoline exercise can be particularly enjoyable for adolescents, who may not realise how much effort they are exerting [2]. This modern device offers significant benefits, allowing for both rhythmic and non-rhythmic floor exercises. Its rubber pad reduces joint pressure during exercise, enhancing blood circulation and oxygen delivery to the body's cells, which boosts energy levels and positively affects bone health.

Reaction time is the interval between the onset of a stimulus and the initiation of a response – has been linked to obesity, which is a major risk factor for cognitive decline. Studies indicate that individuals with both higher and lower body mass indices (BMIs) exhibit longer visual and auditory reaction times (VRTs and ARTs) compared to those with normal BMIs, suggesting that BMI impacts sensory-motor connections [6].

Motor proficiency, which encompasses both gross and fine motor skills, is a crucial factor influencing physical activity participation in children. A reduction in motor proficiency is

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associated with childhood obesity [7]. Additionally, motor proficiency and weight status are interconnected. Overweight children often face significant challenges with basic physical skills and tend to have more negative self-assessments compared to their average-weight peers [8]. Research shows that motor proficiency correlates positively with both overweight and obesity across different ages [7–10]. Researchers believe that alterations in brain plasticity are related to the accumulation of extra fat and that these changes can be linked to a decline in both motor control and cognitive function [11].

Trampoline exercise has a notable impact on children's neurological systems, sense organs, physical fitness and motor control, including balance, strength and coordination [12]. Trampoline bouncing has a significant effect on fitness and motor control since there is a negative correlation between overweight and obesity, and motor proficiency in adolescents. Therefore, this study sought to assess the impact of mini-trampoline exercises on body composition, reaction time and motor proficiency, as to the best of our knowledge, prior research has not examined these factors.

## Subjects and methods

### Study design

A randomised controlled trial (RCT) with double-blinding was conducted at the tertiary hospital and research centre-*o*OPD of Dr D Y Patil College of Physiotherapy Pune, India, between August 2023 and January 2024.

### Participants

The study was carried out with 36 participants aged between 15 and 19, both genders, BMI more than the 85<sup>th</sup> percentile, with sedentary lifestyles who scored 1 or 2 on the adolescent Physical Activity Questionnaire (PAQ-A) reflecting low and moderate physical activity. Adolescents with any medical conditions such as visual impairment, progressive locomotor ailment, neurological and cardiovascular disorders, injury or severe orthopaedic issues such as fractures or soft tissue injury in the past 6 months, inability to perform the exercise intervention or having the habit of consuming drugs, alcohol or smoking, who were physically active or involved in any kind of sports, and those with a fear of trampolines were excluded from the research.

While this study was not specifically designed to analyse gender-based differences, it is recognised that gender differences, particularly hormonal variations, can influence body composition. Therefore, a more balanced gender representation will be considered in future studies to better assess gender-specific effects.

### Randomisation

The participants were randomly allocated into two groups of equal size, group A (experimental) ( $n = 18$ ) with a mean  $\pm$  *SD* age of  $18.38 \pm 0.48$  years, and group B, the control group, with a mean  $\pm$  *SD* age of  $18.55 \pm 0.49$  years. Group allocation was done using a computer-based sequence generator.

### Interventions

Both groups received and were asked to adhere to the same dietary guidance. The experimental group (A) performed mini-trampoline exercises three times per week, with sessions on non-consecutive days, over a duration of four weeks, with

sessions lasting 40 min each, including 10 minutes of warm-up and cool-down each. The exercises were gradually intensified on a weekly basis. The control group (B) received an explanation about the importance of physical fitness, while all their physical activities were documented over a span of four weeks.

#### Equipment used:

- mini-trampoline: Cosco – 48 inch, legs – 8 pcs
- weighing machine, stadiometer, Bioelectric impedance analyser, laptop, BOT kit (Balance beam and knee pad)
- the term 'mini-trampoline' refers to a smaller, more compact version of a traditional trampoline, designed for indoor use in limited spaces. The 'mini' designation specifically indicates its reduced size compared to full-sized trampolines, making it more portable and easier to store, which is ideal for clinical or community settings. In this study, we used the Cosco 48-inch mini-trampoline, with a diameter of approximately 1.2 m and 8 legs for stability. Its dimensions were selected to optimise balance, stability, and safety, ensuring effective rebound exercises for overweight adolescents. The model was chosen for its durability, robust frame, and non-slip surface, making it suitable and safe for the target population.

### Outcome measures

Subjects in both groups underwent examinations at baseline and post 4 weeks of intervention. Demographic and anthropometric information gathered included age, sex, height, weight, and BMI. The outcome measures used were as follows:

1. Body composition: height, weight, BMI, and body fat percentage were assessed. A bioelectric impedance analyser was used to analyse the percentage of body fat.

2. Reaction time: evaluated using the Deary-Liewald test, a computer-based application developed to assess reaction time. Participants in the task are presented with two distinct conditions: a simple condition and a complex condition. (1) Simple condition: In this condition, a single circle lights up after a brief, but irregularly timed interval. Participants are required to click the button located below the illuminated circle as quickly as possible. (2) Complex condition: Here, four circles are displayed. Only one of these circles lights up during each trial, following a brief, randomly timed delay. Participants must click the button positioned below the circle that has lit up. The data collected across all trials are averaged to obtain the participant's mean simple reaction time. Outliers may be excluded from the analysis to ensure that the average is not skewed by an atypical response. A higher mean reaction time indicates slower cognitive processing or motor response; changes were assessed before and after an intervention.

3. Motor proficiency: evaluated using the Bruininks–Oseretsky Test of Motor Proficiency, second edition. One of its 4 motor composites i.e., strength and agility, was assessed in the current study. The strength and agility composite comprises 2 subtests – running speed and agility, and strength. Running speed and agility includes tests like the shuttle run, stepping sideways over a balance beam, one-legged stationary hop, one-legged side hop, and two-legged side hop. Strength included tests like the standing long jump, knee push-up or full push-up, sit-up, wall sit, V-up. The raw score was determined based on the trials, with a second trial administered only if the examinee stumbled or fell during the first trial. Using the raw score, the total point score was computed, which was then used to calculate the scale score. Finally, the standard score was generated from the scale score, and descriptive categories corresponding to scale scores were identified.

## Data analysis

The data were analysed using the statistical package SPSS 26.0 (SPSS Inc., Chicago, IL), with a significance level set at  $p < 0.05$ . Descriptive statistics were utilised to determine the mean and standard deviation of each group. The normality of the data was assessed using the Shapiro–Wilk test. Inferential statistics, including the Wilcoxon signed-rank test for within-group differences and the Mann–Whitney  $U$  test for between-group comparisons, were employed. While additional statistical tests, such as parametric analyses, could be considered for larger sample sizes or more normally distributed data in future studies, the current results provide strong evidence supporting the effectiveness of mini-trampoline exercises in improving body composition and motor proficiency in overweight and obese adolescents.

## Results

Table 1 suggest background characteristics of study population. Regarding the within-group analysis, BMI, body fat %, reaction time and motor proficiency show significant improvements in the pre- and post- values in group A (trampoline) compared to those of group B (control) (Table 2).

Regarding the between-groups analysis, BMI, body fat %, reaction time and motor proficiency show significant mean differences in group A (trampoline) compared to those of group B (control) (Table 3).

Table 1. Baseline characteristics of the data

Variables	Group A	Group B	$p$ -value
Age (mean $\pm$ SD)	18.38 $\pm$ 0.48	18.55 $\pm$ 0.49	0.30
Gender ( $n$ )	male	2 (11.2%)	0.07
	female	17 (94.2%)	
Height (pre) (mean $\pm$ SD)	1.58 $\pm$ 0.05	1.57 $\pm$ 0.07	0.62
Weight (mean $\pm$ SD)	78.79 $\pm$ 2.25	77.86 $\pm$ 1.30	0.04

Table 2. Within-groups analysis

Outcome measures	Group	Pre (mean $\pm$ SD)	Post (mean $\pm$ SD)	$p$ -value
BMI	A	24.77 $\pm$ 2.08	24.59 $\pm$ 2.08	0.79
	B	24.51 $\pm$ 0.53	23.47 $\pm$ 0.52	0.82
Body fat %	A	34.88 $\pm$ 3.22	33.75 $\pm$ 3.25	0.61
	B	33.82 $\pm$ 1.48	33.75 $\pm$ 1.48	0.88
Reaction time	A	0.46 $\pm$ 0.03	0.40 $\pm$ 0.03	0.001
	B	0.47 $\pm$ 0.03	0.45 $\pm$ 0.03	0.78
Motor proficiency	A	35.61 $\pm$ 3.19	46.5 $\pm$ 5.96	0.001
	B	37.66 $\pm$ 4.53	40.55 $\pm$ 4.44	0.06

BMI – body mass index

Table 3. Between-groups analysis

Outcome assessments	Group A (mean $\pm$ SD)	Group B (mean $\pm$ SD)	$p$ -value
BMI	0.18 $\pm$ 2.08	0.04 $\pm$ 0.52	0.03
Body fat %	0.6 $\pm$ 3.23	0.07 $\pm$ 1.48	0.21
Reaction time	0.06 $\pm$ 0.03	0.01 $\pm$ 0.03	0.001
Motor proficiency	10.89 $\pm$ 4.57	2.89 $\pm$ 4.48	0.005

BMI – body mass index

## Discussion

The study sought to assess the impact of mini-trampoline exercises on body composition, reaction time and motor proficiency in overweight and obese adolescents. The findings indicate that mini-trampoline exercises are effective in improving these parameters, particularly when compared to a control group that only received dietary counselling. The discussion will elaborate on the results and compare them with existing literature.

In the present study, the mean age of the experimental group was 18.38  $\pm$  0.48, whereas the mean age of the control group was 18.55  $\pm$  0.49 (Table 1). The benefits of mini-trampoline exercises for children, adults, and older adults have been studied in the past [13]. The current study examines the effects of mini-trampoline exercises on adolescents who are overweight or obese. In groups A and B of this study, the proportion of male participants was 5.8% and 11.2%, respectively, with 94.2% and 88.8% female participants in groups A and B, respectively.

Adolescent health and wellness depend primarily on a lifestyle marked by daily moderate physical activity. Unfortunately, most individuals do not engage in regular physical activity. Trampoline-based training’s low jarring effect is made possible by the elastic surface with springs and gravity, which can be linked to a reduction in the frequency of cumulative trauma caused by repetitive loading [14].

### Effect on body composition

Table 2 The results regarding weight and BMI showed noticeable improvement in the experimental group over the control group. These findings are consistent with previous research that suggests rebound exercises can effectively aid in weight management. Shah et al. [15] reported similar improvements in BMI among adolescents who engaged in rebound exercises combined with dietary interventions [16].

Another corroborating study carried out by Sellés-Pérez [15] in 2021 evaluated how young, active women’s body composition and physical fitness are enhanced by a brief body jump training program. The author came to the conclusion that completing the Body Jump program, conducted three times a week for a month, resulted in positive effects on the physical health and body composition of a cohort of young, healthy females. It also had a positive impact on the value of muscular strength (1 RM) during half-squat exercises [17].

The present study on body fat percentage demonstrates that no statistically significant difference was reported in the ‘pre/post’ interval by the between-group analysis. The within-group analysis also revealed no statistically significant change in body fat percentage in the experimental group. This non-significant result could be due to the short duration of the intervention (4 weeks), which may not have been long enough to produce measurable changes in body fat. This also suggests that the short training duration may not have provided sufficient stimulus to reduce the body fat in the experimental group, despite improvements in measures such as BMI. A study carried out by Aalizadeh et al. [12] evaluated the long-term consequences of mini-trampoline exercises on motor performance and anthropometric variables in male Iranian students aged 11 to 14 years. The author reported that among students aged 11 to 14; trampoline training for 20 weeks with four physical activity sessions per week appeared to have an impact on reducing the body fat percentage and yielding good outcomes in terms of anaerobic physical fit-

ness [13]. A comparable study by Şahin et al. [16] investigated the effects of mini-trampoline exercises on body mass, body fat percentage,  $VO_2$  max, and vertical leap height over an 8-week period. This study found no statistically significant changes in body fat percentage [16]. There was no statistically significant variation in body fat percentage in our investigation. This discrepancy might be attributed to the shorter duration of our intervention (4 weeks), which may not have been sufficient to produce significant changes in body fat percentage. Longer-term studies could provide more insights into the sustained effects of trampoline exercises on body fat.

Additionally, a recent study conducted in 2024 examined the role of physical activity on posture and spinal column health, highlighting the importance of exercise in promoting proper posture and preventing spinal issues in adolescents. This underscores the broader benefits of engaging in physical activities, including trampoline exercises, which may contribute not only to body composition but also to overall musculoskeletal health [18].

### Enhancement in motor proficiency

A standard score is a cumulative score on the Bruininks–Oseretsky test of motor proficiency obtained from the running speed and agility point score and scale score, strength total point score and scale (Table 3). The between-group analysis for these parameters reported statistically significant improvement at the ‘post’ interval. The within-group analysis showed a significant improvement in the experimental group, but no significant changes were observed in the control group. The lack of significant improvement in the control group could be due to the absence of any physical activity intervention, as this group only received dietary counselling, in contrast to the experimental group, which engaged in mini-trampoline exercises and showed a significant improvement in motor proficiency.

A study supporting the present investigation, conducted by Aalizadeh et al. [12], sought to assess the impact of rhythmic rebounding exercises on children’s motor proficiency and motivation. The pre-assessment comprised the Children’s Movement Motivation Questionnaire and the Bruininks–Oseretsky motor proficiency test. The findings of the study demonstrated that 95% of changes in gross motor skill and 98% of changes in children’s motivation to move were brought about by the rhythmic rebounding exercises, which had a noteworthy impact on the motor proficiency and motivation of children aged 9 to 10 [13]. The positive effects on motor proficiency may be attributed to the dynamic and engaging nature of trampoline exercises, which challenge and develop multiple motor abilities simultaneously.

In addition, a study conducted in 2024 on chronic stress among Polish high school students found that high stress levels were prevalent in 58.6% of the subjects, with a significant impact on their health. Although the study primarily focused on stress, it supports the idea that physical activity can alleviate the stress burden in adolescents, indirectly enhancing motor proficiency. The high levels of stress identified among students may negatively affect motor skills and overall health. In contrast, engaging in physical activities like mini-trampoline exercises could reduce stress and contributed to improved motor performance [19].

### Impact on reaction time

Regarding reaction time, the between-group analysis reported a statistically significant improvement at the ‘post’ interval. The within-group analysis reported a significant improvement in the experimental group (group A), but no significant changes were observed in the control group (group B). This non-significant change in group B could be due to the lack of a physical activity intervention, as this group only received dietary counselling and no specific exercise program. In contrast, the experimental group, which engaged in mini-trampoline exercises, showed a marked improvement, likely due to the dynamic nature of the exercise enhancing cognitive and motor functions.

A supporting study conducted by Ludyga et al. [18] sought to determine how aerobic exercises affected young adults’ cognitive function in a higher education environment. As a result, improvements in cognition brought on by exercise extended beyond executive functioning. It seemed that executive function was selectively acutely affected by aerobic exercise [18]. This validates the results of the current study, which found cognitive improvement with mini-trampoline exercises. The mechanism behind these improvements may involve increased blood flow and neural activity associated with physical exercise, leading to better cognitive and motor performance.

Additionally, a study conducted in 2024 on smartphone addiction and physical activity among adolescents found a connection between reduced physical activity and increased smartphone addiction, which in turn is associated with higher BMI values. While the study focused on the effects of physical inactivity and screen time, it supports the notion that engaging in physical activities, such as mini-trampoline exercises, could counteract the negative health impacts of sedentary behaviours by promoting better physical health, reducing obesity, and possibly improving reaction times due to enhanced brain function associated with exercise. The improved reaction time observed in the experimental group could be partly attributed to the reduction in sedentary behaviour through regular engagement in trampoline exercises [19].

### Limitations

The study has several limitations. Its brief 4-week duration may not have captured long-term changes in body composition or motor proficiency, necessitating extended research to assess the sustainability of the effects. The small sample size of 36 participants restricts the study’s robustness and generalisability, as a larger sample would enhance the results and statistical power. Recruiting from a single setup limits the external validity, as the sample may not represent the broader population of overweight and obese adolescents.

### Clinical implications

Mini-trampoline exercises offer significant benefits for adolescents’ fitness by making physical activity more enjoyable and engaging, which helps combat sedentary lifestyles. They are cost-effective and easy to implement, making them an ideal choice for school and community centres, thus encouraging the wider adoption of this fitness programme. Their lower impact reduces joint stress and injury risk, benefitting overweight and obese adolescents, while also improving strength, balance and motor skills.

## Conclusions

This study concludes that overweight and obese adolescents who participated in mini-trampoline exercises for 4 weeks demonstrated a significant reduction in body composition, including BMI, and a notable improvement in reaction time. The intervention also led to a substantial enhancement in motor proficiency, particularly in the strength and agility composite, which includes improvements in running speed and agility (measured by shuttle runs, balance beam steps, and hops) and strength (measured by tests such as the standing long jump, push-ups, sit-ups, wall sits, and V-ups).

These findings suggest that mini-trampoline exercises can be effectively incorporated as a recreational activity to promote physical fitness, improve reaction time, and enhance motor proficiency (strength and agility) in adolescents. The results highlight the potential of trampoline-based exercises in supporting physical and cognitive health in overweight and obese adolescents, making them a feasible and enjoyable intervention in clinical and community settings.

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## Ethical approval

The research related to human use complied with all the relevant national regulations and institutional policies, followed the tenets of the Declaration of Helsinki, and was approved by the Institutional ethical Committee at Dr. D.Y. Patil College of Physiotherapy, Pimpri, Pune (approval No.: DYPCPT/IEC/21/2023, dated 16/03/23) and is registered with the Clinical Trials Registry-India (CTRI) under registration number CTRI/2023/06/054117, dated 19<sup>th</sup> June 2023.

## Informed consent

Informed consent was obtained from all individuals included in this study.

## Disclosure statement

No author has any financial interest or received any financial benefit from this research.

## Conflict of interest

The authors state no conflict of interest.

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