

RESEARCH PAPER

# Effectiveness of a Structured Interventional Package on Knowledge Regarding Childhood Obesity and Physical Parameters Among Adolescents in Selected Schools of Ludhiana, Punjab

Prof. Deepika David<sup>1\*</sup>, Prof. (Dr.) Prabhjot Singh<sup>2</sup>

<sup>1\*</sup>College of Nursing,

Mohan Dai Oswal Hospital, Ludhiana, Punjab.

Email: deepikadavid06@gmail.com.

<sup>2</sup>Professor cum Deputy Director, Faculty of Nursing,  
Desh Bhagat University, Mandi Gobindgarh, Punjab.

---

## ABSTRACT

**Background:** Childhood obesity is an emerging public health concern among adolescents, driven by lifestyle changes and inadequate awareness. School-based interventions may help improve knowledge and promote healthy behaviours.

**Objective:** To evaluate the effectiveness of a structured interventional package on knowledge regarding childhood obesity and physical parameters among adolescents in selected schools of Ludhiana, Punjab.

**Methods:** A quantitative pre-experimental one-group pre-test and post-test design was conducted among 500 adolescents. Data were collected using a structured knowledge questionnaire and anthropometric measurements, including body mass index (BMI), waist circumference, and waist-hip ratio. The intervention included structured teaching and physical activity guidance. Statistical analysis was performed using descriptive and inferential statistics.

**Results:** Post-intervention, knowledge levels improved significantly, with a shift from predominantly average and poor categories to good and excellent levels. The mean knowledge score increased markedly. Significant reductions were observed in weight, BMI, waist circumference, and waist-hip ratio ( $p < 0.001$ ), indicating improvement in physical parameters.

**Conclusion:** The structured interventional package was effective in improving knowledge and positively influencing physical parameters among adolescents. School-based interventions can play a vital role in preventing childhood obesity and promoting healthy lifestyles.

**Keywords:** Childhood obesity; Adolescents; Body mass index; School-based intervention; Health education; Physical activity; Anthropometry; Knowledge; Lifestyle modification

**How to cite this article:** David D, Singh P. Effectiveness of a Structured Interventional Package on Knowledge Regarding Childhood Obesity and Physical Parameters Among Adolescents in Selected Schools of Ludhiana, Punjab. *Int J Drug Deliv Technol.* 2026;16(30s):353-361. DOI: 10.25258/ijddt.16.30s.35.

DOI: xxxx

---

## INTRODUCTION

Childhood obesity has emerged as a major global public health concern in recent decades, with a rapidly increasing prevalence among children and adolescents worldwide.<sup>1,2</sup> Initially considered a problem of high-income countries, it is now increasingly prevalent in low- and middle-income nations, including India.<sup>3</sup> This growing trend is largely attributed to urbanization, lifestyle changes, reduced physical activity, and unhealthy dietary habits.<sup>4</sup> Obesity refers to an excessive or abnormal accumulation of body fat that negatively affects health.<sup>1</sup> In children and adolescents, it is commonly assessed using Body Mass Index (BMI), calculated as weight in kilograms divided by the square of height in meters.<sup>5</sup> The World Health Organization classifies obesity as a major non-communicable disease and identifies

it as a significant risk factor for conditions such as cardiovascular diseases, type 2 diabetes mellitus, musculoskeletal disorders, and certain types of cancer.<sup>6</sup> Globally, the prevalence of overweight and obese children and adolescents aged 5–19 years has increased significantly, rising from approximately 4% in 1975 to more than 18% in 2016, affecting over 340 million individuals.<sup>7</sup> This burden is expected to continue increasing, making obesity a major contributor to morbidity and mortality in the future.<sup>7</sup> India is currently facing a dual burden of malnutrition, where undernutrition coexists with overnutrition.<sup>8</sup> The prevalence of childhood obesity in India ranges from 5% to 14%, with higher rates reported in urban and semi-urban populations.<sup>9</sup> National surveys such as NFHS-5 and reports from the Indian Council of Medical Research indicate a gradual

increase in overweight and obesity among school-going children.<sup>10</sup> States like Punjab have reported increasing trends due to lifestyle transitions and dietary changes.<sup>3</sup> Adolescence is a critical phase characterized by rapid growth and development, during which lifelong behaviours are established.<sup>11,12</sup> During this stage, individuals are more likely to adopt unhealthy lifestyle practices, including consumption of energy-dense foods, reduced physical activity, and increased sedentary behaviours.<sup>13,14</sup> Technological advancements have contributed significantly to sedentary lifestyles, with adolescents spending approximately 6–8 hours daily on screen-based activities.<sup>15</sup> This leads to reduced energy expenditure and increased risk of obesity.<sup>16</sup> Obesity during adolescence is associated with significant psychological and social consequences.<sup>17</sup> Affected individuals often experience reduced self-esteem, poor body image, anxiety, depression, and social withdrawal.<sup>18</sup> Furthermore, obesity during adolescence strongly predicts obesity in adulthood, with nearly 70–80% of obese adolescents remaining obese later in life.<sup>19</sup> Schools play a crucial role in shaping health behaviours among adolescents.<sup>20</sup> They provide an ideal setting for implementing health education programs and promoting healthy lifestyle practices.<sup>21</sup> Nurses and healthcare professionals play a vital role in planning and implementing interventions aimed at preventing and controlling childhood obesity.<sup>22</sup> Structured interventional packages that include education, anthropometric assessment, and physical activity promotion have been shown to enhance knowledge and promote behavioural change among adolescents.<sup>23–25</sup> Early identification and timely intervention during adolescence are essential for preventing obesity and its associated complications.<sup>26</sup> Enhancing knowledge and promoting healthy behaviours during this stage can significantly improve long-term health outcomes.<sup>27</sup> Despite the increasing burden, awareness among adolescents regarding childhood obesity remains inadequate.<sup>25,28</sup> This lack of knowledge contributes to unhealthy lifestyle practices and increased risk of obesity. Therefore, there is a pressing need to evaluate structured interventional strategies that can improve knowledge and influence physical parameters among adolescents. In this context, the present study was undertaken to assess the effectiveness of an interventional package on knowledge regarding childhood obesity and physical parameters among adolescents in selected schools of Ludhiana, Punjab.

## METHODS

### Study Design and Approach

A quantitative research approach was adopted to evaluate the effectiveness of a structured interventional package on knowledge regarding childhood obesity and physical parameters among adolescents. A pre-experimental one-group pre-test and post-test research design was employed. The study design is represented as:

$$O_1 \rightarrow X \rightarrow O_2$$

where  $O_1$  represents the pre-test assessment,  $X$  denotes the intervention, and  $O_2$  represents the post-test assessment.

Study Setting

The study was conducted in selected schools of Ludhiana, Punjab. A total of five schools, including both government and private institutions, were selected to ensure diversity in socioeconomic backgrounds and feasibility of data collection. The school setting provided an appropriate environment for implementing structured teaching sessions, conducting anthropometric measurements, and promoting physical activity among adolescents.

### Study Population

The target population comprised adolescents aged 10–19 years. The accessible population included adolescents within this age group who were enrolled in selected schools of Ludhiana and were available during the data collection period.

### Sample Size and Sampling Technique

A total of 500 adolescents were included in the study. The sample size was calculated using the Kish and Leslie formula, with a 95% confidence level ( $Z = 1.96$ ), estimated prevalence ( $P = 0.6$ ), and margin of error ( $C = 0.05$ ). The calculated sample size was approximately 369, which was increased to 500 to enhance generalizability and ensure adequate representation. A non-probability purposive sampling technique was used. Participants who met the inclusion criteria and were available during the data collection period were selected.

### Eligibility Criteria

#### Inclusion criteria:

- Adolescents studying in selected schools of Ludhiana, Punjab
- Present during the period of data collection
- Willing to participate in the study
- Able to understand and respond to the questionnaire

#### Exclusion criteria:

- Adolescents absent during data collection
- Those unwilling to participate
- Individuals with serious illness affecting participation

### Research Variables

The **independent variable** was the structured interventional package, which included educational and physical activity components.

The **dependent variables** were:

- Knowledge regarding childhood obesity
- Physical parameters, including Body Mass Index (BMI), height, weight, waist circumference, and waist-hip ratio

Selected socio-demographic variables such as age, gender, dietary habits, physical activity, screen time, and parental characteristics were also considered.

#### Description of the Interventional Package

The interventional package was developed based on literature review, expert consultation, and study objectives. It comprised three components:

### 1. Structured Teaching Programme

The educational component included:

- Definition and concept of childhood obesity
- BMI calculation and interpretation
- Risk factors and causes
- Health consequences
- Prevention and management strategies
- Importance of healthy diet and physical activity

Teaching methods included:

- PowerPoint presentations
- Lecture-cum-discussion
- Charts and visual aids
- Interactive questioning

### 2. Anthropometric Assessment

The following physical parameters were measured:

- Height (cm)
- Weight (kg)
- Body Mass Index (BMI)
- Waist circumference
- Waist-hip ratio

BMI was calculated using the standard formula:

$$\text{BMI} = \text{weight (kg)} / \text{height (m}^2\text{)}$$

### 3. WHO-Recommended Physical Activity Programme

Participants were educated and demonstrated:

- Daily physical activity (minimum 30 minutes)
- Aerobic exercises (walking, running, skipping)
- Stretching and flexibility exercises

#### Data Collection Tool

The data collection instrument consisted of three sections:

#### Section A: Demographic Variables

Included age, gender, religion, parental education and occupation, family type, dietary habits, physical activity, screen time, and related variables.

#### Section B: Structured Knowledge Questionnaire

A self-structured questionnaire assessed knowledge regarding:

- Causes and risk factors
- Complications
- Prevention and management

#### Scoring system:

- Correct answer = 1
- Incorrect answer = 0

#### Knowledge levels:

- 0–3: Poor
- 4–6: Average
- 7–9: Good
- 10–12: Excellent

#### Section C: Physical Parameters

Included measurement of height, weight, BMI, waist

circumference, and waist-hip ratio.

#### Validity and Reliability

Content validity of the tool was established by a panel of six experts from nursing specialties. The tool was evaluated for clarity, relevance, and appropriateness.

Reliability was assessed using the test-retest method. The Pearson correlation coefficient indicated a high level of reliability, with a statistically significant correlation ( $p < 0.001$ ), demonstrating consistency of the instrument.

#### Pilot Study

A pilot study was conducted among 50 adolescents at a selected school in Ludhiana to assess feasibility and refine methodology. The findings confirmed that the study was feasible, and no major modifications were required.

#### Data Collection Procedure

After obtaining administrative approval and informed consent, data were collected in the following sequence:

1. Pre-test assessment of knowledge using a structured questionnaire
2. Measurement of anthropometric parameters
3. Implementation of the interventional package
4. Post-test assessment conducted after 15 days
5. Reassessment of physical parameters

#### Ethical Considerations

- Institutional permission was obtained prior to data collection
- Informed consent from parents/guardians and assent from participants were obtained
- Confidentiality and anonymity were maintained
- Participants were assigned unique identification codes

#### Statistical Analysis

Data were analyzed using Statistical Package for the Social Sciences (SPSS).

- **Descriptive statistics:** frequency, percentage, mean, and standard deviation
- **Inferential statistics:** paired t-test and chi-square test
- Significance level was set at  $p \leq 0.05$

#### RESULTS

The analysis was performed on 500 adolescents using descriptive and inferential statistics, in accordance with the predefined objectives. The level of significance was set at  $p \leq 0.05$ .

#### Pre-test Knowledge Regarding Childhood Obesity

The distribution of pre-test knowledge scores revealed that none of the participants (0%) had excellent knowledge. A majority of adolescents demonstrated average knowledge (44.4%), followed by good knowledge (37.8%), while 17.8% had poor knowledge. The mean pre-test knowledge score was  $5.54 \pm 1.897$ , with a median of 5.5 and a mean percentage score of 46.20%, indicating an overall moderate

but inadequate level of knowledge.

The details are shown in Figure 1.

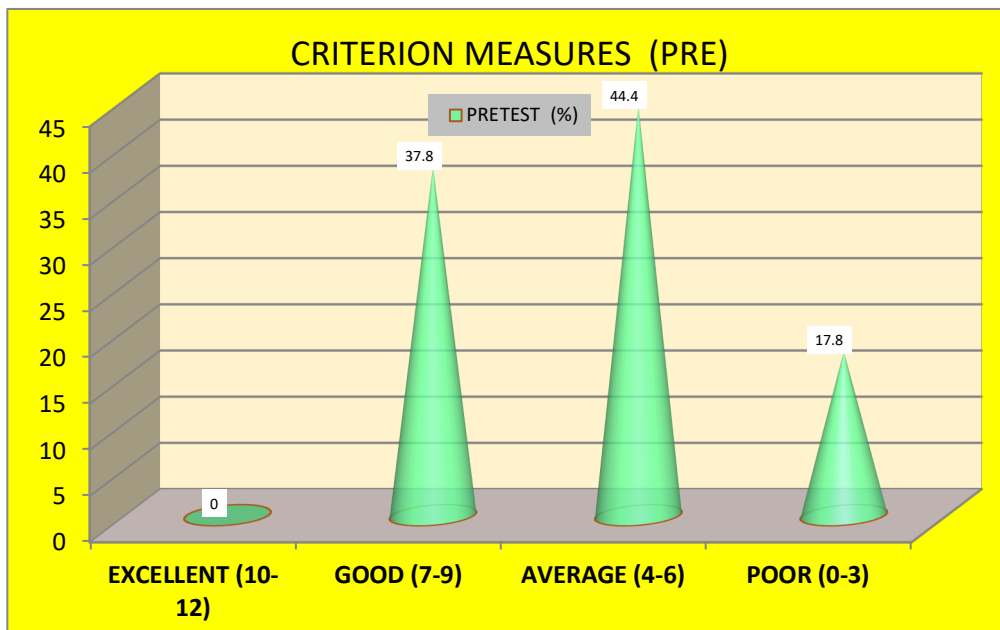


Figure 1: Bar Diagram of Pre-test Knowledge Distribution

**Baseline Physical Parameters of Adolescents**

At baseline, the majority of adolescents (96.0%) were underweight, while only 4.0% had normal BMI. No participants were categorized as overweight or obese. Waist

circumference assessment showed that 59.6% had abnormal values, while 40.4% were within normal limits. In contrast 64% had normal in post-test and 36% abnormal in post-test. This is shown in Figure 2.

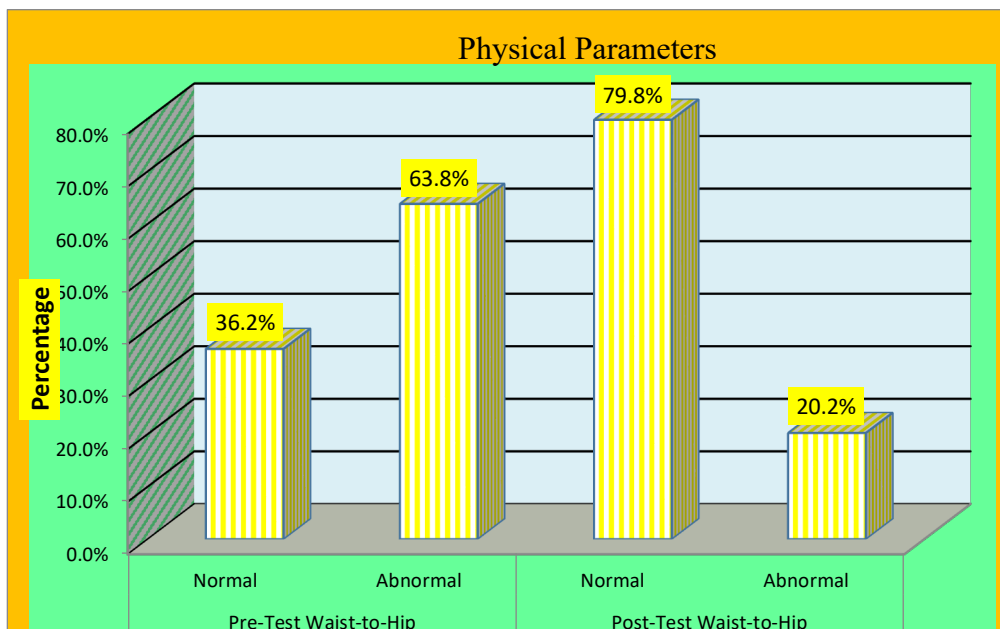


Figure 2: Distribution of Physical Parameters Pre-test and post-test

A statistically significant association was observed between pre-test BMI and variables such as age, gender, religion, father’s education, mother’s education, father’s occupation, mother’s occupation, family type, dietary pattern, junk food intake, physical activity, screen time, and number of siblings, as their values were above the level of significance. No association could be interpreted for BMI categories

themselves due to lack of variation in some categories. Overall, the findings indicate that pre-test BMI of adolescents was significantly associated with most socio-demographic and lifestyle variables, suggesting that these factors influence nutritional status.

A statistically significant association was observed between knowledge scores and physical parameters such as BMI and

waist-to-hip ratio ( $p < 0.05$ ). Adolescents with better physical parameters (normal BMI and waist-to-hip ratio) demonstrated higher knowledge scores compared to those with abnormal values.

Chi-square analysis revealed a significant association between knowledge scores and several socio-demographic variables, including:

- Age
- Gender
- Religion
- Parental education
- Mother's occupation
- Family type

- Dietary pattern
- Junk food intake
- Physical activity
- Screen time
- Number of siblings
- BMI and waist-to-hip ratio

( $p < 0.05$ )

No significant association was found with:

- Father's occupation
- Pre-test waist circumference

This is shown in Table 1.

Table 1: Association Of Post-test BMI (Kg/M2) Scores Of Selected Socio-Demographic Variables.

ASSOCIATION OF POSTTEST BMI (kg/m2) SCORES OF SELECTED SOCIO-DEMOGRAPHIC VARIABLES.										
Variables	Opts	Under	Normal	Over	Obes	Chi Test	P Value	df	Table Value	Result
Age (years)	10-13 Years	10	100	0	0	11.587	0.003	2	5.991	Significant
	14-16 Years	20	239	0	0					
	17-19 Years	0	131	0	0					
Gender	Male	0	249	0	0	31.661	<0.001	1	3.841	Significant
	Female	30	221	0	0					
Religion	Hindu	20	300	0	0	25.709	<0.001	3	7.815	Significant
	Muslim	0	70	0	0					
	Christian	10	40	0	0					
	Sikh	0	60	0	0					
	Any other	0	0	0	0					
Father's Education	No Formal Education	0	0	0	0	23.387	<0.001	3	7.815	Significant
	Primary	0	30	0	0					
	Secondary	20	161	0	0					
	Graduate	0	179	0	0					
	Post Graduate and above	10	100	0	0					
Mother's Education	No Formal Education	0	50	0	0	46.716	<0.001	4	9.488	Significant
	Primary	10	61	0	0					
	Secondary	10	180	0	0					
	Graduate	0	149	0	0					
	Post Graduate and above	10	30	0	0					
Father's Occupation	Unemployed	0	0	0	0	37.465	<0.001	1	3.841	Significant
	Private	0	270	0	0					
	Government	30	200	0	0					
Mother's Occupation	Unemployed	20	210	0	0	16.651	<0.001	2	5.991	Significant
	Private	0	170	0	0					
	Government	10	90	0	0					
Family Type	Nuclear	30	250	0	0	25.076	<0.001	1	3.841	Significant
	Joint	0	220	0	0					
Dietary Pattern	Vegetarian	10	190	0	0	47.872	<0.001	2	5.991	Significant
	Non-vegetarian	0	200	0	0					
	Eggetarian	20	80	0	0					
Junk Food Intake	Daily	0	120	0	0	45.224	<0.001	3	7.815	Significant
	3-4 times/ week	0	130	0	0					
	1-2 times/ week	10	130	0	0					
	Rarely	20	90	0	0					

Physical Activity (per day)	< 30 mins	0	250	0	0	113.153	<0.001	2	5.991	Significant
	30 mins – 1 hour	0	140	0	0					
	> 1 hour	30	80	0	0					
Screen Time (per day)	< 1 hour	20	70	0	0	63.006	<0.001	3	7.815	Significant
	1-2 hours	10	100	0	0					
	2-4 hours	0	161	0	0					
	>4 hours	0	139	0	0					
No. of Siblings	None	20	50	0	0	77.845	<0.001	3	7.815	Significant
	One	10	200	0	0					
	Two	0	159	0	0					
	Three	0	61	0	0					
	Above Three	0	0	0	0					
Pre-Test BMI (kg/m <sup>2</sup> )	Under weight	20	0	0	0	326.389	<0.001	1	3.841	Significant
	Normal	10	470	0	0					
	Overweight	0	0	0	0					
	Obese	0	0	0	0					
Post-Test BMI (kg/m <sup>2</sup> )	Under weight	30	0	0	0	NA				
	Normal	0	470	0	0					
	Overweight	0	0	0	0					
	Obese	0	0	0	0					
Pre-Test Waist (cm)	Normal	30	172	0	0	47.082	<0.001	1	3.841	Significant
	Abnormal	0	298	0	0					
Post-Test Waist (cm)	Normal	30	290	0	0	17.952	<0.001	1	3.841	Significant
	Abnormal	0	180	0	0					
Pre-Test Waist-to-Hip	Normal	30	151	0	0	56.248	<0.001	1	3.841	Significant
	Abnormal	0	319	0	0					
Post-Test Waist-to-Hip	Normal	30	369	0	0	8.079	0.004	1	3.841	Significant
	Abnormal	0	101	0	0					

### Effectiveness of Intervention on Knowledge

Post-intervention findings demonstrated a marked improvement in knowledge levels. A substantial proportion

of adolescents achieved good (46.0%) and excellent (38.2%) knowledge levels, while none remained in the poor category. This is shown in Figure 3.

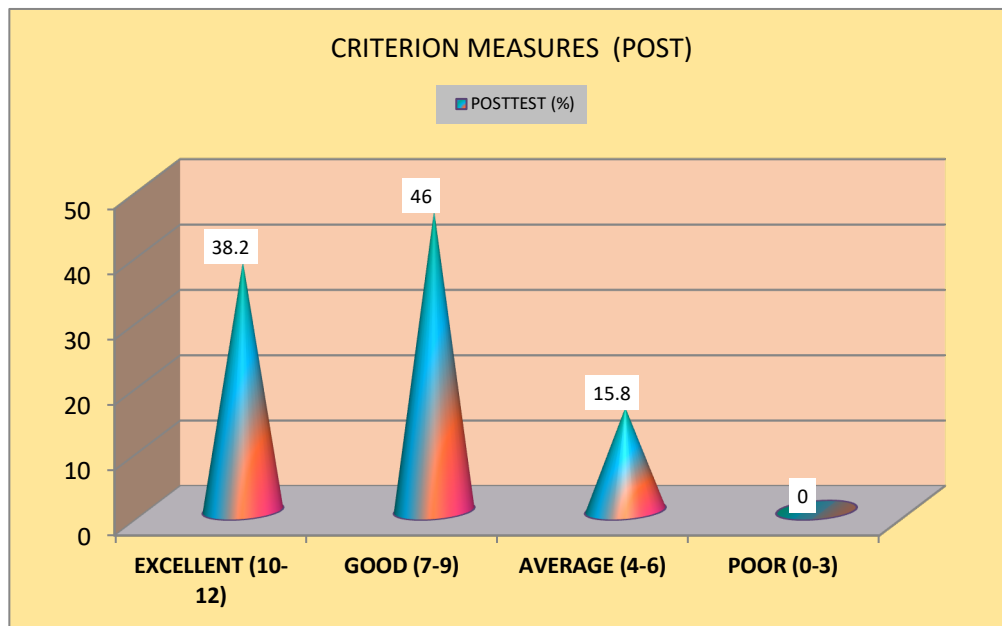


Figure 3: Post-test intervention scores

In the pre-test, none of the subjects (0%) were in the excellent category, whereas in the post-test, 38.2% achieved

excellent knowledge, showing a major improvement. The proportion of subjects with good knowledge increased

from 37.8% in the pre-test to 46.0% in the post-test, indicating a positive shift.

The percentage of subjects with average knowledge decreased significantly from 44.4% in the pre-test to 15.8% in the post-test.

Similarly, the poor knowledge category reduced from 17.8% in the pre-test to 0% in the post-test, indicating

complete elimination of low knowledge levels. Overall, a clear shift from lower knowledge levels (poor and average) to higher levels (good and excellent) after the intervention is observed, confirming its effectiveness in improving knowledge among adolescents. This is shown in Figure 4.

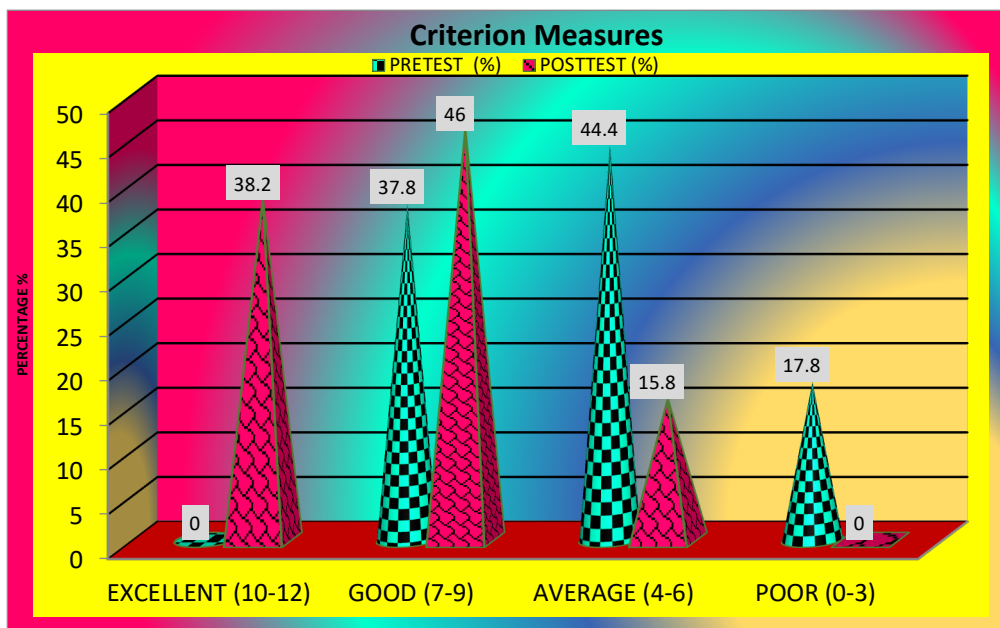


Figure 4: Comparison of Pre-test and Post-test Knowledge Levels

The paired t-test analysis showed a statistically significant improvement in knowledge:

- Mean difference = **3.15**
- t-value = **192.034**

• p-value = **<0.001**

This confirms that the interventional package was highly effective in improving knowledge. This is shown in Table 2.

Table 2: Paired t-test for Knowledge Scores

Paired T Test	N=500						
	Mean±S.D.	Mean%	Range	Mean Diff.	Paired T Test	P value	Table Value at 0.05
PRE TEST KNOWLEDGE	5.54±1.897	46.20	2-9	3.150	192.034	<0.001	1.97
POST TEST KNOWLEDGE	8.69±1.871	72.40	5-12				
** Significance Level 0.05 Maximum=12 Minimum=0							

**Effectiveness of Intervention on Physical Parameters**

Significant improvements were observed in physical parameters following the intervention:

- **Height:** Increased from 163.93 ± 5.69 cm to 164.27 ± 5.54 cm (p < 0.001)
- **Weight:** Decreased from 56.12 ± 4.69 kg to 54.63 ± 4.79 kg (p < 0.001)
- **BMI:** Reduced from 20.88 ± 1.06 to 20.22 ± 1.11 (p < 0.001)
- **Waist circumference:** Reduced from 85.58 ± 4.53 cm to 82.92 ± 4.63 cm (p < 0.001)
- **Waist-hip ratio:** Reduced from 0.89 ± 0.03 to 0.86 ± 0.03 (p < 0.001)

These findings indicate statistically significant

improvements in all measured physical parameters.

**Discussion**

The present study was conducted to evaluate the effectiveness of a structured interventional package on knowledge regarding childhood obesity and physical parameters among adolescents. The findings revealed a significant improvement in both knowledge levels and physical health indicators following the intervention. At baseline, the majority of adolescents demonstrated average (44.4%) to good (37.8%) levels of knowledge, while 17.8% had poor knowledge and none had excellent knowledge. This indicates that although some adolescents possessed basic awareness, overall knowledge regarding childhood

obesity was insufficient. These findings are consistent with previous studies reporting inadequate awareness among adolescents regarding obesity, its risk factors, and preventive measures.<sup>25,28</sup>

Following the intervention, a marked improvement in knowledge was observed, with 46.0% of adolescents achieving good knowledge and 38.2% attaining excellent levels, while no participant remained in the poor category. This shift from lower to higher knowledge categories clearly demonstrates the effectiveness of the structured interventional package. Similar findings have been reported in earlier studies, where school-based educational interventions significantly improved knowledge among adolescents.<sup>23-25</sup> The mean knowledge score increased from  $5.54 \pm 1.897$  in the pre-test to  $8.69 \pm 1.871$  in the post-test, with a mean difference of 3.15, which was found to be statistically highly significant ( $p < 0.001$ ). This substantial improvement highlights the effectiveness of structured teaching combined with interactive learning strategies. Previous intervention studies have also demonstrated similar statistically significant improvements in knowledge following educational programs.<sup>23,24</sup>

In addition to knowledge improvement, significant changes were observed in physical parameters. There was a statistically significant reduction in weight, BMI, waist circumference, and waist-to-hip ratio following the intervention ( $p < 0.001$ ). The reduction in BMI from  $20.88 \pm 1.06$  to  $20.22 \pm 1.11$  reflects improvement in overall nutritional status, while reductions in waist circumference and waist-to-hip ratio indicate decreased central adiposity. These findings are in line with previous research demonstrating that combined educational and physical activity interventions can lead to measurable improvements in anthropometric outcomes among adolescents.<sup>25,26</sup> The observed increase in height, although statistically significant, is likely attributable to normal growth patterns during adolescence rather than the intervention itself. This is supported by developmental studies highlighting rapid growth during this stage of life.<sup>11,12</sup>

The study also revealed a significant association between knowledge and physical parameters such as BMI and waist-to-hip ratio. Adolescents with better knowledge tended to have healthier physical parameters, suggesting that increased awareness may contribute to positive behavioural changes. This finding is consistent with existing literature emphasizing the role of knowledge in influencing health behaviours, including diet and physical activity.<sup>20,21</sup> Furthermore, significant associations were observed between knowledge scores and various socio-demographic variables, including age, gender, parental education, dietary habits, physical activity, and screen time. Older adolescents and females demonstrated higher knowledge levels, possibly due to increased exposure to health-related information and greater cognitive maturity. Higher parental education was also associated with better knowledge, reflecting the influence of family environment and health literacy. Lifestyle factors such as junk food consumption, physical activity, and screen time showed significant relationships with knowledge, indicating that behavioural

patterns are closely linked with awareness levels. These findings are supported by previous studies that highlight the impact of lifestyle and environmental factors on adolescent health behaviours.<sup>13,15,16</sup>

However, no significant association was found with certain variables such as father's occupation, suggesting that not all socio-demographic factors equally influence knowledge levels. Overall, the findings of the present study clearly demonstrate that the structured interventional package was highly effective in improving both knowledge and physical parameters among adolescents. The significant improvement observed highlights the importance of school-based interventions in addressing childhood obesity. Educational strategies combined with physical activity promotion can play a crucial role in fostering healthy behaviours during adolescence. Schools serve as an ideal platform for implementing such interventions, and healthcare professionals, particularly nurses, can contribute significantly to their successful execution.

#### **LIMITATIONS**

The study was limited by the use of a one-group pre-test and post-test design without a control group, which restricts causal inference. The study was conducted in selected schools of Ludhiana, limiting generalizability. Additionally, the short duration of follow-up did not allow assessment of long-term sustainability of the intervention effects.

#### **FUTURE DIRECTIONS**

Future studies should employ randomized controlled designs with larger and more diverse populations. Long-term follow-up is recommended to assess sustained behavioural and physical changes. Inclusion of dietary assessment, parental involvement, and use of digital or school-based reinforcement strategies may further enhance the effectiveness of interventions.

#### **CONCLUSION**

The study concludes that the structured interventional package was highly effective in improving knowledge regarding childhood obesity and positively influencing physical parameters among adolescents. The significant enhancement in knowledge scores, along with improvements in BMI and other anthropometric measures, highlights the importance of school-based health education and physical activity interventions. Early intervention during adolescence can contribute to the prevention of obesity and its long-term health consequences.

#### **REFERENCES**

1. World Health Organization. Obesity and overweight. Geneva: WHO; 2021.
2. Ng M, Fleming T, Robinson M, Thomson B, Graetz N, Margono C, et al. Global, regional, and national prevalence of overweight and obesity in children and adults. *Lancet*. 2014;384(9945):766-81.
3. Gupta N, Goel K, Shah P, Misra A. Childhood obesity in developing countries. *Indian J Pediatr*. 2012;79(Suppl 1):S48-54.

4. Popkin BM, Adair LS, Ng SW. Global nutrition transition and the pandemic of obesity. *Nutr Rev.* 2012;70(1):3-21.
5. Centers for Disease Control and Prevention. About BMI for children and teens. Atlanta: CDC; 2020.
6. World Health Organization. Noncommunicable diseases: Key facts. Geneva: WHO; 2021.
7. World Health Organization. Global health observatory data. Geneva: WHO; 2018.
8. World Health Organization. Double burden of malnutrition. Geneva: WHO; 2017.
9. Ranjani H, Mehreen TS, Pradeepa R, Anjana RM, Garg R, Anand K et al. Epidemiology of childhood obesity. *Indian J Med Res.* 2016;143(2):160-174.
10. International Institute for Population Sciences (IIPS), ICF. National family health survey (NFHS-5), India. Mumbai: IIPS; 2021.
11. World Health Organization. Adolescent health and development. Geneva: WHO; 2020.
12. Sawyer SM, Azzopardi PS, Wickremarathne D, Patton GC. The age of adolescence. *Lancet Child Adolesc Health.* 2018;2(3):223-8.
13. World Health Organization. Global recommendations on physical activity for health. Geneva: WHO; 2010.
14. Tremblay MS, LeBlanc AG, Kho ME, Saunders TJ, Larouche R, Colley RC, et al. Systematic review of sedentary behaviour. *Int J Behav Nutr Phys Act.* 2011;8:98.
15. Rideout VJ, Foehr UG, Roberts DF. Generation M2: Media in the lives of 8–18-year-olds. Kaiser Family Foundation; 2010.
16. World Health Organization. Physical activity guidelines. Geneva: WHO; 2020.
17. World Health Organization. Obesity and mental health. Geneva: WHO; 2021.
18. Griffiths LJ, Parsons TJ, Hill AJ. Self-esteem in obese children and adolescents. *Int J Pediatr Obes.* 2010;5(4):282-304.
19. Singh AS, Mulder C, Twisk JW. Tracking of childhood overweight into adulthood. *Obes Rev.* 2008;9(5):474-88.
20. World Health Organization. Health promoting schools: Framework for action. Geneva: WHO; 1998.
21. Centers for Disease Control and Prevention. School health guidelines to promote healthy eating and physical activity. Atlanta: CDC; 2011.
22. Pbert L, Druker S, Gapinski MA, Gellar L, Magner R, Reed G, et al. School nurse-delivered intervention for overweight adolescents. *J Sch Health.* 2013;83(3):182-93.
23. World Health Organization. Global strategy on diet, physical activity and health. Geneva: WHO; 2004.
24. Contento IR. Nutrition education: Linking research, theory, and practice. 2nd ed. Sudbury: Jones & Bartlett; 2011.
25. Sharma M. School-based interventions for childhood obesity. *Obes Rev.* 2006;7(3):261-269.
26. World Health Organization. Adolescent obesity and related health risks. Geneva: WHO; 2017.
27. Sawyer SM, Afifi RA, Bearinger LH, Blakemore SJ, Dick B, Ezech AC, et al. Adolescence: A foundation for future health. *Lancet.* 2012;379(9826):1630-40.
28. World Health Organization. Report of the commission on ending childhood obesity. Geneva: WHO; 2016