

Efficacy and Safety of Once-Weekly Subcutaneous Semaglutide in Adolescents With Obesity: A Retrospective Study

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Abstract

Background

Childhood and adolescent obesity are increasing public health concerns in India and are associated with cardiometabolic complications. However, real-world evidence on the safety and effectiveness of once-weekly subcutaneous semaglutide among adolescents with overweight or obesity in routine clinical practice remains limited.

Objectives

This study evaluated the efficacy and safety of once-weekly subcutaneous semaglutide (r-DNA) among Indian adolescents aged 12-18 years with overweight or obesity.

Methods

This retrospective, observational study (IAH-BMR/072/06-26) involved 40 adolescents on once-weekly subcutaneous semaglutide (0.25-2.4 mg) over 32 weeks. Anthropometric measures (body weight (BW), body mass index (BMI), BMI standard deviation score (BMI-SDS), waist circumference (WC), and blood pressure (BP)) were tracked over time. Biochemical outcomes included fasting blood sugar (FBS), postprandial blood sugar (PPBS), glycated hemoglobin (HbA1c), fasting insulin, lipid profile, thyroid-stimulating hormone (TSH), and liver enzymes. Repeated-measures analysis of variance (RM-ANOVA) and paired comparisons were used to assess changes.

Results

The study population comprised 24 female (60.0%) and 16 male (40.0%) adolescents, with a mean age of 14.82 ± 1.78 years. After 32 weeks, semaglutide demonstrated significant mean reductions in BW (-15.20 kg; 17.2%), BMI (-6.70 kg/m²; 19.4%), BMI-SDS (-1.08), WC (-10.71 cm; 10.82%), systolic BP (-8.30 mmHg), and diastolic BP (-4.50 mmHg) (all $p < 0.001$). Significant improvements were also observed in FBS, PPBS, HbA1c, fasting insulin, total cholesterol, triglycerides, TSH, serum glutamic-oxaloacetic transaminase, and serum glutamic-pyruvic transaminase (all $p < 0.001$). Improvements were consistent across sexes. No adverse events (AEs) were documented.

Conclusions

Once-weekly subcutaneous semaglutide (r-DNA) was associated with improvements in anthropometric and metabolic parameters among Indian adolescents with overweight or obesity. These real-world findings are broadly consistent with the reductions in BMI and improvements in selected cardiometabolic risk factors reported in the STEP TEENS trial. Larger prospective multicenter studies are warranted to further evaluate its long-term effectiveness and safety.

Categories: Integrative/Complementary Medicine, Pediatrics, Endocrinology/Diabetes/Metabolism

Keywords: adolescents, body mass index, childhood obesity, glp-1 receptor agonist, overweight, pediatric obesity, real-world evidence, semaglutide

Introduction

Childhood and adolescent obesity have emerged as one of the most significant global public health challenges of the 21st century [1]. The World Health Organization (WHO) estimates that approximately 1.1 billion people worldwide were living with obesity in 2024. Among children and adolescents aged 5-19 years, an estimated 400 million were affected by overweight, including 170 million living with obesity. The prevalence of pediatric obesity has increased substantially over the past four decades. It continues to rise, particularly in low- and middle-income countries (LMICs), reflecting distinct variations in nutrition, urbanization, and lifestyle patterns. This growing epidemic has transformed obesity from a condition

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predominantly affecting high-income countries into a global health concern, necessitating preventive and therapeutic strategies [2,3].

In India, recent evidence indicates that overweight and obesity among school-aged children and adolescents have become major public health concerns, particularly in urban settings. A meta-analysis conducted among 21 studies between 2003 and 2023 reported pooled prevalence rates of 12.4% for overweight and 8.4% for obesity, with a higher risk observed among boys than girls. The study also identified key socioeconomic determinants, including private school attendance, maternal employment, and a family history of obesity, highlighting the multifactorial nature of pediatric obesity in India [4]. Similarly, Idomeh et al. assessed childhood obesity across urban and rural India and found a substantially higher prevalence in the urban population (9.0%) than in the rural population (4.0%), emphasizing the influence of urbanization, unhealthy dietary patterns, physical inactivity, and socioeconomic factors on obesity risk [5]. Collectively, these findings underscore the critical importance of implementing effective interventions during adolescence to prevent the lifetime risk of cardiometabolic diseases.

Lifestyle modification, including dietary optimization, increased physical activity, and behavioral therapy, remains the cornerstone of pediatric obesity management; however, sustained weight reduction is often modest and difficult to maintain, particularly among adolescents with moderate-to-severe obesity [6-8]. Given that obesity is a chronic, relapsing disease, contemporary guidelines, including the 2023 American Academy of Pediatrics (AAP) Clinical Practice Guideline and the 2026 American Diabetes Association (ADA) Standards of Care, recommend considering anti-obesity pharmacotherapy when lifestyle intervention alone fails to achieve clinically meaningful weight reduction [9,10].

Among currently available anti-obesity pharmacotherapies, the once-weekly glucagon-like peptide-1 receptor (GLP-1R) agonist semaglutide, in particular, has demonstrated the greatest efficacy for obesity management [11]. Through appetite suppression, delayed gastric emptying, and improvements in glucose and energy homeostasis, semaglutide produces clinically meaningful and sustained weight reduction while improving multiple cardiometabolic risk factors [12-16].

In India, semaglutide formulations have received approval for adult use, including oral semaglutide for the management of type 2 diabetes mellitus, since 2020. More recently, in May 2026, the Central Drugs Standard Control Organization (CDSCO) extended its approval of semaglutide (Wegovy®) for weight management in adolescents aged 12 years and older who have a body weight (BW) exceeding 60 kg, as an adjunct to a reduced-calorie diet and increased physical activity [17]. Consequently, the application of semaglutide in Indian adolescents warrants cautious interpretation.

The efficacy of semaglutide in adolescents with obesity has been established in randomized controlled trials (RCTs). In the STEP TEENS trial, once-weekly semaglutide combined with lifestyle intervention produced substantial reductions in body mass index (BMI) and BW compared with placebo, supporting its use in the management of adolescent obesity [18]. However, evidence in adolescents remains considerably more limited than in adults, and available real-world studies have been conducted predominantly in Western populations [19]. Consequently, the generalizability of these findings to Indian adolescents remains uncertain. Therefore, the real-world effectiveness and safety of semaglutide in Indian adolescents with overweight or obesity remain insufficiently characterized.

Although RCTs have demonstrated the efficacy of semaglutide in adolescents with obesity, trial populations are selected and may not fully reflect routine clinical practice. Real-world evidence (RWE) provides an important complement by evaluating treatment effectiveness and safety in a more heterogeneous population managed under routine-care conditions. Given the limited availability of real-world data on Indian adolescents, this retrospective study was conducted to evaluate the effectiveness and safety of once-weekly subcutaneous semaglutide (r-DNA) in Indian adolescents with overweight or obesity receiving treatment in routine clinical practice.

Materials And Methods

Study design

This retrospective, single-center, observational, cohort study included adolescents aged 12-18 years with overweight or obesity who received once-weekly subcutaneous semaglutide (r-DNA) over a 32-week period. The study included patients who had attended the pediatric outpatient department of the Indraprastha Apollo Hospitals, Delhi, and had been treated with once-weekly subcutaneous semaglutide (0.25-2.4 mg) between September 2025 and April 2026. Participants were followed for 32 weeks, with baseline defined as the date of treatment initiation and follow-up assessments conducted approximately every eight weeks.

This study was designed and reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement [20]. The STROBE flow diagram is provided in Supplemental material 2.

Ethical considerations

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki and received approval from the Institutional Ethics Committee-Biomedical Research at Indraprastha Apollo Hospitals, New Delhi (Study Registration No.: IAH-BMR/072/06-26; approval date: August 3, 2026). The Institutional Ethics Committee explicitly granted a waiver of informed consent and assent for minors due to the study's retrospective nature and the use of de-identified data. The study used data from the medical records of patients who had already received once-weekly subcutaneous semaglutide therapy to ensure patient confidentiality and privacy.

Data collection

A total of 40 eligible patient records were retrieved and retrospectively analyzed. Data were extracted from the medical records and included anthropometric and biochemical parameters. Information on concomitant medications was not systematically available in the retrospective medical records and was therefore excluded from the analysis. The anthropometric and clinical variables included age, height, weight, BMI, waist circumference (WC), and blood pressure (BP). Biochemical variables included fasting blood sugar (FBS), postprandial blood sugar (PPBS), glycated hemoglobin (HbA1c), fasting insulin, serum lipid parameters (total cholesterol (TC) and triglycerides (TG)), liver enzymes (serum glutamic-oxaloacetic transaminase (SGOT) and serum glutamic-pyruvic transaminase (SGPT)), and thyroid function (thyroid-stimulating hormone (TSH)). The anthropometric and clinical data were collected at the start of therapy (baseline) and at approximately three follow-up visits, every two months, throughout the study period, whereas the biochemical parameters were recorded at the beginning and the end of the study (refer to Figure 1 for the study timeline and dose escalation schedule).

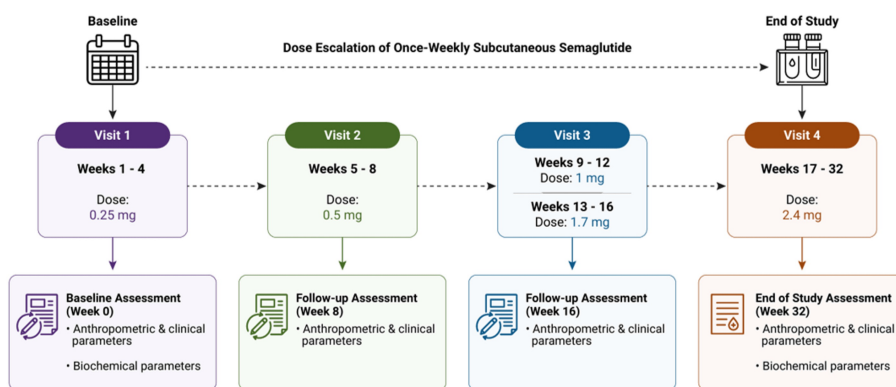


FIGURE 1: Study timeline and dose escalation schedule during once-weekly subcutaneous semaglutide (r-DNA) therapy

Eligible adolescents with overweight or obesity received once-weekly subcutaneous semaglutide (r-DNA), with dose escalation from 0.25 mg to 2.4 mg over a 32-week study period. Anthropometric and biochemical parameters were assessed throughout the study.

Figure created by the authors using Adobe Illustrator (Adobe Systems Inc., San Jose, CA, USA).

As part of routine clinical management, patients were counseled on lifestyle modifications alongside semaglutide therapy, including regular physical activity (e.g., walking and resistance/strength training) and dietary changes emphasizing higher protein and reduced carbohydrate intake. These lifestyle interventions were recommended as supportive measures for weight management; however, adherence to dietary and exercise recommendations was not systematically quantified in the retrospective records.

In routine clinical practice, patients underwent a baseline assessment, followed by follow-up assessments at approximately weeks 8 and 16, and a final end-of-study assessment at approximately week 32. To accommodate variations inherent to real-world clinical practice, visit windows of ± 2 weeks were permitted. For effectiveness analyses, baseline measurements and the most recent available assessment within the study follow-up period were used.

Patient selection

Adolescents aged 12-18 years were eligible for inclusion if they had overweight (BMI for age ≥ 85 th to <95 th percentile according to the WHO 2007 growth reference) accompanied by at least one weight-related comorbidity, or obesity (BMI for age ≥ 95 th percentile according to the WHO 2007 growth reference). Eligible participants had demonstrated an inadequate response to structured lifestyle interventions, defined as failure to achieve clinically meaningful weight reduction following at least six months of dietary, physical

activity, and behavioral modification measures. Previous anti-obesity pharmacotherapy was not mandatory; however, treatment history, including prior use of agents such as orlistat, was recorded where applicable. Patients prescribed once-weekly subcutaneous semaglutide (r-DNA) (0.25–2.4 mg) during routine clinical care, with available baseline and follow-up clinical and biochemical data, were included. Patients with incomplete medical records, missing clinical data, participation in another interventional clinical study, significant weight changes (>5 kg) following prior pharmacotherapy and lifestyle interventions, a history of bariatric surgery, secondary causes of obesity, a family history of medullary thyroid carcinoma, or a history of pancreatitis were excluded from the analysis.

Sample size estimation

No formal sample size estimation was performed because of the retrospective nature of the study. The study included all eligible adolescents treated with once-weekly subcutaneous semaglutide (r-DNA) at the study center during the predefined study period who fulfilled the eligibility criteria and had complete clinical and biochemical follow-up medical records.

Endpoints

The primary endpoint was the change in BMI standard deviation score (BMI-SDS) from baseline to week 32 (Visit 4) following initiation of once-weekly subcutaneous semaglutide (r-DNA) therapy in routine clinical practice. Secondary endpoints included changes in anthropometric outcomes from baseline to week 32, including absolute and percentage changes in BW, absolute and percentage changes in BMI, the proportions of participants achieving $\geq 5\%$ and $\geq 10\%$ weight loss, the proportion achieving $\geq 5\%$ BMI reduction, and changes in WC and BP. Additional secondary endpoints included changes in cardiometabolic parameters, including fasting blood glucose, postprandial blood glucose, fasting insulin, HbA1c, lipid profile, liver function tests, and thyroid function parameters.

Safety endpoints included the identification of documented adverse drug reactions (ADRs), serious adverse events (SAEs), and serious ADRs (SADRs) recorded in the medical records during the study period. Exploratory endpoints included sex-stratified analyses of anthropometric, clinical, and biochemical outcomes to assess whether changes observed during treatment differed between male and female participants.

Statistical analysis

Descriptive and summary statistics were calculated to provide an overall perspective of the study data. Continuous variables were summarized as mean, standard deviation (SD), minimum, and maximum, while categorical variables were summarized as frequencies and percentages. Normality and lognormality analyses were performed to determine whether parametric or non-parametric analyses were appropriate. BMI-SDS was derived using the WHO 2007 growth reference (AnthroPlus) based on age, sex, height, and weight [21]. Anthropometric variables were evaluated using repeated-measures analysis of variance (RM-ANOVA). Mauchly's test was used to assess sphericity, and when violated, Greenhouse-Geisser correction (GG ϵ) was applied. Bonferroni-adjusted pairwise comparisons were performed for post hoc analyses. For the between-sex subgroup analyses, a two-way mixed-design RM-ANOVA (mixed ANOVA) was performed, with visit as the within-subject factor and sex (male/female) as the between-subject factor. Greenhouse-Geisser correction was applied when the assumption of sphericity was violated. Changes in biochemical parameters were evaluated using paired t-tests and are presented as mean differences (MDs) with 95% confidence intervals (CIs). Normality was assessed using the Shapiro-Wilk test. Effect sizes for repeated-measures analyses were reported using partial eta squared (η^2). A p-value < 0.05 was considered statistically significant. Data were analyzed using IBM SPSS Statistics version 25.0 (IBM Corp., Armonk, NY, USA) and RStudio, version 1.1.0 (Posit Software, Boston, MA, USA).

Results

Baseline anthropometric characteristics of the participants

A total of 40 patients were included in the study. The cohort comprised a higher proportion of female (n = 24, 60%) than male (n = 16, 40%) participants. The mean age of the enrolled patients was 14.82 ± 1.78 years, with an age range of 12.0 to 17.5 years. The mean height and weight were 159.64 ± 11.24 cm and 88.18 ± 14.03 kg, respectively, with ranges of 134 to 178 cm and 66 to 144.9 kg. The mean BMI and BMI-SDS were observed to be 34.56 ± 3.39 kg/m² and 3.05 ± 0.50 . The average WC was 98.78 ± 8.62 cm, ranging between 81.3 and 114.3 cm. The mean baseline systolic BP (SBP) was 126.35 ± 10.76 mmHg, and the mean baseline diastolic BP (DBP) was 78.90 ± 5.64 mmHg. These findings reflect the baseline anthropometric characteristics of the study population (Table 1).

Characteristics	Mean ± SD	Minimum	Maximum
Anthropometric characteristics			
Age (years)	14.82 ± 1.78	12.0	17.5
Height (cm)	159.64 ± 11.24	134.0	178.0
Weight (kg)	88.18 ± 14.03	66.0	144.9
Body mass index (BMI, kg/m²)	34.56 ± 3.39	30.3	45.7
Body mass index standard deviation score (BMI-SDS)	3.05 ± 0.50	2.3	4.4
Waist circumference (WC, cm)	98.78 ± 8.62	81.3	114.3
Systolic blood pressure (SBP, mmHg)	126.35 ± 10.76	104	148
Diastolic blood pressure (DBP, mmHg)	78.90 ± 5.64	70	90
Biochemical characteristics			
Fasting blood sugar (FBS, mg/dL)	110.33 ± 14.64	76	136
Postprandial blood sugar (PPBS, mg/dL)	162.45 ± 20.94	128	200
Glycated hemoglobin (HbA1c, %)	5.54 ± 0.50	4.6	6.4
Fasting insulin (µIU/mL)	31.55 ± 11.05	14	55
Total cholesterol (TC, mg/dL)	161.60 ± 28.27	120	212
Triglycerides (TG, mg/dL)	136.83 ± 22.75	99	178
Thyroid-stimulating hormone (TSH, mIU/L)	5.72 ± 1.88	3.6	9.8
Serum glutamic-oxaloacetic transaminase (SGOT, U/L)	40.75 ± 11.59	25	66
Serum glutamic-pyruvic transaminase (SGPT, U/L)	40.20 ± 11.94	22	68

TABLE 1: Baseline characteristics of the participants

Values are expressed as mean ± SD and minimum and maximum

SD: standard deviation

Baseline biochemical characteristics of the participants

The mean glycemic indices at baseline were FBS 110.33 ± 14.64 mg/dL, PPBS 162.45 ± 20.94 mg/dL, and HbA1c 5.54% ± 0.50%. Additionally, the mean fasting insulin level was 31.55 ± 11.05 µIU/mL. Lipid parameters included a mean TC of 161.60 ± 28.27 mg/dL and a mean TG of 136.83 ± 22.75 mg/dL. Thyroid function, assessed by TSH, averaged 5.72 ± 1.88 mIU/L. The mean baseline SGOT and SGPT levels were 40.75 ± 11.59 U/L and 40.20 ± 11.94 U/L. These findings summarize the baseline metabolic and biochemical characteristics of the study population (Table 1).

Effect of semaglutide on anthropometric and clinical characteristics throughout the study duration

Mean height increased throughout the 32-week study period, as expected during adolescent growth, from 159.64 ± 11.24 cm at baseline to 161.52 ± 10.06 cm at Visit 4. Additionally, the mean weight reduced from 88.18 ± 14.03 kg at baseline to 72.99 ± 12.18 kg at Visit 4 (MD: -15.20; 95% CI: -16.56 to -13.83). The mean percent weight reduction from baseline to Visit 4 was 17.23%. Responder analysis further demonstrated that 100% of participants achieved ≥5% and ≥10% weight reductions. Thirty-three participants (82.5%) achieved a ≥15% reduction in BW, while six participants (15.0%) achieved a ≥20% reduction. The effect was statistically significant (p < 0.001). Pairwise comparisons confirmed significant reductions between all visits, indicating meaningful weight loss with the subcutaneous semaglutide therapy (Figure 2A).

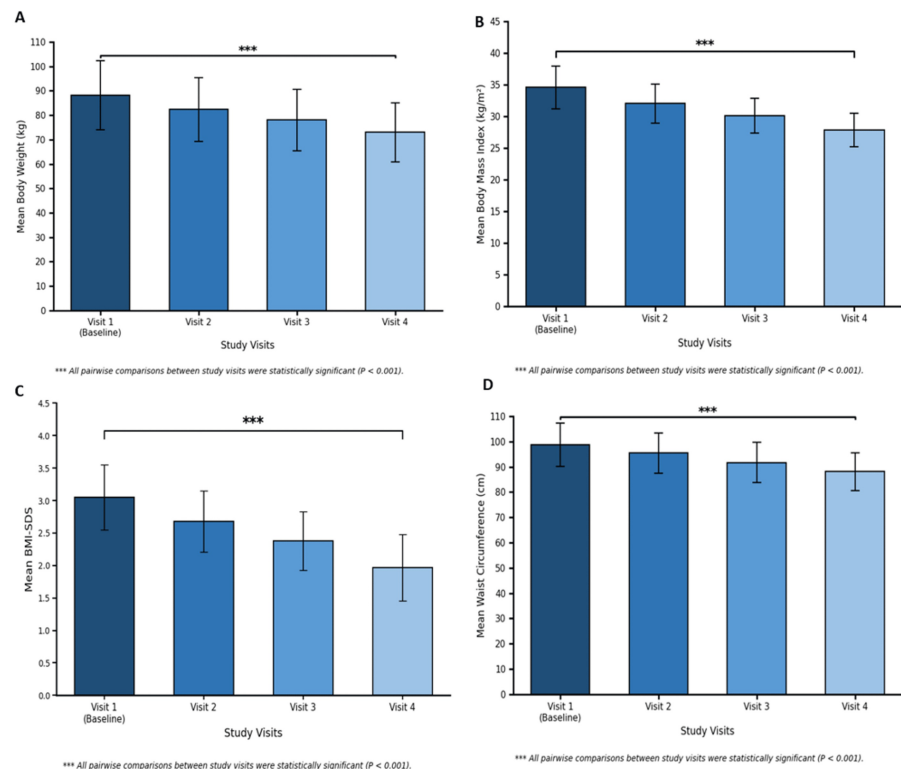


FIGURE 2: Effect on anthropometric parameters

(A) Mean body weight (kg) reduced progressively from baseline to Visit 4 following semaglutide therapy. (B) Mean body mass index (kg/m²) reduced progressively from baseline to Visit 4 following semaglutide therapy. (C) Mean body mass index standard deviation score (BMI-SDS) reduced progressively from baseline to Visit 4 following semaglutide therapy. (D) Mean waist circumference (cm) reduced progressively from baseline to Visit 4 following semaglutide therapy. Data are presented as mean $\pm$ SD ($n = 40$). Statistical analysis was performed using RM-ANOVA with Bonferroni's multiple-comparison test ($p < 0.001$).

RM-ANOVA: repeated-measures analysis of variance; SD: standard deviation

Mean BMI decreased significantly over the 32-week study period, from 34.56 ± 3.39 kg/m² at baseline to 27.86 ± 2.67 kg/m² at Visit 4. Analysis showed a statistically significant effect ($p < 0.001$), and pairwise comparisons confirmed that BMI improved significantly between study visits. The greatest reduction in mean BMI occurred between baseline and Visit 4 (MD: -6.70 kg/m²; 95% CI: -7.41 to -5.98), and the mean percent BMI reduction from baseline to Visit 4 was 19.38%. Responder analysis showed that 100% achieved a $\geq 5\%$ BMI reduction, 38 participants (95.0%) achieved a $\geq 15\%$ reduction, 16 (40.0%) achieved a $\geq 20\%$ reduction, and two (5.0%) achieved a $\geq 25\%$ reduction by the end of the study. BMI-SDS also decreased from 3.05 ± 0.50 at baseline to 1.97 ± 0.51 at Visit 4 (MD: -1.08 ; 95% CI: -1.17 to -0.99), with a mean percent BMI-SDS reduction of 19.38%. The effect was statistically significant ($p < 0.001$). Pairwise comparisons confirmed significant reductions at all visits, reflecting sustained improvement in obesity severity. These findings demonstrate a clinically meaningful reduction in BMI and BMI-SDS with subcutaneous semaglutide therapy throughout the study period (Figures 2B, 2C).

The mean WC was significantly reduced from 98.78 ± 8.62 cm at baseline to 88.07 ± 7.50 cm at Visit 4. The analysis demonstrated a highly significant effect ($p < 0.001$). Pairwise comparisons confirmed significant reductions between all visits. The most significant reduction was observed at Visit 4 (MD: 10.71 ; 95% CI: -9.61 to -11.81), with a mean WC reduction of 10.82%. These findings indicate a significant reduction in central adiposity, associated with improved cardiometabolic risk, throughout the study period following subcutaneous semaglutide therapy (Figure 2D).

The mean SBP improved significantly from 126.35 ± 10.76 mmHg at baseline to 118.05 ± 7.07 mmHg at Visit 4. The analysis showed a significant effect ($p < 0.001$). The largest SBP reduction was observed between baseline and Visit 4 (MD: -8.30 ; 95% CI: -10.94 to -5.66). Similarly, the mean DBP improved significantly from 78.90 ± 5.64 mmHg at baseline to 74.40 ± 4.58 mmHg at Visit 4 (MD: -4.50 ; 95% CI: -6.33 to -2.67). Analysis confirmed a significant effect ($p < 0.001$). Pairwise comparisons showed significant reductions across all visits, indicating improved BP control with subcutaneous semaglutide therapy. A detailed analysis is presented in Table 2.

Parameter	Visit 1 (baseline)	Visit 2	Visit 3	Visit 4	MD (95% CI)	RM-ANOVA
Height (cm)	159.64 ± 11.24	160.24 ± 10.87	160.83 ± 10.53	161.52 ± 10.06	1.89 (95% CI: 1.16 to 2.61)	F (1.17, 45.78) = 47.60; ηp² = 0.550; p < 0.001; GG ε = 0.391
Weight (kg)	88.18 ± 14.03	82.40 ± 13.04	78.08 ± 12.60	72.99 ± 12.18	-15.20 (95% CI: -16.56 to -13.83)	F (1.63, 63.36) = 710.51; ηp² = 0.948; p < 0.001; GG ε = 0.542
Body mass index (kg/m²)	34.56 ± 3.39	32.02 ± 3.11	30.08 ± 2.74	27.86 ± 2.67	-6.70 (95% CI: -7.41 to -5.98)	F (1.36, 53.09) = 532.67; ηp² = 0.932; p < 0.001; GG ε = 0.454
Body mass index standard deviation score	3.05 ± 0.50	2.68 ± 0.47	2.38 ± 0.45	1.97 ± 0.51	-1.08 (95% CI: -1.17 to -0.99)	F (1.56, 60.92) = 765.58; ηp² = 0.952; p < 0.001; GG ε = 0.521
Waist circumference (cm)	98.78 ± 8.62	95.44 ± 8.04	91.67 ± 7.93	88.07 ± 7.50	-10.71 (95% CI: -9.61 to -11.81)	F (1.93, 75.28) = 526.72; ηp² = 0.931; p < 0.001; GG ε = 0.643
Systolic blood pressure (mmHg)	126.35 ± 10.76	122.50 ± 7.89	120.55 ± 6.94	118.05 ± 7.07	-8.30 (95% CI: -10.94 to -5.66)	F (1.68, 65.66) = 55.05; ηp² = 0.585; p < 0.001; GG ε = 0.561
Diastolic blood pressure (mmHg)	78.90 ± 5.64	76.75 ± 5.18	75.70 ± 4.99	74.40 ± 4.58	-4.50 (95% CI: -6.33 to -2.67)	F (1.87, 72.81) = 31.91; ηp² = 0.450; p < 0.001; GG ε = 0.622

TABLE 2: Changes in anthropometric and clinical characteristics throughout the study duration

Values are expressed as mean ± SD; MD represents the mean difference between Visit 4 and baseline.

MD: mean difference; CI: confidence interval; RM-ANOVA: repeated-measures analysis of variance; GG: Greenhouse-Geisser; ηp²: partial eta squared; SD: standard deviation

Effect of semaglutide on metabolic parameters throughout the study duration

Significant improvements in glycemic indices were observed over the study period. FBS and PPBS showed significant improvement from a mean of 110.33 ± 14.64 mg/dL and a mean of 162.45 ± 20.94 mg/dL to 99.95 ± 11.46 mg/dL (MD: -10.38; 95% CI: -13.04 to -7.71; p < 0.001) and 137.73 ± 9.79 mg/dL (MD: -24.73; 95% CI: -30.73 to -18.72; p < 0.001). The mean HbA1c levels decreased from 5.54% ± 0.50% to 5.09% ± 0.30% (MD: -0.45; 95% CI: -0.57 to -0.34; p < 0.001). The mean fasting insulin reduced from 31.55 ± 11.05 μIU/mL at baseline to 17.50 ± 5.49 μIU/mL at follow-up (MD: -14.05; 95% CI: -16.75 to -11.35; p < 0.001). These findings highlighted a clinically meaningful improvement in glycemic regulation with subcutaneous semaglutide therapy (Figure 3A).

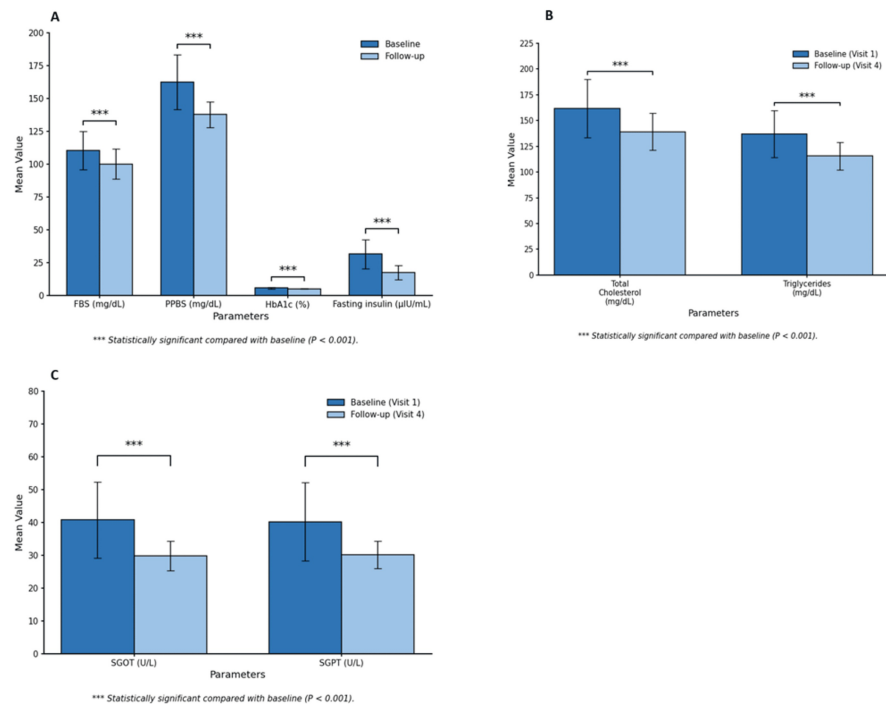


FIGURE 3: Effect on metabolic parameters

(A) Mean glycemic indices, including fasting blood sugar (FBS) (mg/dL) and postprandial blood sugar (PPBS) (mg/dL), glycated hemoglobin (HbA1c) (%), and fasting insulin (μ U/mL), improved significantly from baseline to Visit 4 following semaglutide therapy. (B) Mean lipid parameters, such as total cholesterol (TC) (mg/dL) and triglycerides (TG) (mg/dL), improved significantly from baseline to Visit 4 following semaglutide therapy. (C) Mean liver function parameters, such as serum glutamic-oxaloacetic transaminase (SGOT) (U/L) and serum glutamic-pyruvic transaminase (SGPT) (U/L), improved significantly from baseline to Visit 4 following semaglutide therapy. Data are presented as mean $\pm$ SD ($n = 40$).

SD: standard deviation

Significant improvements were observed across lipid parameters. The mean TC decreased from 161.60 ± 28.27 mg/dL at baseline to 139.20 ± 17.94 mg/dL by the end of the study, with a MD of -22.40 mg/dL (95% CI: -27.10 to -17.70 ; $p < 0.001$). The mean TG levels decreased from 136.83 ± 22.75 mg/dL to 115.53 ± 13.59 mg/dL, representing a mean reduction of -21.30 mg/dL (95% CI: -26.56 to -16.04 ; $p < 0.001$). These findings in lipid parameters suggest improved cardiometabolic health with subcutaneous semaglutide therapy (Figure 3B).

Significant improvements were observed in TSH levels. The mean TSH levels reduced from 5.72 ± 1.88 mIU/L at baseline to 4.17 ± 0.43 mIU/L at follow-up, with a MD of -1.55 mIU/L (95% CI: -2.12 to -0.98 ; $p < 0.001$). These findings suggest improvement in thyroid function during the study period with subcutaneous semaglutide therapy. Significant improvements were observed across liver function parameters. The mean SGOT reduced from 40.75 ± 11.59 U/L to 29.80 ± 4.56 U/L (MD: -10.95 ; 95% CI: -14.18 to -7.73 ; $p < 0.001$). The mean SGPT decreased from 40.20 ± 11.94 U/L to 30.18 ± 4.18 U/L (MD: -10.03 ; 95% CI: -13.35 to -6.70 ; $p < 0.001$). These reductions suggest an improvement in liver enzyme levels with subcutaneous semaglutide therapy (Figure 3C).

Subgroup analysis of anthropometric and clinical characteristics by sex

The mean height of male participants increased significantly from 164.81 ± 7.13 cm at baseline to 166.21 ± 6.61 cm at Visit 4. Female participants' mean height increased from 156.19 ± 12.24 cm at baseline to 158.40 ± 10.84 cm at Visit 4 during the study. Both sexes exhibited expected age-related linear growth. The mean BW decreased from 89.55 ± 11.05 kg at baseline to 74.08 ± 8.66 kg at Visit 4 in males and from 87.27 ± 15.87 kg at baseline to 72.25 ± 14.18 kg at Visit 4 in females. Responder analyses demonstrated that all male and female participants achieved $\geq 5\%$ and $\geq 10\%$ weight loss. Furthermore, $\geq 15\%$ weight loss was achieved by 81.3% of males and 83.3% of females, while $\geq 20\%$ weight loss was achieved by 6.3% and 20.8% of participants, respectively. RM-ANOVA showed no significant time-by-sex interaction for BW ($F = 0.160$, $p = 0.807$), suggesting a broadly similar pattern of weight reduction across sexes.

The mean BMI reduced progressively across all study visits in both male and female participants. Male participants showed a reduction from 32.88 ± 2.59 kg/m² at baseline to 26.76 ± 2.01 kg/m² at Visit 4, while female participants reduced from 35.68 ± 3.44 kg/m² to 28.60 ± 2.83 kg/m². All participants achieved $\geq 5\%$ and $\geq 10\%$ BMI reductions. Additionally, $\geq 15\%$ BMI reduction was observed in 100.0% of males and 91.7% of females, while $\geq 20\%$ BMI reduction was achieved by 31.3% and 45.8%, respectively. No significant time-by-sex interaction was observed for BMI ($F = 3.08$, $p = 0.071$).

BMI-SDS reduced from 2.90 ± 0.37 at baseline to 1.83 ± 0.47 at Visit 4 in males and from 3.16 ± 0.55 at baseline to 2.07 ± 0.52 at Visit 4 in females. All participants achieved $\geq 5\%$, $\geq 10\%$, $\geq 15\%$, and $\geq 20\%$ reductions in BMI-SDS. Furthermore, $\geq 25\%$ reductions were observed in 93.8% of males and 91.7% of females, while $\geq 30\%$ reductions were observed in 68.8% and 70.8%, respectively. No significant time-by-sex interaction was observed for BMI-SDS ($F = 0.12$, $p = 0.840$).

The mean WC reduced from 95.62 ± 8.60 cm at baseline to 85.68 ± 8.15 cm at Visit 4 in males and from 100.89 ± 8.14 cm at baseline to 89.67 ± 6.74 cm at Visit 4 in females. All participants achieved $\geq 5\%$ reductions in WC, while $\geq 10\%$ reductions were observed in 50.0% of males and 70.8% of females. No participant achieved $\geq 20\%$ reduction in WC. RM-ANOVA demonstrated no significant time-by-sex interaction for WC ($F = 3.01$, $p = 0.058$).

The mean SBP reduced from 128.63 ± 8.76 mmHg at baseline to 119.25 ± 7.15 mmHg at Visit 4 in males, and from 124.83 ± 11.85 mmHg at baseline to 117.25 ± 7.05 mmHg at Visit 4 in females. The mean DBP reduced from 80.12 ± 6.00 mmHg at baseline to 75.63 ± 4.33 mmHg at Visit 4 in males, and from 78.08 ± 5.36 mmHg at baseline to 73.58 ± 4.64 mmHg at Visit 4 in females. No significant time-by-sex interactions were observed for SBP ($F = 0.63$, $p = 0.510$) or DBP ($F = 0.01$, $p = 0.992$), indicating broadly similar BP changes over time in both sexes. Detailed analysis is reported in Supplemental material 3.

Subgroup analysis of biochemical characteristics by sex

Biochemical characteristics were compared between male and female participants. At baseline, female participants had significantly higher HbA1c levels than males ($5.68\% \pm 0.49\%$ vs. $5.33\% \pm 0.46\%$, $p = 0.027$). No significant gender differences were observed in FBS, PPBS, fasting insulin, TC, TG, TSH, SGOT, or SGPT (all $p > 0.05$). At Visit 4, no significant differences were observed between males and females for any biochemical parameter (all $p > 0.05$), indicating comparable biochemical profiles following subcutaneous semaglutide therapy in both sexes. Detailed analysis is reported in Supplemental material 4.

Adverse events reporting

No adverse events (AEs) or severe AEs were documented during the study period; therefore, descriptive analysis of events was not applicable.

Discussion

The present retrospective, real-world study demonstrates that once-weekly subcutaneous semaglutide (r-DNA) therapy was associated with clinically meaningful improvements in anthropometric, cardiometabolic, and biochemical parameters among Indian adolescents with overweight or obesity over a 32-week study period. Significant reductions were observed in BW, BMI, BMI-SDS, WC, BP, glycemic indices, lipid parameters, thyroid function, and liver enzymes, with no AEs being documented. Taken together, these findings provide important RWE supporting the efficacy and safety of subcutaneous semaglutide in routine pediatric obesity management, complementing evidence from RCTs.

Childhood and adolescent obesity have emerged as one of the most prevalent global public health challenges, with a growing burden across LMICs such as India. The rising trend is associated with various health-risk behaviors, such as sedentary lifestyles, excessive consumption of junk food, and low levels of physical activity [22]. Excess adiposity during adolescence leads to insulin resistance, dyslipidemia, hypertension, type 2 diabetes mellitus, and premature cardiovascular disease, frequently persisting into adulthood [23]. Recent clinical practice guidelines from the 2023 AAP and the 2026 ADA recognized obesity as a chronic, relapsing disease requiring comprehensive, long-term management, with GLP-1R agonists recommended when lifestyle interventions alone fail to achieve adequate weight reduction [9,10]. The present study findings therefore reinforce the growing shift toward earlier incorporation of pharmacotherapy alongside lifestyle modification in adolescents with obesity.

Significant improvements in anthropometric parameters observed in the present study align closely with the known pharmacological actions of semaglutide. As illustrated in Figure 4, subcutaneous semaglutide, a long-acting GLP-1R agonist, activates the GLP-1R, which is widely distributed throughout the central and peripheral tissues, including the central nervous system (CNS), pancreatic β -cells, gastrointestinal tract, cardiovascular tissues, and several metabolically relevant peripheral tissues. GLP-1R activation stimulates anorexigenic pro-opiomelanocortin/cocaine- and amphetamine-regulated transcript (POMC/CART) neurons while simultaneously suppressing orexigenic neuropeptide Y/agouti-related peptide (NPY/AgRP) neurons, thereby reducing hunger, enhancing satiety, and attenuating food-reward behavior. Concurrently, delayed

gastric emptying prolongs postprandial fullness and decreases caloric intake [24,25]. These mechanistic effects collectively contribute to progressive weight reduction and improvement in overall adiposity [13,23,26,27].

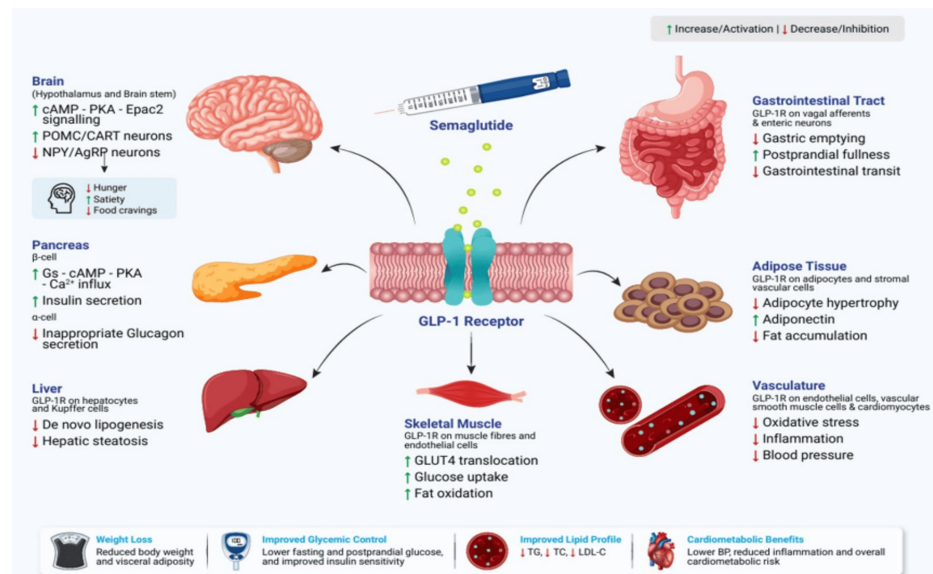


FIGURE 4: Pharmacological mechanisms underlying the metabolic and cardiometabolic effects of subcutaneous semaglutide through GLP-1R signaling

Semaglutide exerts its therapeutic effects primarily through GLP-1R activation in the CNS, gastrointestinal tract, pancreas, vasculature, and other tissues. These regulate appetite, glucose homeostasis, lipid metabolism, and cardiovascular function, resulting in weight reduction and improved glycemic control [13,23,26,27].

GLP-1R: glucagon-like peptide-1 receptor; POMC/CART: pro-opiomelanocortin/cocaine- and amphetamine-regulated transcript; NPY/AgRP: neuropeptide Y/agouti-related peptide; TG: triglycerides; TC: total cholesterol; LDL-C: low-density lipoprotein cholesterol; BP: blood pressure; CNS: central nervous system

Figure created by the authors using Adobe Illustrator (Adobe Systems Inc., San Jose, CA, USA).

The present study demonstrated a 17% reduction in mean BW and a 19.38% reduction in mean BMI from baseline, along with significant reductions in BMI-SDS and WC. These findings are directionally consistent with the landmark STEP TEENS trial by Weghuber et al., in which subcutaneous semaglutide (2.4 mg) reported a -16.1% BMI reduction from baseline after 68 weeks, compared with a 0.6% increase in the placebo group, with nearly 73% of adolescents achieving at least 5% weight loss, with 62%, 53%, and 37% achieving $\geq 10\%$, $\geq 15\%$, and $\geq 20\%$ BW reductions, respectively [18]. In the present real-world cohort, 82.5% achieved a $\geq 15\%$ reduction in BW, while 15.0% achieved a $\geq 20\%$ reduction, demonstrating that a substantial proportion of participants attained clinically meaningful weight loss despite a considerably shorter follow-up duration of 32 weeks. Collectively, these findings suggest that semaglutide provides comparable early-stage effectiveness in routine clinical practice and reinforce the translational relevance of outcomes observed in pivotal clinical trials.

BMI-SDS is considered one of the preferred outcome measures for pediatric obesity, as it accounts for physiological growth and age-dependent variations during adolescence [21]. The substantial decline in BMI-SDS observed indicates a significant improvement in obesity severity. Our findings are consistent with the STEP TEENS trial, which achieved a BMI-SDS reduction of -0.99 at week 68, representing a substantially greater improvement than that reported with liraglutide in the SCALE Teens trial (-0.22 at week 56) and with once-weekly exenatide (-0.09 at week 24) in adolescents. Overall, these findings reinforce the growing evidence that GLP-1R agonists, particularly semaglutide, yield substantially greater improvements in obesity severity [18,27]. Central adiposity is associated with visceral fat accumulation. Visceral adipose tissue secretes pro-inflammatory adipokines, including tumor necrosis factor- α , interleukin-6, monocyte chemoattractant protein-1, and resistin, while reducing adiponectin production, thereby promoting systemic inflammation and metabolic dysfunction [23,26]. By reducing visceral adiposity through a sustained energy deficit, semaglutide therapy was associated with a significant decline in WC, suggesting improvement in cardiometabolic risk.

Semaglutide demonstrated significant improvements in glycemic parameters, representing another critical

endpoint of the present study. Significant improvements in glycemic indices, such as FBS, PPBS, HbA1c, and fasting insulin, indicate a substantial enhancement of glucose homeostasis. Activation of pancreatic GLP-1R enhances glucose-dependent insulin secretion from pancreatic β -cells while suppressing inappropriate glucagon secretion, thereby improving fasting and postprandial glucose regulation [14]. Similarly, improvements in insulin resistance have been reported in STEP trials in adults and in real-world studies, highlighting the dual metabolic benefits of GLP-1R agonists such as semaglutide beyond weight reduction [15,16,28-30]. Semaglutide treatment was also associated with significant improvements in lipid profile, including reductions in TC and TG levels. These improvements reflect multiple complementary mechanisms rather than weight loss alone. GLP-1R agonists improve hepatic lipid metabolism through indirect mechanisms by reducing food intake, promoting weight loss, and enhancing insulin secretion. These effects suppress hepatic de novo lipogenesis, reduce TG and very-low-density lipoprotein (VLDL) secretion, and decrease postprandial lipoprotein secretion. Sustained weight loss and reductions in hepatic steatosis are further associated with improvements in liver lipid homeostasis and cardiometabolic health [13].

Semaglutide demonstrated significant reductions in SGOT and SGPT levels, suggesting reduced hepatic injury and steatosis secondary to weight loss. A study by Wang et al. supports the therapeutic role of GLP-1R agonists in reducing liver fat content and improving liver enzyme profiles, particularly with semaglutide [12]. The present study did not include direct assessment of hepatic steatosis. Therefore, reductions in aminotransferase levels should not be interpreted as definitive evidence of improvement in hepatic steatosis. Mild reductions in TSH levels were also observed during treatment and may reflect improvements in obesity-associated endocrine alterations. Mean TSH decreased from baseline but remained near the upper limit of the reference range (0.4-4.0 mIU/L). Therefore, these findings should be interpreted as indicating a potential improvement in obesity-related dysregulation of the thyroid axis [31]. A study by Dharia et al. reported the overlapping role of obesity and thyroid dysfunction, emphasizing the impact of weight on basal metabolic rate, glucose, and lipid metabolism [32]. Our study findings support the evidence that progressive weight loss improves thyroid function, particularly with semaglutide.

Semaglutide demonstrated comparable therapeutic effectiveness across both sexes in terms of anthropometric and biochemical improvements. Safety reporting in the pediatric population remains important; however, no treatment-related AEs were documented during routine clinical follow-up. GLP-1R agonists are frequently reported to demonstrate mild gastrointestinal AEs, including nausea, vomiting, abdominal discomfort, and constipation, although these effects are generally transient and manageable through gradual dose escalation [33]. Appropriate supportive management, including antiemetics, helps manage these gastrointestinal AEs [34]. Overall, the present study demonstrates the potential therapeutic effectiveness of subcutaneous semaglutide in adolescents with obesity, offering substantial weight reduction, improved metabolic health, and reduced cardiovascular risk factors.

Strengths of the study

The study presents real-world evaluations of once-weekly subcutaneous semaglutide (r-DNA) therapy in Indian adolescents with overweight or obesity, addressing a crucial gap in pediatric obesity management within LMIC settings. Unlike RCTs, the study reflects routine clinical practice and therefore enhances the external validity and clinical applicability of the findings. The study provides a comprehensive assessment of treatment outcomes over 32 weeks, encompassing anthropometric parameters, BP, glycemic indices, lipids, and liver and thyroid function, offering a holistic evaluation of semaglutide therapy. Collectively, the study findings complement the existing evidence from the STEP trials and contribute important real-world data to support clinical decision-making in pediatric obesity management, particularly in the Indian healthcare setting.

Limitations of the study

Along with its strengths, several limitations should be considered when interpreting the findings. First, the retrospective observational design precludes causal inference and is inherently susceptible to selection bias, information bias, and residual confounding. The absence of a control or comparator group further limits the ability to differentiate the observed changes from the effects of normal adolescent growth and development, concurrent lifestyle interventions, regression to the mean, or other unmeasured factors.

Second, the study was conducted at a single tertiary-care center and included a relatively small sample of adolescents with complete follow-up data, which may limit the precision of estimates and the generalizability of findings to broader pediatric populations and other healthcare settings. Inclusion of only participants with complete records and follow-up may have introduced completer or survivor bias, potentially overestimating treatment responses if adolescents who discontinued therapy because of intolerance, cost, inadequate response, or other reasons were not captured. In addition, information on all treatment initiations, treatment discontinuations, and losses to follow-up was unavailable, limiting interpretation of the reported responder rates at the population level.

Potential confounding factors, including dietary intake, physical activity, socioeconomic status, treatment adherence, and concomitant medication use, were not systematically documented in the retrospective medical records and therefore could not be adjusted for in the analysis. Furthermore, although a

standardized dose escalation regimen was followed in routine practice, detailed data regarding treatment adherence, dose interruptions, dose reductions, and actual maintenance doses achieved were not consistently available.

The study follow-up period was limited to 32 weeks; therefore, the durability of weight reduction and long-term cardiometabolic benefits remain uncertain. Likewise, the study was not designed or powered to robustly evaluate uncommon AEs, sex-related differences in treatment response, or developmental outcomes such as growth and pubertal progression.

Finally, safety outcomes were derived from retrospective review of routinely documented medical records rather than prospective AE surveillance. Consequently, mild, transient, or undocumented AEs may have been missed, and the absence of documented AEs should not be interpreted as evidence of complete treatment safety or tolerability. Long-term prospective controlled studies with systematic assessment of effectiveness, safety, treatment adherence, and developmental outcomes are required to validate these findings and better characterize the role of semaglutide in adolescent obesity management.

Future scope

Prospective multicenter studies involving larger and more diverse pediatric populations are warranted to validate these findings across different regions and healthcare settings in India. RCTs evaluating semaglutide against other GLP-1R agonists, emerging anti-obesity pharmacotherapies, and other lifestyle interventions would further validate its clinical effectiveness. Future research should also investigate predictors of treatment response, including baseline obesity severity, pubertal status, insulin resistance, genetic susceptibility, and lifestyle factors, to inform individualized treatment strategies. Finally, real-world health economic evaluations assessing cost-effectiveness, healthcare resource utilization, and treatment persistence will be essential to support the wider implementation of subcutaneous semaglutide in pediatric obesity management programs in India.

Conclusions

The present study demonstrated that once-weekly subcutaneous semaglutide (r-DNA) treatment was associated with clinically meaningful reductions in BW, BMI, BMI-SDS, and WC and improvements in several cardiometabolic parameters, including BP, glycemic indices, lipid parameters, and liver enzyme levels, among adolescents aged 12–18 years with overweight or obesity treated at a tertiary-care center. These improvements were observed over a 32-week follow-up period and are broadly consistent with findings from randomized trials and previous real-world studies. However, the findings should be interpreted in the context of the study's retrospective, uncontrolled, single-center design, modest sample size, complete-case inclusion approach, and limited ability to account for potential confounding factors, including lifestyle interventions and treatment adherence. Furthermore, the absence of documented AEs should not be interpreted as definitive evidence of treatment safety, as systematic ascertainment of AEs was not feasible in this retrospective review. Despite these limitations, the findings suggest that semaglutide may be a promising therapeutic option for managing adolescent obesity in routine clinical practice. Larger prospective, multicenter, controlled studies with longer follow-up are warranted to better define long-term effectiveness, safety, treatment persistence, and sustainability of response.

Appendices

Supplemental material 1

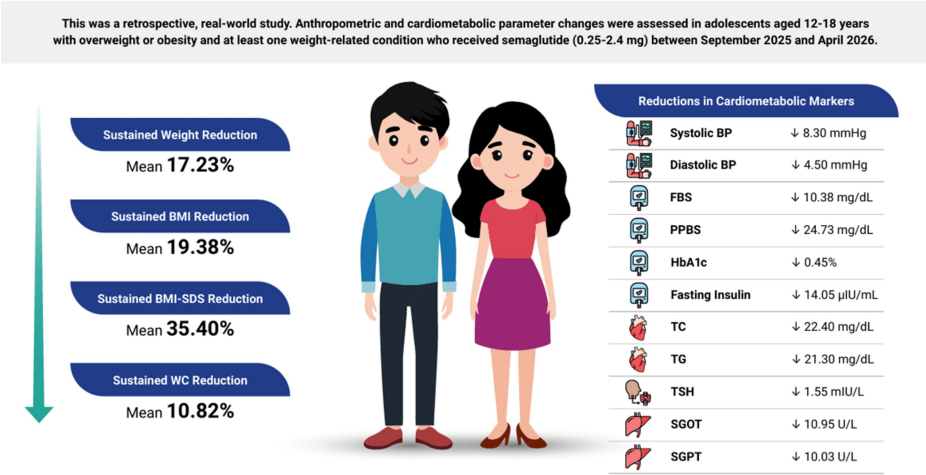


FIGURE 5: Graphical abstract

BMI: body mass index; BMI-SDS: body mass index standard deviation score; WC: waist circumference; BP: blood pressure; FBS: fasting blood sugar; PPBS: postprandial blood sugar; HbA1c: glycated hemoglobin; TC: total cholesterol; TG: triglycerides; TSH: thyroid-stimulating hormone; SGOT: serum glutamic-oxaloacetic transaminase; SGPT: serum glutamic-pyruvic transaminase

Figure created by the authors using Adobe Illustrator (Adobe Systems Inc., San Jose, CA, USA).

Supplemental material 2

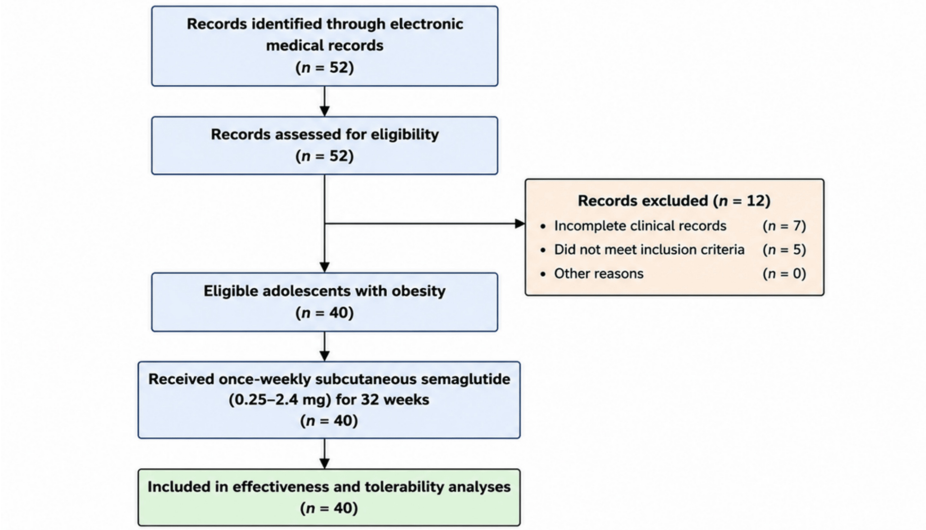


FIGURE 6: STROBE flow diagram

STROBE: Strengthening the Reporting of Observational Studies in Epidemiology

Supplemental material 3

Parameter	Sex	Visit 1 (baseline)	Visit 2	Visit 3	Visit 4	MD (95% CI)	RM-ANOVA
Height (cm)	Male	164.81 ± 7.13	165.37 ± 6.79	165.78 ± 6.64	166.21 ± 6.61	+1.40 (95% CI: +0.90 to +1.90)	Time: F (1.18, 44.80) = 43.32, η^2 = 0.533, p < 0.001; gender: F (1, 38) = 6.68, p = 0.014; time × gender: F = 2.40, p = 0.124; GG ϵ = 0.393
	Female	156.19 ± 12.24	156.83 ± 11.82	157.52 ± 11.44	158.40 ± 10.84	+2.21 (95% CI: +1.40 to +3.02)	
Weight (kg)	Male	89.55 ± 11.05	83.58 ± 10.25	79.36 ± 9.47	74.08 ± 8.66	-15.47 (95% CI: -16.80 to -14.14)	Time: F (1.62, 61.60) = 670.71, η^2 = 0.946, p < 0.001; gender: F (1, 38) = 0.24, p = 0.628; time × gender: F = 0.160, p = 0.807; GG ϵ = 0.540
	Female	87.27 ± 15.87	81.61 ± 14.78	77.22 ± 14.45	72.25 ± 14.18	-15.02 (95% CI: -16.60 to -13.44)	
BMI (kg/m ²)	Male	32.88 ± 2.59	30.48 ± 2.54	28.79 ± 2.19	26.76 ± 2.01	-6.12 (95% CI: -6.80 to -5.44)	Time: F (1.40, 53.02) = 522.67, η^2 = 0.932, p < 0.001; gender: F (1, 38) = 7.13, p = 0.011; time × gender: F = 3.08, p = 0.071; GG ϵ = 0.465
	Female	35.68 ± 3.44	33.05 ± 3.08	30.93 ± 2.77	28.60 ± 2.83	-7.08 (95% CI: -7.90 to -6.26)	
BMI-SDS	Male	2.90 ± 0.37	2.53 ± 0.38	2.24 ± 0.39	1.83 ± 0.47	-1.07 (95% CI: -1.15 to -0.99)	Time: F (1.56, 59.15) = 716.40, η^2 = 0.950, p < 0.001; gender: F (1, 38) = 2.66, p = 0.111; time × gender: F = 0.12, p = 0.840; GG ϵ = 0.519
	Female	3.16 ± 0.55	2.77 ± 0.51	2.47 ± 0.47	2.07 ± 0.52	-1.09 (95% CI: -1.19 to -0.99)	
WC (cm)	Male	95.62 ± 8.60	92.09 ± 7.93	88.57 ± 8.17	85.68 ± 8.15	-9.94 (95% CI: -10.29 to -9.59)	Time: F (1.90, 72.06) = 519.07, η^2 = 0.932, p < 0.001; gender: F (1, 38) = 4.11, p = 0.050; time × gender: F = 3.01, p = 0.058; GG ϵ = 0.632
	Female	100.89 ± 8.14	97.67 ± 7.45	93.75 ± 7.21	89.67 ± 6.74	-11.22 (95% CI: -11.53 to -10.91)	
SBP (mmHg)	Male	128.63 ± 8.76	124.00 ± 6.65	122.37 ± 6.16	119.25 ± 7.15	-9.38 (95% CI: -11.20 to -7.56)	Time: F (1.68, 63.83) = 54.36, η^2 = 0.589, p < 0.001; gender: F (1, 38) = 1.24, p = 0.272; time × gender: F = 0.63, p = 0.510; GG ϵ = 0.560
	Female	124.83 ± 11.85	121.50 ± 8.61	119.33 ± 7.29	117.25 ± 7.05	-7.58 (95% CI: -9.40 to -5.76)	
DBP (mmHg)	Male	80.12 ± 6.00	78.00 ± 5.61	76.88 ± 5.06	75.63 ± 4.33	-4.49 (95% CI: -6.20 to -2.78)	Time: F (1.87, 70.92) = 29.90, η^2 = 0.440, p < 0.001; gender: F (1, 38) = 1.78, p = 0.190; time × gender: F = 0.01, p = 0.992; GG ϵ = 0.622
	Female	78.08 ± 5.36	75.92 ± 4.81	74.92 ± 4.90	73.58 ± 4.64	-4.50 (95% CI: -6.10 to -2.90)	

TABLE 3: Changes in anthropometric and clinical characteristics throughout the study duration by sex

Values are expressed as mean ± SD; MD represents the mean difference between Visit 4 and baseline.

BMI: body mass index; BMI-SDS: body mass index standard deviation score; WC: waist circumference; SBP: systolic blood pressure; DBP: diastolic blood pressure; MD: mean difference; CI: confidence interval; RM-ANOVA: repeated-measures analysis of variance; GG: Greenhouse-Geisser; η^2 : partial eta squared; SD: standard deviation

Supplemental material 4

Parameter	Visit 1 (baseline)		p-value	Visit 4		p-value
	Male (n = 16)	Female (n = 24)		Male (n = 16)	Female (n = 24)	
FBS (mg/dL)	107.81 ± 14.76	112.00 ± 14.63	0.382	99.81 ± 14.30	100.04 ± 9.45	0.952
PPBS (mg/dL)	158.00 ± 19.38	165.42 ± 21.81	0.278	138.06 ± 9.68	137.50 ± 10.06	0.861
HbA1c (%)	5.33 ± 0.46	5.68 ± 0.49	0.027	5.06 ± 0.30	5.12 ± 0.30	0.536
Fasting insulin (µIU/mL)	29.69 ± 10.58	32.79 ± 11.40	0.391	16.63 ± 5.52	18.08 ± 5.51	0.418
TC (mg/dL)	155.13 ± 27.60	165.92 ± 28.46	0.242	135.19 ± 17.92	141.88 ± 17.82	0.253
TG (mg/dL)	132.19 ± 24.35	139.92 ± 21.58	0.298	114.31 ± 15.06	116.33 ± 12.79	0.651
TSH (mIU/L)	5.46 ± 1.71	5.89 ± 2.00	0.491	4.13 ± 0.46	4.19 ± 0.41	0.636
SGOT (U/L)	37.75 ± 11.32	42.75 ± 11.56	0.185	28.31 ± 4.47	30.79 ± 4.43	0.092
SGPT (U/L)	38.94 ± 12.17	41.04 ± 11.97	0.592	29.00 ± 4.08	30.96 ± 4.14	0.149

TABLE 4: Changes in biochemical characteristics throughout the study duration by sex

Values are expressed as mean ± SD; p-values were obtained using the independent-samples t-test.

FBS: fasting blood sugar; PPBS: postprandial blood sugar; HbA1c: glycated hemoglobin; TC: total cholesterol; TG: triglycerides; TSH: thyroid-stimulating hormone; SGOT: serum glutamic-oxaloacetic transaminase; SGPT: serum glutamic-pyruvic transaminase; SD: standard deviation

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Inderpal S. Kochar, Keerthi Anusha, Shikha Uppal

Acquisition, analysis, or interpretation of data: Inderpal S. Kochar, Keerthi Anusha, Shikha Uppal

Drafting of the manuscript: Inderpal S. Kochar, Keerthi Anusha, Shikha Uppal

Critical review of the manuscript for important intellectual content: Inderpal S. Kochar, Keerthi Anusha, Shikha Uppal

Supervision: Inderpal S. Kochar, Keerthi Anusha, Shikha Uppal

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. Institutional Ethics Committee-Biomedical Research issued approval IAH-BMR/072/06-26. Animal subjects: All authors have confirmed that this study did not involve animal subjects or tissue. Conflicts of interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following: Payment/services info: In this study, the reference semaglutide product is Wegovy® from Novo Nordisk, Bagsværd, Denmark. Medical writing support was provided by Khush Jain (Alpha MD Pvt. Ltd, Mumbai). Funding was supported by Novo Nordisk as independent publication support to Dr. Inderpal S. Kochar. Financial relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. Other relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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