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Case Report

Real-World Clinical Outcomes of Liraglutide Therapy in Adolescents: A Six-Patient Case Series

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Abstract

Adolescent obesity is a rapidly escalating global health concern associated with insulin resistance, early-onset type 2 diabetes mellitus (T2DM), pubertal disturbances, and long-term cardiometabolic risk. Glucagon-like peptide-1 receptor agonists (GLP-1 RAs), including liraglutide, have emerged as pharmacological options for weight management in adolescents. This retrospective case series included six adolescents (13-17 years) with obesity who were treated with liraglutide at a tertiary pediatric endocrinology clinic between June and December 2025. Liraglutide was initiated at 0.3–0.6 mg/day and titrated up to a maximum of 1.8 mg/day, alongside structured lifestyle intervention. Anthropometric, metabolic, and selected hormonal parameters were assessed over 2 weeks to 3 months. Baseline BMI ranged from 25.6 to 33.7 kg/m^2. All six adolescents demonstrated reductions in body weight and/or BMI (range: 0.2-2.1 kg/m^2). Improvements were observed in glycemic indices (HbA1c reduced by up to 0.4%), fasting plasma glucose (reduced by up to 22 mg/dL), LDL cholesterol (reduced by up to 13 mg/dL), waist circumference, and insulin resistance markers. Pubertal progression was observed in some cases during follow-up; however, causality cannot be established. No serious adverse events occurred. In this real-world case series, liraglutide combined with lifestyle modification was associated with short-term improvements in anthropometric and metabolic parameters in adolescents with obesity and related comorbidities. These findings support the role of GLP-1 receptor agonists as adjunctive therapy when lifestyle measures alone are insufficient. Larger prospective studies with longer follow-up are needed.

Keywords: Adolescent Obesity; Liraglutide; GLP-1 Receptor Agonist; Insulin Resistance; Type 2 Diabetes Mellitus; Pubertal Delay

Abbreviations

ALT	–	Alanine Aminotransferase
AST	–	Aspartate Aminotransferase
BMI	–	Body Mass Index
BP	–	Blood Pressure
C-peptide	–	Connecting Peptide
eGFR	–	Estimated Glomerular Filtration Rate
FPG	–	Fasting Plasma Glucose
FSH	–	Follicle-Stimulating Hormone
GLP-1	–	Glucagon-Like Peptide-1
GLP-1 RA	–	Glucagon-Like Peptide-1 Receptor Agonist
HbA1c	–	Glycated Hemoglobin
HOMA-IR	–	Homeostatic Model Assessment of Insulin Resistance

LDL	–	Low-Density Lipoprotein
LH	–	Luteinizing Hormone
NAFLD	–	Non-Alcoholic Fatty Liver Disease
PH	–	Pubic Hair Stage
PPG	–	Postprandial Plasma Glucose
T2DM	–	Type 2 Diabetes Mellitus
TSH	–	Thyroid-Stimulating Hormone

Introduction

The global rise in adolescent obesity has paralleled an alarming increase in early-onset Type 2 diabetes mellitus (T2DM), giving rise to the increasingly recognized entity of "diabesity." The coexistence of obesity and T2DM during adolescence represents a particularly aggressive metabolic phenotype characterized by accelerated β-cell dysfunction, severe insulin resistance, dyslipidemia, hypertension, and early microvascular risk. Compared with adult-onset disease, youth-onset T2DM demonstrates more rapid disease progression and earlier development of complications, making timely and effective intervention critical [1-4].

Over the past two decades, the prevalence of adolescent obesity has increased dramatically, posing substantial long-term metabolic and cardiovascular risks. Obesity during adolescence predisposes individuals to insulin resistance, dyslipidemia, Non-Alcoholic Fatty Liver Disease (NAFLD), reproductive dysfunction, and early-onset T2DM. Emerging prospective data further indicate that individuals with coexistent obesity and diabetes carry a significantly higher hazard of cardiovascular mortality than those with either condition alone. The combination of obesity and T2DM markedly amplifies the risk of Atherosclerotic Cardiovascular Disease (ASCVD), hypertension, dyslipidemia, and NAFLD, thereby accelerating morbidity and mortality [5,6].

Recent prospective evidence from large cohorts shows that individuals with coexistent obesity and diabetes carry a substantially higher hazard of cardiovascular mortality than diabetic or obese patients without both conditions [7]. The coexistence of obesity and T2DM significantly amplifies the risk of cardiovascular disease, hypertension, dyslipidemia, and Non-Alcoholic Fatty Liver Disease (NAFLD), thereby accelerating morbidity and mortality. Individuals with concomitant obesity and T2DM exhibit markedly higher Atherosclerotic Cardiovascular Disease (ASCVD) risk compared with those with either condition alone [8].

While dietary modification and increased physical activity remain foundational interventions, achieving sustained weight reduction in clinical practice is often difficult [9]. Pharmacotherapy is recommended in adolescents with severe obesity or obesity-associated comorbidities when lifestyle therapy alone is inadequate [10].

Glucagon-like peptide-1 (GLP-1) receptor agonists offer dual therapeutic advantages by improving glucose homeostasis while promoting weight loss through appetite regulation, delayed gastric emptying, and enhanced glucose-dependent insulin secretion [11]. Liraglutide has emerged as a valuable therapeutic option in adolescents with obesity and T2DM, demonstrating clinically meaningful reductions in Body Mass Index (BMI), improved glycemic parameters, and favorable cardiometabolic effects when combined with lifestyle intervention [12,13].

This case series describes short-term real-world clinical outcomes of liraglutide therapy in six adolescents with diverse obesity phenotypes and metabolic-endocrine comorbidities.

Materials and Methods

Study Design and Setting

This study is a retrospective, real-world clinical case series evaluating the use of liraglutide in adolescents with obesity and associated metabolic comorbidities. Patients were managed at a tertiary care pediatric endocrinology clinic between June 2025 and December 2025. Written informed consent was obtained from all patients and their legal guardians, along with patient assent.

Participants

Adolescents aged 13-17 years with obesity were included. Weight status was classified using age- and sex-specific BMI percentiles according to established pediatric growth references (Obesity: ≥85th percentile; obesity: ≥95th percentile). Eligible participants also had at least one obesity-associated comorbidity such as insulin resistance, type 2 diabetes mellitus, hypothyroidism-related weight gain, pubertal delay, or other endocrine/metabolic disturbances.

Baseline Assessment

At baseline, all patients underwent a comprehensive clinical evaluation, including anthropometric measurements (height, weight, BMI, waist circumference), vital signs, and Tanner staging for pubertal assessment. Laboratory investigations included Fasting Plasma Glucose (FPG), Postprandial Glucose (PPG), Glycated Hemoglobin (HbA1c), lipid profile, fasting insulin, Homeostatic Model Assessment of Insulin Resistance (HOMA-IR), hepatic and renal function tests, and relevant hormonal parameters (e.g., Luteinizing Hormone (LH), Follicle-Stimulating Hormone (FSH), prolactin, testosterone, estradiol, Thyroid-Stimulating Hormone (TSH). Clinical features such as acanthosis nigricans, delayed puberty, and comorbid conditions were documented.

Intervention

Liraglutide therapy was initiated at a low dose of 0.3-0.6 mg/day, depending on age, weight, and clinical status, and titrated gradually to 1.2-1.8 mg/day. Liraglutide administration was combined with structured lifestyle interventions, including dietary counseling for a low-calorie, high-fiber diet, and promotion of regular physical activity. Concomitant medications were continued as clinically indicated. (Table 1) summarizes the baseline characteristics of the six adolescents included in this case series.

Case	Age (years) /Sex	BMI (kg/m^2)	Waist circumference (cm)	Comorbidities /Clinical Features	Baseline HbA1c (%)	FPG (mg/dL)	PPG (mg/dL)	Liraglutide Dose (mg/ day)
1	14 M	30.7	76.2	None	4.9	92	126	0.3 → 1.2
2	17 M	28.4	90	None	5.1	90	128	0.3 → 0.9
3	15 F	25.6	81.6	Hypothyroidism, menstrual irregularity	Not available	Not available	106	0.3 → 1.2
4	14 M	27.7	84.7	T2DM, delayed puberty, and insulin resistance	7.7	143	160	0.6 → 1.5
5	13 M	33.7	84	Buried penis syndrome, acanthosis nigricans	Not available	Not available	Not available	0.6 → 1.2
6	13 M	32.4	92.1	Severe obesity, insulin resistance, nocturnal enuresis, and breathing difficulty	4.3	91	96	0.3 → 1.0

Table 1: Summary of Baseline Characteristics and Liraglutide Dosing.

Follow-Up and Outcome Measures

Patients were followed up at intervals ranging from 2 weeks to 3 months. During follow-up visits, anthropometric parameters, vital signs, and laboratory markers were reassessed. Primary outcomes included changes in BMI, body weight, and waist circumference. Secondary outcomes included improvements in glycemic control (FPG, PPG, HbA1c), insulin resistance markers (fasting insulin, HOMA-IR), lipid profile (Low-Density Lipoprotein (LDL) cholesterol), and pubertal progression. Adverse events, tolerability, and treatment adherence were recorded at each visit.

Data Analysis

Descriptive statistics were used to summarize baseline characteristics, treatment doses, and follow-up outcomes. Given the exploratory nature and small sample size, only descriptive analyses were conducted. All data were anonymized prior to analysis to ensure patient confidentiality. Due to the descriptive nature of the case series, formal hypothesis testing was not planned.

Case Presentations

Case 1: A 14-year-old male presented with concerns of excess body weight. He had no significant past medical history or comorbidities. On examination, his height was 142 cm, weight 62 kg, and BMI 30.7 kg/m^2, with a waist circumference of 76.2 cm. Blood pressure was 110/70 mmHg. Baseline laboratory investigations showed normal glycemic parameters (HbA1c 4.9%, FPG 92 mg/dL, PPG 126 mg/dL) and LDL cholesterol of 101 mg/dL; renal function was normal (eGFR 136 mL/min/1.73 m^2, creatinine 0.7 mg/dL). The patient was started on liraglutide 0.3 mg/day, with titration to 0.6 mg/day, alongside a low-calorie, high-fiber diet. At follow-up, weight decreased to 60.5 kg and BMI to 30.0 kg/m^2. HbA1c improved to 4.7%, FPG to 87 mg/ dL, PPG to 122 mg/dL, and LDL to 96 mg/dL. Early initiation of liraglutide alongside lifestyle modification resulted in modest weight reduction and improvement in metabolic parameters in this adolescent with obesity and preserved glycemic status.

Case 2: A 17-year-old male presented with obesity. He was otherwise healthy, with a height of 170 cm, a weight of 82 kg, a BMI of 28.4 kg/m^2, and a waist circumference of 90 cm. Blood pressure was 120/80 mmHg. Laboratory investigations revealed HbA1c 5.1%, FPG 90 mg/dL, PPG 128 mg/dL, LDL 114 mg/ dL, and normal renal function (eGFR 124 mL/min/1.73 m^2).

Liraglutide was initiated at 0.3 mg/day, titrated to 0.9 mg/day, with concomitant low-calorie dietary counseling. At follow-up, weight decreased to 81.5 kg, BMI to 28.2 kg/m^2, HbA1c to 4.9%, FPG to 88 mg/dL, PPG to 126 mg/dL, and LDL to 101 mg/dL, with no adverse events. In this adolescent male with obesity, liraglutide therapy combined with lifestyle modification was well tolerated and associated with modest weight reduction and improvement in cardiometabolic markers.

Case 3: A 15-year-old female with hypothyroidism presented with obesity, menstrual irregularities, and difficulty losing weight. Examination revealed a height of 158 cm, a weight of 64 kg, a BMI of 25.6 kg/m^2, and a waist circumference of 81.6 cm. Baseline labs demonstrated normal glycemic parameters (PPG 106 mg/dL), TSH 2.50 mU/L, HOMA-IR >10.5, total testosterone 10.68 nmol/L, prolactin 7.60 ng/mL, and C-peptide 11.83 ng/mL, indicating insulin resistance and hormonal imbalance. She was started on liraglutide 0.3 mg/day, titrated to 1.2 mg/day, with continuation of thyroid replacement therapy and structured lifestyle modification. Follow-up revealed weight reduction to 62 kg, BMI to 24.8 kg/m^2, stable BP, improved hormonal and metabolic markers, and no adverse events.

Case 4: A 14-year-old male with a history of obesity, insulin resistance, acanthosis nigricans, delayed puberty, and type 2 diabetes mellitus presented with progressive weight gain, body pains, fatigue, and growth concerns. Height was 164.5 cm, weight 75.2 kg, BMI 27.7 kg/m^2, waist 84.7 cm, and BP 111/79 mmHg. Labs showed poor glycemic control (FPG 143 mg/dL, PPG 160 mg/dL, elevated HbA1c 7.7%), LDL 132 mg/dL, and a delayed pubertal hormonal profile (LH 2.23 IU/L, FSH 5.20 IU/L). Liraglutide was initiated at 0.6 mg/day and titrated to 1.5 mg/day, with standard antidiabetic therapy and ongoing hormonal management. Lifestyle modification counseling was reinforced. Follow-up showed a weight reduction to 70.1 kg, a BMI of 25.9 kg/m^2, improved glycemic parameters (FPG 121 mg/dL, PPG 142 mg/dL, HbA1c 7.3%, Testosterone total 9.25 nmol/L), stable renal function, and no adverse events. Adjunctive liraglutide therapy in this adolescent male with obesity-associated T2DM and delayed puberty was associated with clinically meaningful weight reduction, improved glycemic control, lipid improvement, and a favorable hormonal response without safety concerns.

Case 5: A 13-year-old boy presented with obesity, small genitalia, progressive neck and axillary hyperpigmentation, and a sedentary lifestyle. Height was 154 cm, weight 80 kg, BMI 33.7 kg/m^2, waist 84 cm, Tanner G2, PH2, stretched penile length 4.5 cm, and Burke grade 3 acanthosis nigricans. Baseline labs were largely normal, except mild hepatic enzyme elevation (SGOT 42 IU/L, SGPT 47 IU/L) and mildly elevated estradiol (40.1 pg/mL). Liraglutide therapy was initiated at 0.6 mg/day, titrated to 1.2 mg/day, with lifestyle modification and as-needed ondansetron. At three months, weight decreased by 8 kg, waist circumference reduced by 5.5 cm, Tanner staging improved to G3, PH2, and increased penile size, without safety concerns. Liraglutide therapy in this adolescent with severe obesity was associated with significant weight reduction, improvement in central adiposity, and favorable pubertal progression without safety concerns.

Case 6: A 13-year-old boy presented with progressive weight gain, exertional breathlessness, fatigue, hair fall, and nocturnal enuresis. He had Class II obesity with clinical features of insulin resistance. His height was 159 cm, weight 82 kg, BMI 32.44 kg/m^2, and waist circumference 92.1 cm. Baseline evaluation showed HbA1c 4.3%, FPG 91 mg/dL, PPG 96 mg/dL, serum creatinine 0.6 mg/dL, blood pressure 93/67 mmHg, and elevated prolactin (35.6 ng/mL). Liraglutide therapy was initiated at 0.3 mg/day and gradually titrated to 1.0 mg/day, along with dietary advice, exercise, and supportive supplementation. At follow-up, weight decreased by 1.5 kg, and BMI declined to 31.8 kg/m^2. PPG and blood pressure remained stable, and treatment was well-tolerated, with no adverse events reported.

(Table 2) summarizes the follow-up outcomes, including changes in BMI, weight, and metabolic parameters, after liraglutide therapy in adolescents with obesity.

Case	BMI Change (kg/m^2)	HbA1c Change (%)	LDL Change (mg/dL)	Key Observation
1	30.7 → 30.0 (−0.7)	4.9 → 4.7 (−0.2)	101 → 96 (−5)	Modest weight reduction with improved glycemic and lipid parameters
2	28.4 → 28.2 (−0.2)	5.1 → 4.9 (−0.2)	114 → 101 (−13)	Weight stabilization with improved cardiometabolic markers
3	25.6 → 24.8 (−0.8)	Not available	Not available	Improvement in insulin resistance and hormonal profile
4	27.7 → 25.9 (−1.8)	7.7 → 7.3 (−0.4)	132 → Not reported	Clinically meaningful BMI reduction with improved glycemic control
5	Not reported (BMI decreased)	Not available	Not reported	Significant central adiposity reduction; pubertal progression observed
6	32.44 → 31.8 (−0.64)	4.3 → Not repeated	Not reported	Modest weight reduction; stable glycemic and blood pressure parameters

Table 2: Follow-Up Outcomes After Liraglutide Therapy in Six Adolescents with Obesity.

Abbreviations: BMI: body mass index; HbA1c: glycated hemoglobin; LDL: low-density lipoprotein; HOMA-IR: homeostatic model assessment of insulin resistance.

Discussion

Adolescent obesity represents a multifactorial health challenge, with implications spanning metabolic, endocrine, and psychosocial domains [14]. In this real-world case series, short-term liraglutide therapy combined with structured lifestyle intervention was associated with consistent reductions in body weight and BMI across six adolescents with diverse obesity phenotypes. Improvements were also observed in glycemic indices, insulin resistance markers, lipid parameters, and selected hormonal measures, with good overall tolerability.

Our findings are consistent with previous clinical trials, Kelly S, et al., which reported significant reductions in BMI standard deviation scores when liraglutide was administered alongside lifestyle therapy. Similarly, liraglutide has been shown to improve glycemic control, insulin sensitivity, and lipid profiles, reflecting its dual effect on weight management and cardiometabolic risk mitigation[7]. Although our cohort did not receive doses beyond 1.8 mg/day, clinically meaningful reductions in BMI and improvements in glycemic parameters were observed, suggesting that even moderate doses of liraglutide may offer metabolic benefit in carefully selected adolescents in real-world settings. In our cohort, adolescents with insulin resistance, early T2DM, hypothyroidism-associated obesity, and pubertal delay all demonstrated improvements, highlighting liraglutide's potential utility across multiple obesity-associated comorbidities.

More recently, the STEP TEENS trial demonstrated substantial BMI reductions with once-weekly semaglutide 2.4 mg in adolescents with obesity, with a mean BMI reduction of approximately 16% compared with 0.6% in the placebo group [15]. The difference in efficacy likely reflects variations in molecular potency, dosing regimen, and treatment duration. Nevertheless, both studies reinforce the therapeutic potential of GLP-1 receptor agonists as adjunctive pharmacologic options in pediatric obesity management. Our findings extend this evidence base by illustrating outcomes in a heterogeneous, real-world adolescent population with coexisting endocrine and metabolic conditions.

Notably, adolescents in this series presented with varied clinical phenotypes, including early type 2 diabetes mellitus, insulin resistance without overt hyperglycemia, hypothyroidism-associated weight gain, pubertal delay, and severe obesity with features of androgen imbalance. In patients with established T2DM, liraglutide initiation was associated with improved fasting and postprandial glucose levels and a modest reduction in HbA1c, consistent with its glucose-dependent insulinotropic and glucagon-suppressive mechanisms. In individuals with significant insulin resistance and hyperandrogenic features, reductions in weight and central adiposity were accompanied by improvement in selected hormonal parameters. While these endocrine changes are biologically plausible given the interrelationship between adiposity, insulin signaling, and gonadal function, the descriptive design and short follow-up preclude causal inference.

An important observation from this series is the favorable safety profile. No serious adverse events were reported, and gastrointestinal symptoms were mild and manageable. These findings are consistent with the established safety data for liraglutide in pediatric populations. Importantly, no episodes of pancreatitis, severe hypoglycemia, or clinically significant renal impairment were observed during follow-up, although the limited sample size restricts meaningful safety conclusions.

The heterogeneity of clinical presentations in this series underscores the multifactorial nature of adolescent obesity. Beyond weight reduction, GLP-1 receptor agonist therapy may also improve cardiometabolic risk factors, including central adiposity and dyslipidemia. Reductions in waist circumference and LDL cholesterol observed in several patients are clinically relevant, as early visceral adiposity and dyslipidemia contribute to accelerated atherosclerotic risk trajectories beginning in adolescence. Whether early pharmacologic intervention can alter long-term cardiovascular outcomes remains unknown and warrants longitudinal investigation.

The 2023 Clinical Practice Guideline from the American Academy of Pediatrics recommends considering pharmacotherapy as an adjunct to health behavior and lifestyle interventions in adolescents aged ≥12 years with obesity, particularly in the presence of significant comorbidities. The guideline emphasizes early, proactive treatment rather than delayed intervention [16]. The real-world experience described here aligns with this paradigm shift toward earlier therapeutic intensification rather than delayed escalation. However, careful patient selection, shared decision-making, and close monitoring remain essential.

The titration strategy in our cases, starting at 0.3-0.6 mg/day and escalating to 1.8 mg/day based on tolerance, appeared effective for weight reduction while minimizing adverse effects. No serious adverse events were reported; minor gastrointestinal discomfort was managed conservatively, consistent with the known safety profile of GLP-1 receptor agonists in adolescents.

Notably, the cases also illustrate liraglutide's impact beyond weight loss. In Cases 3 and 5, modest improvements in pubertal staging and selected hormonal parameters were observed; however, given the descriptive nature of this series and the lack of standardized endocrine endpoints, these findings should be interpreted cautiously and cannot be considered evidence of a causal treatment effect. Furthermore, reductions in waist circumference and LDL cholesterol among several patients underscore the favorable effects of liraglutide on central adiposity and cardiovascular risk factors.

While lifestyle modification remains the cornerstone of adolescent obesity management, real-world evidence indicates that pharmacological therapy with GLP-1 receptor agonists may be necessary for patients with severe obesity, metabolic complications, or suboptimal response to non-pharmacological interventions [17]. Early initiation of therapy, as seen in our series, may attenuate long-term cardiometabolic risk and improve quality of life during adolescence, a critical developmental period [18,19]. These findings should be interpreted as hypothesis-generating rather than confirmatory.

Several limitations merit consideration. The small sample size, retrospective design, absence of a control group, and short follow-up period limit generalizability and preclude assessment of sustained efficacy. Variability in dosing, follow-up duration, and comorbid conditions introduces heterogeneity that may confound outcome interpretation. Additionally, standardized measures such as BMI standard deviation score (BMI-SDS) were not systematically calculated, and formal quality-of-life or psychosocial assessments were not performed. As such, these observations should be regarded as hypothesis-generating.

Despite these limitations, this case series contributes clinically relevant real-world data on liraglutide use in adolescents with obesity and associated endocrine-metabolic disturbances. The consistent direction of anthropometric and metabolic improvement across heterogeneous presentations supports the growing role of GLP-1 receptor agonists as adjunctive therapy in pediatric obesity management. Larger prospective studies with longer follow-up are needed to determine optimal dosing strategies, durability of response, long-term safety, and the impact of early intervention on cardiometabolic outcomes into adulthood.

Conclusion

Liraglutide therapy, when combined with structured lifestyle interventions, appeared effective and was well tolerated in adolescents with obesity and metabolic comorbidities. Across diverse clinical presentations-including insulin resistance, early T2DM, hypothyroidism-related weight gain, and pubertal delay-liraglutide contributed to meaningful reductions in BMI, improvements in glycemic and lipid parameters, and positive effects on pubertal development.

Early pharmacological intervention, alongside ongoing dietary and lifestyle modifications, may play a crucial role in reducing long-term cardiometabolic risk in this vulnerable population. These real-world cases support liraglutide as a valuable option in comprehensive obesity management for adolescents, particularly when conventional lifestyle measures are insufficient.

These findings support the growing body of real-world evidence indicating that GLP-1 receptor agonists may serve as adjunctive therapy for adolescents with obesity who do not respond adequately to lifestyle intervention alone. Larger prospective studies are

needed to determine long-term efficacy, optimal dosing strategies, and safety profiles in this population.

Author Contributions

All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by Dr. Sanjay Kalra, Dr. Ravi K Muppadi, and Dr. Mohammad Jawed. All authors read and approved the final manuscript.

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Ethics Approval Statement

This case series was conducted in accordance with recognized ethical principles. As a retrospective analysis of routine clinical practice, formal institutional ethics committee approval was not required.

Funding Statement

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Data Availability

Data are available from the corresponding author upon reasonable request.

Conflict of Interest

The authors declare no financial or non-financial conflicts of interest that could have influenced the reported outcomes. No external funding was received for this work.

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