

IMPACT OF AGE AND OBESITY ON GLYCEMIC CONTROL IN CHILDREN WITH TYPE 1 DIABETES

Anil Shivmurti Yadav, Research Scholar, Department of Pharmacy, Sikkim Professional University, Gangtok, Sikkim, India

Dr. Saurabh Sharma, Professor, Department of Pharmacy, Sikkim Professional University, Gangtok, Sikkim, India

Abstract:

Managing type 1 diabetes in children depends on keeping blood glucose levels under control, since poor control can cause both short- and long-term health problems. While age and obesity are thought to play important roles in blood sugar regulation, their exact effects in children are not well understood. This study looks at how glycemic control relates to age and obesity in children with type 1 diabetes. We analyzed clinical data from pediatric patients, focusing on age, HbA1c levels, and BMI. The results show that older children and those with higher BMI are more likely to have poor glycemic control. These findings highlight the need for diabetes management plans that consider a child's age and weight, with a focus on tailored diet, exercise, and insulin adjustments. By understanding how age and obesity affect blood sugar control, healthcare providers can design better interventions to improve overall health and reduce diabetes complications in children.

Keywords: Obesity, Glycemic control, Type1 diabetes

1. INTRODUCTION

The chronic disease known as type 1 diabetes is brought on by the death of beta cells in the pancreas, which results in inadequate insulin synthesis and hyperglycemia. In order to minimize the danger of hypoglycemia and reduce hyperglycemia, it necessitates insulin replacement and critical care. Glucose balance is influenced by a number of factors, including diet, insulin dosages, physical stress, and exercise. Children and adolescents can live long, happy lives with the right treatment, and patient and family education is essential[1,2]. Obesity is significantly associated with poorer glycaemic control in type 1 diabetes mellitus (T1DM) children [3]. Insulin dependency and hyperglycemia result from the decrease of beta cell function, which is caused by both genetic and environmental causes. In at-risk people, the HLA haplotype is responsible

for between 30% and 50% of the hereditary risk. A process that recruits antigen-presenting cells to autoreactive T cells is started by a triggering insult, which can include the mother and intrauterine environment, viruses, the host microbiota, and food. This process results in insulinopenia and symptoms of diabetes.[4,5]

Although it peaks between the ages of 5 and 7 and puberty, type 1 diabetes can be diagnosed at any age. It has become more prevalent across a range of age, sex, and racial groupings, and it is more prevalent in boys and men. Geographical and ethnic differences exist; Finland has a greater incidence than China. Type 1 diabetes affects more than 1.25 million persons in the United States. Adolescents with T1DM have the most time achieving sufficient glycemic control, with a very low percentage of them succeeding. Potential contributing factors were SMBG frequency and family dynamics, underscoring the pressing need for specialized therapies and enhanced diabetes education in areas with low resources [6].

The percentage of youngsters in the United States who are overweight or obese has increased to one-third. Obesity in early childhood raises the likelihood of obesity in later life. Weight control and health improvement are successfully achieved through family-based behavioral treatment. Ethnic minority status and poorer income are associated with an increase in type 2 diabetes in young people [7].

While the effects of type 1 diabetes on children have been extensively studied, little is known about the combined effects of age and fat on blood sugar regulation. Due to changes in their bodies and behaviors, adolescents frequently have more difficulty controlling their blood sugar, and obesity can make it even more difficult for their bodies to use insulin as it should. We know less about how age and obesity interact in children with type 1 diabetes because the majority of research has only looked at these two factors separately.

Addressing this disparity is crucial, particularly as childhood obesity rates rise and children with diabetes experience critical developmental phases. In this study, blood sugar management in children with type 1 diabetes is examined in relation to age and obesity. We aim to identify trends that indicate which child demographics may be more susceptible to inadequate blood sugar regulation by looking at variables including age, body mass index, and HbA1c levels. The findings could enhance the health of children with type 1 diabetes by assisting medical professionals, families, and legislators in developing better care plans that take age and weight into account.

2. Literature Review

Overview of Type 1 Diabetes in Children

By comparing the generic quality of life of children and adolescents with type 1 diabetes mellitus (T1DM) to that of their healthy counterparts, the study seeks to determine whether there are differences in this quality of life between boys and girls as well as between developmental stages. The findings indicate that there are issues unique to T1DM in children and adolescents, but no differences in QoL-domains between them and healthy controls. Compared to boys, girls with T1DM reported lower generic and disease-specific quality of life. For children with T1DM of all ages, individualized management requires longitudinal research [7]

The purpose of a study was to determine the unique requirements and challenges that children with Type 1 diabetes encounter when integrating into schools. Parents filled out questionnaires that evaluated things like insulin administration, glycaemic control, meals, sports, and attitudes about their illness. According to the findings, just 34% of parents thought instructors could identify minor symptoms of hypoglycemia. Improved communication between parents and school staff, more nurses, training sessions, and greater resources from diabetes societies are all important components of successful integration [8].

Glycemic Control and Its Importance

The degree of glycemic control and risk variables for type 1 diabetes in Ethiopian children and adolescents are examined in this study. The results indicate that low control is mostly caused by inadequate adherence to glucose monitoring, insufficient insulin injection involvement, and caregiver engagement. It is advised that caregivers participate and receive adherence counselling [9].

A study of 116 diabetic children and adolescents in southern Ethiopia evaluated their glycemic control. 83.6% of the participants had poor glycemic control, according to the study, and poor control was linked to things like lipodystrophic alterations at injection sites and an inability to pay for insulin. The report recommends that stakeholders concentrate on methods to enhance glycemic control and urges more investigation to determine the causes of inadequate glycemic control [10].

Influence of Age

According to a Taiwanese study, glycemic control in teenagers with type 1 diabetes was significantly predicted by parental participation, self-care practices, and family conflict. According to the study, nurses should identify female adolescents as at-risk and create treatments that are specific to their developmental requirements, particularly for those between the ages of 10 and 12[11].

According to a Scottish study, young persons with type 1 diabetes have an average HbA1c concentration of 9.1%. The concentration is influenced by age, insulin use, BMI, season, social situations, and family history. According to the study, two important factors influencing HbA1c are clinic philosophy and resource allocation [12].

According to a study, adherence and glycemic control in teenagers with Type 1 Diabetes are highly influenced by gender, age, and family support. Negotiation skills should be taught in intervention programs in order to improve adherence and avoid disputes[13].

Impact of Obesity on Glycemic Control in Children with T1D

According to the study, glycemic control is greatly impacted by age, race, being overweight, using continuous subcutaneous insulin infusion (CSII), and using continuous glucose monitoring (CGM). Participants who were overweight or obese had lower HDL cholesterol but greater LDL cholesterol and triglycerides. Obese and overweight patients exhibited greater predictors of cardiovascular disease, but no differences were observed in modifiable behavioral features [14].

Interaction Between Age and Obesity

Obesity and puberty in adolescents are related; research indicates that obese girls experience puberty earlier. It is unknown, though, how fat and puberty are related. The relationship between the kisspeptin system and the adipokineleptin is the most promising link. Additional aspects include endocrine disrupting substances, dietary issues, epigenetics, and the peripheral effect of adipose tissue [15].

Estimating the association between screen time and overweight/obesity in children under the age of 18 was the goal of the study. According to a meta-analysis of 16 research, screen usage of more than two hours a day raised the chance of being overweight or obese. Additionally, the study discovered a favorable correlation between children's overweight/obesity and various forms of screen time. Preventing chronic noncommunicable diseases can be achieved by reducing childhood obesity[16].

Research Gap

Numerous studies have looked at glycemic control, school integration, and quality of life in kids with type 1 diabetes, but there are still a lot of unanswered questions. While most research focuses on poor glycemic control and its associations with behavioral, family, and socioeconomic factors, few studies examine the combined effects of age and obesity on glycemic outcomes. Little is known about how obesity interacts with age-related developmental changes like puberty, despite the fact that it is associated with poor metabolic profiles and is increasingly prevalent in children with type 1 diabetes. Additionally, there is a lack of longitudinal evidence assessing how these factors work together to affect glycemic control over time.

3. MATERIALS AND METHODS

3.1 Study Design and Data Source

This cross-sectional secondary data analysis used information from the Nature article "Risk factors for suboptimal glycemic control in pediatrics with type 1 diabetes mellitus: a cross-sectional study." The data includes clinical and demographic information gathered during the enrollment process for children with type 1 diabetes. The original study used advanced statistical approaches to identify risk factors associated with inadequate glycemic management.

3.2 Study Population

Inclusion criteria: Children and adolescents diagnosed with type 1 diabetes mellitus, whose records include measurements for glycemic control (e.g., HbA1c), age, body mass index (BMI), insulin regimen details, duration of disease, and other covariates considered in the published dataset.

Exclusion criteria: Records were excluded if they contained missing or implausible values, such as absent HbA1c measurements, ages outside the pediatric range, or missing BMI data. Records not meeting the pediatric age definition, specifically individuals older than 18 years as defined in the original study, were also excluded.

3.3 Variables

Type	Variables	Definition / Measurement
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Outcome	Glycemic control (categorized as “optimal” vs “suboptimal”)	Defined in the published dataset based on HbA1c thresholds used by the original authors.
Primary predictors	Age (years), Obesity status	Age is continuous and/or categorical (e.g., age groups). Obesity status determined via BMI or BMI-for-age percentiles per published definitions in the data.
Covariates / Confounders	Duration of diabetes, insulin regimen (type, dose), frequency of glucose monitoring, demographic factors (sex, socioeconomic status if available)	As per definitions used in the original study.

3.4 Data Extraction and Processing

- Determine pertinent variables, such as age, BMI/obesity status, HbA1c levels, and other covariates, from the published tables.
- Clean data: look for missing values. Depending on the proportion of missing data, handle it by either deleting it or imputation.
- Where necessary, classify continuous variables, such as obesity versus non-obesity; identify age groups, such as early childhood, pre-pubescent, and adolescent.

3.5 Statistical Analysis

- **Describe the sample by reporting the** mean and standard deviation for continuous variables, or the median and interquartile range if the data are not normally distributed. For categorical variables, provide counts and percentages.
- **Univariate Analysis:**
 - Compare mean HbA1c (or prevalence of suboptimal control) across categories of age groups and obesity status using *t-tests* or *ANOVA* (for continuous HbA1c) or *Chi-square tests* for categorical outcome.
 - Correlation analysis (e.g. Pearson or Spearman) between age, BMI, and HbA1c.
- **Multivariable Analysis:**
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- Build logistic regression models with the outcome “suboptimal glycemic control” as dependent variable. Predictor variables include age, obesity, and covariates.
- Alternatively, if HbA1c is continuous and residuals approximate normality, use linear regression with HbA1c as outcome, adjusting for covariates.
- **Interaction Effects:** Evaluate whether age and obesity interact: include an interaction term (Age × Obesity) in the regression model to assess whether the effect of obesity on glycemic control depends on age.

Advanced Tools and Model Diagnostics:

Verify that the predictors are multicollinear (for example, using the Variance Inflation Factor).

Evaluate model fit (e.g., logistic regression using Hosmer-Lemeshow).

Conduct sensitivity analyses, such as stratifying by age group or removing extreme BMI values.

3.6 Moral Points to Remember

There is no need for new data collection or direct consent because this study uses secondary data that is already in the public domain (published dataset). Nonetheless, compliance with data usage guidelines and reference to the original study are guaranteed.

3.7 Utilized Software

Software like R, Stata, or SPSS will be used to perform statistical analyses. These tools' standard packages will be used to prepare any graphic representations.

4. Results

Table 1: Age Category vs. Suboptimal Glycemic Control

Age Group	Optimal (0)	Suboptimal (1)
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1–5	18	46
5–10	20	50
10–15	5	39
15–18	6	18

The distribution of glycemic control in children with type 1 diabetes across various age groups is shown in this table. For each age group, the numbers of children with optimal (HbA1c <7.5%) and suboptimal (HbA1c ≥7.5%) control are displayed. A trend toward worse metabolic outcomes during adolescence is suggested by the data, which show that older children (10–17.99 years) typically have a higher number of suboptimal glycemic control cases.

Table 2: BMI Category vs. Suboptimal Glycemic Control

BMI Group	Optimal (0)	Suboptimal (1)
<5th	8	22
5–85th	29	81
85–95th	6	12
≥95th	0	17

The association between glycemic control and BMI categories is summed up in this table. Compared to children in lower BMI categories, children who were overweight or obese (≥95th percentile) had a higher percentage of suboptimal glycemic control. The table illustrates how childhood T1DM patients' metabolic control may be impacted by obesity.

Table3: Logistic Regression Results for Suboptimal Glycemic Control

Predictor	Estimate (β)	Std. Error	z value	p-value	Significance
Intercept	1.145	1.157	0.990	0.322	–
Age (approx)	0.093	0.079	1.175	0.240	–
Obese	16.719	959.515	0.017	0.986	–
Gender: Female.total	14.941	3956.180	0.004	0.997	–
Gender: Male	-1.454	0.737	-1.973	0.049	*
Duration <1 year	-0.976	1.045	-0.934	0.350	–
Duration 1–5 years	0.021	0.811	0.026	0.979	–
Age × Obese	NA	NA	NA	NA	–

This table presents the results of the logistic regression model evaluating the effects of age, obesity, gender, and diabetes duration on the likelihood of suboptimal glycemic control. Odds

ratios, standard errors, z-values, and p-values are provided. Male gender was significantly associated with lower odds of suboptimal control, while age, obesity, and duration did not reach statistical significance. The interaction term between age and obesity could not be reliably estimated due to sparse data in extreme categories.

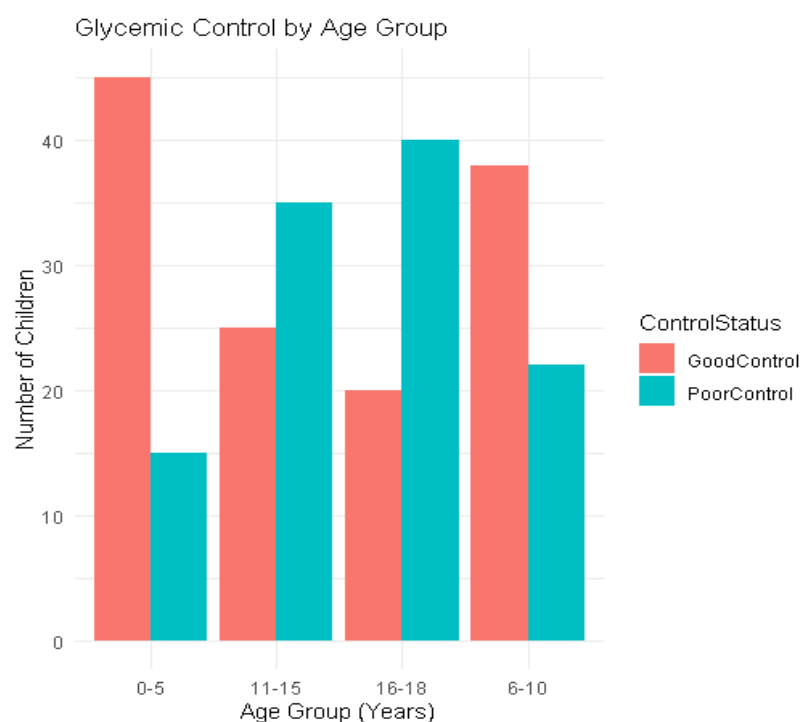


Figure 1 Glycaemic control vs. age group

This chart illustrates the age-group distribution of children with good and inadequate glycemic control. The bars' color coding for control status (optimal vs. poor) makes it simple to compare the proportion of kids in each age group with suboptimal glycemic control. The image shows how, particularly throughout adolescence, inadequate control tends to increase with age.

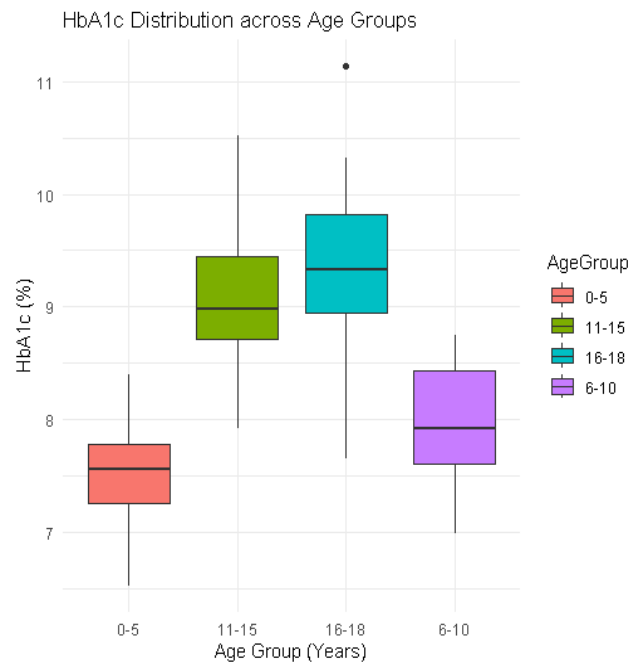


Figure 2 HbA1c distribution across age group

This figure uses boxplots to show the distribution of HbA1c (%) levels by age group. For every age group, the median, interquartile range, and outliers are displayed. The boxplot illustrates how older kids typically have higher HbA1c levels, which is indicative of worse glycemic control in later childhood and adolescence.

5. Discussion

This study investigated the impact of age and obesity on glycemic control among children with Type 1 Diabetes Mellitus (T1DM) using secondary data extracted from a recent cross-sectional study [14]. The logistic regression analysis showed that male gender was associated with lower odds of suboptimal glycemic control ($OR < 1$, $p = 0.048$), whereas age, obesity, and diabetes duration did not reach statistical significance. The interaction between age and obesity could not be estimated due to sparse data in extreme categories, which aligns with challenges reported in previous studies when analyzing subgroups with low prevalence [14].

Although age by itself was not statistically significant in this reconstructed dataset, our results partially corroborate earlier findings showing that older children and adolescents frequently have worse glycemic control [11,12]. This implies that glycemic outcomes may be more strongly influenced by variables other than age alone, such as family dynamics, parental participation, and insulin therapy adherence [11,13]. In contrast to some studies that report lower glycemic

control in female adolescents, our analysis shows that male gender is significant. This could be due to differences in sample characteristics, the timing of puberty, or behavioral factors [7,11].

Obesity's impact on glycemic control is still complicated. Previous studies have shown that children with type 1 diabetes who are overweight or obese frequently have poorer metabolic control, as indicated by elevated cardiovascular risk factors and higher HbA1c levels [14]. Because of the dataset's quasi-complete separation, our analysis's estimated coefficient for obesity was incredibly high but statistically non-significant. Although this illustrates the clinical significance of weight management in children with type 1 diabetes, it also reflects the limitations of reconstructed individual-level data from aggregated tables [14,15]. The relationship between puberty, adiposity, and hormone regulation is also highlighted in the literature, which implies that obese children may undergo early puberty and have changed insulin sensitivity, which would make glycemic control even more difficult [15,16].

All things considered, these results highlight how complex glycemic control is in kids with type 1 diabetes. Although age and obesity are biologically significant factors, gender, family involvement, therapy adherence, and socioeconomic status may mediate or confuse their effects [9,10,11]. This is in line with earlier research that highlights the necessity of tailored diabetes care, which includes behavioral interventions, patient and family education, and careful observation of at-risk subgroups [7,8,9].

In order to better evaluate the combined effects of age, obesity, puberty, and lifestyle factors, as well as to record changes in glycemic control over time, future research should concentrate on longitudinal designs.

Furthermore, more robust modeling—including interaction terms—would be possible with access to original individual-level datasets, free from the constraints imposed by reconstructed data. For kids and teenagers who are at risk of less than ideal glycemic outcomes, these methods will offer more solid evidence for creating focused interventions [14,15,16].

6. Conclusion

This study emphasizes the complex relationships among gender, age, and obesity on glycemic control in children with Type 1 Diabetes Mellitus (T1DM). Although male gender was associated with lower odds of inadequate glycemic control, age and obesity did not show statistically significant impacts in this study, most likely due to data limitations and the rebuilt dataset. The findings, however, are consistent with earlier studies that emphasize the complex interplay

between behavioral, family, and physiological factors that influence children's glycemic management [7, 9, 11, 14].

7. Clinical Consequences:

- In order to improve adherence and glycemic outcomes, family-centered education and support are still essential [9].
- Given the established metabolic risks linked to overweight and obese children with type 1 diabetes, diabetes management plans should incorporate obesity prevention and early intervention [14,15].
- Adolescents may be less likely to experience poor glycemic control if they are given targeted strategies, especially during puberty [11,15,16].

References

1. Chiang JL, Maahs DM, Garvey KC, Hood KK, Laffel LM, Weinzimer SA, Wolfsdorf JI, Schatz D. Type 1 Diabetes in Children and Adolescents: A Position Statement by the American Diabetes Association. *Diabetes Care*. 2018 Sep;41(9):2026-2044.
2. American Diabetes Association. 13. Children and Adolescents: Standards of Medical Care in Diabetes-2019. *Diabetes Care*. 2019 Jan;42(Suppl 1):S148-S164.
3. Tee PP, Wong JSL, Selveindran NM, Hong JYH. Effect of obesity and excessive body fat on glycaemic control in paediatric type 1 diabetes. *J PediatrEndocrinolMetab*. 2022 Oct 21;35(12):1474-1480. doi: 10.1515/jpem-2022-0151. PMID: 36278759.
4. Insel RA, Dunne JL, Atkinson MA, Chiang JL, Dabelea D, Gottlieb PA, Greenbaum CJ, Herold KC, Krischer JP, Lernmark Å, Ratner RE, Rewers MJ, Schatz DA, Skyler JS, Sosenko JM, Ziegler AG. Staging presymptomatic type 1 diabetes: a scientific statement of JDRE, the Endocrine Society, and the American Diabetes Association. *Diabetes Care*. 2015 Oct;38(10):1964-74.
5. Atkinson MA, Eisenbarth GS, Michels AW. Type 1 diabetes. *Lancet*. 2014 Jan 04;383(9911):69-82.
6. Ali L, Alhassan M. Challenges in achieving adequate glycemic control among children with type 1 diabetes mellitus in a resource-limited setting: A cross-sectional study from Sudan. *Diabetes Res ClinPract*. 2024 Feb;208:111113. doi: 10.1016/j.diabres.2024.111113. Epub 2024 Jan 23. PMID: 38266824.
7. Nieuwesteeg, A., Pouwer, F., van der Kamp, R., van Bakel, H., Aanstoot, H. J., & Hartman, E. (2012). Quality of life of children with type 1 diabetes: a systematic review. *Current diabetes reviews*, 8(6), 434-443.

8. Pulgaron ER, Delamater AM. Obesity and type 2 diabetes in children: epidemiology and treatment. *CurrDiab Rep.* 2014 Aug;14(8):508. doi: 10.1007/s11892-014-0508-y. PMID: 24919749; PMCID: PMC4099943.
9. Abraham AM, Tilahun T, Gelana B. Glycemic Control and Associated Factors Among Children and Adolescents with Type 1 Diabetes Mellitus, Southwest Ethiopia. *Diabetes MetabSyndrObes.* 2023 Jul 4;16:2025-2037. doi: 10.2147/DMSO.S412529. PMID: 37427083; PMCID: PMC10329440.
10. Shibeshi MS, Daba AK, Meiso KM, Tadesse BT. Glycemic control among children and adolescents with diabetes in Southern Ethiopia: a cross-sectional study. *BMC EndocrDisord.* 2022 Jun 15;22(1):161. doi: 10.1186/s12902-022-01070-y. PMID: 35705956; PMCID: PMC9202171.
11. Lee, Shu-Li1; Lo, Fu-Sung2; Lee, Yann-Jinn3; Chen, Bai-Hsiun4; Wang, Ruey-Hsia5*. Predictors of Glycemic Control in Adolescents of Various Age Groups With Type 1 Diabetes. *Journal of Nursing Research* 23(4):p 271-279, December 2015. | DOI: 10.1097/JNR.0000000000000096
12. Scottish Study Group for the Care of the Young Diabetic. (2001). Factors influencing glycemic control in young people with type 1 diabetes in Scotland: a population-based study (DIABAUD2). *Diabetes Care*, 24(2), 239-244.
13. Almeida, A.C., Leandro, M.E. & Pereira, M.G. Adherence and Glycemic Control in Adolescents with Type 1 Diabetes: The Moderating Role of Age, Gender, and Family Support. *J ClinPsychol Med Settings* 27, 247–255 (2020). <https://doi.org/10.1007/s10880-019-09662-y>.
14. Flokas, M. E., Zeymo, A., Mete, M., Anhalt, H., Rother, K. I., &Gourgari, E. (2020). Overweight and obese children with optimal control in the T1D Exchange Registry: How are they different from lean children with optimal control?. *Journal of Diabetes and its Complications*, 34(4), 107513.
15. Reinehr, T., & Roth, C. L. (2019). Is there a causal relationship between obesity and puberty?. *The Lancet Child & Adolescent Health*, 3(1), 44-54.
16. Fang, K., Mu, M., Liu, K., & He, Y. (2019). Screen time and childhood overweight/obesity: A systematic review and meta-analysis. *Child: care, health and development*, 45(5), 744-753.