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Impact of COVID-19 Lockdown on Glycemic Control and Lifestyle Changes in Greek Children with Type 1 Diabetes Mellitus

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Abstract: In 2019, due to the global pandemic of the new coronavirus (SARS-CoV-2), lockdown was imposed in Greece. Children with Type 1 Diabetes (T1D) during that period had to maintain a good level of glycemic control despite the subversive changes in their lives. The aim of this study was to assess the impact of lockdown on glycemic control and lifestyle changes of children with type 1 diabetes. The present cross-sectional study included 59 children with T1D who measured their glucose levels through glucose monitoring systems (Continuous Glucose Monitoring (CGM) and Flash Glucose Monitoring (FGM)). Their glycemic profile and demographic data were recorded in three different periods (before, during and after the lockdown). The changes in their daily routine were farther investigated through a short questionnaire which assesses changes in lifestyle-related behavior during COVID 19 pandemic. A significant improvement was noted in the glycemic control of children with T1D during the restrictive measures. Boys scored higher on scale of lifestyle behavior changes during the pandemic (-0.1 vs. -0.3, p=0.015). The results of this study highlight the need for continuous education and insistence on children's adherence with the treatment plan and the beneficial effects of using the new technology for easier monitoring.

Keywords: Children Diabetes Mellitus Type 1; Lockdown; Coronavirus; COVID-19; Glycemic control

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1. Introduction

On December 31st of 2019, the World Health Organization (WHO) announced a new disease, COVID-19, caused by the coronavirus, SARS-CoV-2 after several reports of massive viral pneumonia in the city of Wuhan in China [1]. The COVID-19 symptoms vary, ranging from mild symptoms, like those of the common cold, to severe respiratory distress and in serious cases the death. Some of the underlying medical conditions that increase a person's risk of severe illness from COVID-19 are: Cancer, chronic kidney disease, chronic liver disease, chronic lung disease, cystic fibrosis, neurological disease, Diabetes Mellitus (type 1 or 2), disabilities, cardiovascular disease, stroke, HIV infection, immunocompromised patients, anemia, mental disorders, overweight, obesity, pregnancy, smoking and substance use disorder [2].

Meanwhile guidelines from the Centers for Disease Control and Prevention (CDC) state that patients with Diabetes Mellitus (DM) type 1 or 2 are more likely to develop serious complications if they get COVID-19 [3]. A meta-analysis carried out by Chinese researchers states that DM patients who infected with COVID-19 had more risk of ICU admission [4].

On March 24th of 2020, the International Society of Pediatric and Adolescent Diabetes (ISPAD) records that according to studies by pediatric endocrinologists in China and Italy, no cases of COVID-19 in young people with Diabetes Mellitus requiring hospitalization, have been observed [5]. The importance of continuous care for children with DM in order to avoid emergency situations is

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underlined. Moreover, there has been a rapid development of telemedicine, a method that provides virtual the necessary advice and guidelines for the management of the disease, reducing the risk of virus spread and infection.

Greece implemented urgent local restrictive measures on February 28th, 2020, with the first lockdown starting on March 23rd, 2020. These measures included the temporary pause of educational institutions by region, the respite of all flights from and to Italy, the closure of entertainment venues, and the ban on cultural events. Subsequently, shopping malls, cafes, bars, museums, sports facilities, and restaurants were also closed [2].

During the second wave of the pandemic, nationwide restrictions were imposed on November 7th, 2020. All educational institutions were closed until January 11th, 2021, and secondary education institutions reopened on February 1st, 2021. However, in March 2021, due to a rapid increase of patients with COVID-19, all educational institutions and shops were temporarily respite. Finally, on May 10th, 2021, schools, including kindergartens, primary, middle, and high schools, reopened with mandatory self-testing for COVID-19 twice a week and strict protective measures inside the place [6].

Throughout these periods of measures and restrictions, patients with DM had to maintain good glycemic control despite the disruptive changes in their lives. Maintaining adequate glycemic control was equally crucial for children with Type 1 Diabetes and their families as they isolated at home, discontinued school attendance, and could no longer participate in their regular daily activities. The aim of this study was to investigate the self-management of glucose levels of school-aged children with Type 1 DM by utilizing glucose monitoring systems before, during, and after the lifestyle changes brought about by the COVID-19 pandemic.

2. Materials and Methods

Patients and Study Design

A cross-sectional descriptive study of correlations was carried out in the period 2021-2022. The final sample of the study consisted of 59 children of which 42 followed at a Public Children's Hospital of Athens and 17 followed by pediatricians-endocrinologists of a Private Hospital in Athens. The study was performed in accordance with the Helsinki Declaration and was approved by the Ethics Committee of the Nursing Department of University of Athens (UOA), as well as by the Scientific and Administrative Council of the Public Children's Hospital of Athens. Participants and/or their parents were informed about the purpose of the study and completed an informed consent form.

The children participating in the study were aged 6-18 years, they have been diagnosed with T1D for at least more than 6 months, they had stopped attend to school due to restrictions at the period of 2020-2021 and when the restrictive measures were lifted, they returned to the school environment. Also, they were users of glucose monitor systems so data from past periods can be accessed. Specifically, 55 children used the FreeStyle Libre system, and 4 children the Guardian™ Connect. Exclusion criteria were a) children who did not return to school after the lifting of restrictive measures, and b) desire to break off the study.

We used a 20-item Likert-type questionnaire by Kumari, A et al.,[7] regarding children's habits during Covid-19 to assess changes in their lifestyles during the national lockdown. We validated the questionnaire in the Greek population, after asking the permission from the creators to use and to translate it from English to Greek, and vice versa.

A data collection form based on predefined documentation was used for the collection of demographic characteristics of the participants and a second one were completed the recorded data of the participants concerning the clinical characteristics (mean glucose, time in target range (TIR), time above target range (TAR), time below target range (TBR), and hypoglycemic events) and for three different time periods (at October 2020 before the restrictive measures, during the restrictive measures at April 2021, and after the restrictive measures at May). Clinical characteristics were uploaded by digital system that allows the healthcare professional to remotely access the patient's glucose data.

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For statistical analysis and graphical demonstration SPSS 22.0. was used. The means and Standard Deviation (SD) were used to describe the quantitative variables. Absolute (N) and relative (%) frequencies were used to describe qualitative variables. Normality of the distributions was checked with the Kolmogorov – Smirnov criterion. Cronbach's α index was used to test the reliability of the resulting factor measurements. For the comparison of quantitative variables between two independent groups, the parametric Student's T-test was used, while the Wilcoxon test was used for the comparison of quantitative variables between two dependent groups. To compare quantitative variables between more than two groups, ANOVA test was used. To check for type I error, due to multiple comparisons, the Bonferroni correction was used whereby the significance level is 0.05/κ (κ= number of comparisons). The Mc Nemar test was used to compare two qualitative dependent variables. Pearson's or Spearman's correlation coefficient (rho) was used to test the relationship between two quantitative variables. Stepwise linear regression analysis was used to find independent factors associated with the score of the scale of assessment of lifestyle changes during the COVID–19 pandemic from which dependence coefficients were derived (b) and their standard errors (SE). A p value of 0.05 or less was considered statistically significant.

3. Results

3.1.1. Descriptive Characteristics

Fifty-nine kids and adolescents were enrolled in the study of which 57.6% (n=34) were girls. Demographic and anthropometric characteristics of the studied population are presented in Table 1. The mean age of the children was 12.1 years (SD = 3.5 years) while the T1D median duration of the participants was 4.3 years (Range = 2.5 – 6 years). The 45.8% of the children attended primary school and 93.2% had Greek nationality. The mean Body Mass Index (BMI) of the children was 21.1 kg/m2 (SD=3.3 kg/m2).

Table 1. Descriptive demographic and anthropometric characteristics of the sample.

Characteristics		N	%
Sex	Boys	25	42.4
	Girls	34	57.6
Age (years), *range (6-18yrs)*		Mean 12.1 yrs (SD=3.5)	
Duration of Diabetes (years), *range (2.5 – 6 yrs)*		Mean 4.3 yrs (SD=2.6)	
Diabetes Treatment - Multiple Daily Injections		59	100
Celiac disease		4	6.7
Education level			
Level in Primary school		27	45.8
	A	7	11.9
	B	3	5.1
	C	5	8.5
	D	4	6.8
	E	4	6.8
	ST	4	6.8
Level in Junior High school		15	25.4
	A	7	11.9
	B	5	8.5
	C	3	5.1

Level in High school		17	28.8
	A	7	11.9
	B	6	10.2
	C	4	6.8
Nationality	Greek	55	93.2
	Cypriot	0	0.0
	Albanian	2	3.4
	Other	2	3.4
Body mass index (kg/m²)		Mean 21.1kg/m² (SD=3.3)	

3.1.2. Lifestyle Changes during Pandemic

During the COVID-19 pandemic, the 37.3% of children showed a "slightly" to "significantly increased" probability of skipping one of the main meals, and 47.5% experienced a "slightly or significantly increased" snacking habit between meals. The 47.5% of the participants had a "Grossly similar" habit in the amount and portions of meals and snacks they consumed, and 54.2% of the children maintained a balanced diet that included whole grains, legumes, eggs, nuts, fruits, and vegetables. About the 30% of the sample experienced during the COVID pandemic, "slightly to significantly decreased" consumption of junk / fast food as well as fried food, while 43.9% maintained a "similar" frequency of consumption as in the period before the pandemic. In addition, 30.5% and 42.4% showed "slightly to significantly increased" their intake of sugar-sweetened beverages (carbonated soft drinks, sugar-sweetened juices) and general consumption of sweets, candies, and chocolates respectively. The 62.7% showed "Grossly similar" participation in cooking new or traditional recipes and 27.1% showed "increased" consumption of unhealthy foods when bored or stressed or upset during the COVID pandemic. However, the 47.5% adhered to their habit.

Also, 25.4% showed on the one hand an "increased" intake of foods that enhance immunity and the intake of dietary supplements to strengthen their immune system. The largest percentage had a "Grossly similar" habit (57.6%). In addition, 28.8% "slightly increased" to "significantly" their family and friends support in healthy eating and 33.9% their interest in learning healthy eating tips from the media. 62.7% decreased their participation in aerobic exercise and 38% their participation in leisure and household chores during the COVID pandemic. Sedentary time and screen time increased for 84.7% of the sample and sleep hours increased for 64.4%. However, sleep quality remained stable for 53.4% of the sample. Finally, 59.3% of the sample showed "increased" levels of stress and anxiety (Table 2).

Table 2. Lifestyle related behaviour changes during pandemic.

Behaviour changes during COVID pandemic	Slightly to Significantly
1. how has your probability of skipping one of the main meals (breakfast/lunch/dinner) changed?	37.3% increased
2. how has your habit of snacking between meals changed?	47.5% increased
3. how has your quantity/portions of meals and snacks changed?	47.5% "Grossly similar"
4. how has your daily intake of fruits and vegetables changed?	54.2% "Grossly similar"
5. how has your intake of a balanced diet (including healthy ingredients such as whole	54.2% "Grossly similar"

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wheat, pulses, legumes, eggs, nuts, fruits and vegetables) changed?	
6. how has your consumption of junk food/fast food and fried food changed?	30% decreased
7. how has your intake of sugar-sweetened beverages (carbonated soft drinks, sugar-sweetened juices) changed?	30.5% increased
8. how has your consumption of sweets/candies/chocolate changed?	42.4% increased
9. how has your participation in cooking new/traditional recipes changed?	62.7% "Grossly similar"
10. how has your consumption of unhealthy food when you are bored or stressed or upset changed?	27.1% increased
11. how has your intake of immunity-boosting foods (lemon, turmeric, garlic, citrus fruits and green leafy vegetables) in the diet changed?	25.4% increased
12. how has your intake of nutrition supplements to boost immunity changed?	57.6% "Grossly similar"
13. how has the support of your family and friends in eating healthy changed?	28.8% increased
14. how has your interest in learning healthy eating tips from the media (newspaper articles/magazines blogs/videos/TV shows/text messages) changed?	33.9% increased
15. how has your participation in aerobic exercise changed?	62.7% decreased
16. how has your participation in leisure and household chores changed?	38% decreased
17. how has your sitting and screen time changed?	84.7% increased
18. how have your hours of sleep changed?	64.4% increased
19. how has your quality of sleep changed?	53.4% "Grossly similar"
20. how have your stress and anxiety levels changed?	59.3% increased

3.1.3. Glycemic Assessment between Three Time Periods

The Table 3 presents the variables related to time "within", "above", and "below" of the target range, as well as the number of hypoglycemic events experienced by participants during three different periods.

Comparisons of values for glucose levels within the target range were conducted across all three measurement periods, and no statistically significant difference ($p > 0.001$) was found. However, the largest percentage of participants who managed to maintain glucose levels within the target range was observed after the lockdown. Specifically, it was found that 35.7% of children had glucose levels within the target range before the lockdown, compared to 33.9% of the sample that had target glucose

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levels during the lockdown (p=0.312), and compared to 39.6% of the sample after the lockdown (p=0.234) (Table 3)

Table 3. Glycemic Profile Data at 3 different periods.

	N	%	P1	P2	P3
Glucose levels within target					
Before lockdown	20	35.7	0.312		0.234
During lockdown	19	33.9		0.375	
After lockdown	21	39.6			
TIR (time on target)					
Before lockdown	14	25.0	**0.003**		0.070
During lockdown	26	47.3		**0.016**	
After lockdown	18	34.6			
TAR (Time Above Target)					
Before lockdown	22	39.3	**0.035**		0.121
During lockdown	30	54.5		0.164	
After lockdown	25	48.1			
TBR (Time Below Target)					
Before lockdown	35	62.5	0.109		0.070
During lockdown	40	72.7		**0.016**	
After lockdown	29	55.8			
Increase in episodes of hypoglycaemia					
After lockdown compared to before	28	54.9	0.193		**0.006**
After the lockdown compared to During	31	59.6		**0.010**	
During lockdown compared to Before	18	34.6			

P1: Before lockdown vs During lockdown, P2: During lockdown vs After lockdown, P3: Before lockdown vs After lockdown, + *McNemar test.*

Normal TIR values before the lockdown were observed in 25% of the sample, while 47.3% had normal TIR values during the lockdown (p = 0.003), and 34.6% had them after the lockdown (p = 0.070). Comparing TIR between the time periods during and after the lockdown, a statistically significant difference was found (p = 0.016). (Table 3)

Normal TAR values before the lockdown were observed in 39.3% of the sample, while during the lockdown, this figure was 54.5%, indicating a statistically significant relationship between the two periods (p = 0.035). After the lockdown, 48.1% had normal TAR values (p = 0.121). No statistically significant difference was found between the periods during and after the lockdown (p = 0.164). (Table 3)

Normal values of TBR before the lockdown were present in 62.5% of participants, during the lockdown, this percentage increased to 72.7% (p = 0.109), and after the lockdown, it decreased to 55.8% (p = 0.070). However, a statistically significant relationship was observed between the periods during and after the lockdown (p = 0.016). Finally, 54.9% of the sample exhibited an increase in hypoglycemia episodes after the lockdown compared to before, with a statistically significant difference (p = 0.006). When comparing the hypoglycemia episodes after the lockdown to during the

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lockdown, 59.6% experienced an increase (p=0.010), while during the lockdown compared to before, 34.6% of the participants did so without a statistically significant difference (p = 0.193). (Table 3)

There were statistically significant differences in time spent within the target range (TIR %), time spent below the target range (TBR %), and the occurrence of hypoglycemia events among participants after the lockdown compared to during the lockdown period (p=0.040, p=0.004, p=0.009, respectively). Specifically, participants had a higher percentage of time within the target range (%) during the lockdown (SD=65.5) compared to post-lockdown (SD=64.1) period. However, participants had higher rates of time spent below the target range (SD=4.8) and experienced more hypoglycemia events (SD=10.2) post-lockdown compared to during the lockdown (SD=3.5, SD=7.6, respectively). (Table 4)

Table 4. Glycemic profile results during and after Lockdown.

	During LOCKDOWN period (April)		After LOCKDOWN period (May)		P
	Mean (SD)	**Median (Ind. range)**	**Mean (SD)**	**Median (Ind. range)**	
Mean glucose	152.3 (36.7)	149.5 (125-175.5)	153.9 (33.7)	150 (130-179)	0.885
Time within target range (%)	65.6 (19.4)	68 (51-81)	64.1 (19.8)	66 (50–79.5)	**0.040**
Time above target range (%)	30.8 (19.2)	26 (13-43)	31.1 (19.9)	30.5 (14–45.5)	0.622
Time below target range (%)	3.5 (3.7)	2 (1-5)	4.8 (4.2)	4 (1.5–6.5)	**0.004**
Hypogly caemia events	7.6 (6.1)	7 (3.5-10)	10.2 (9.9)	6 (4-14)	**0.009**

+ Wilcoxon test.

There was no statistically significant correlation found between the ratings of participants on the scale assessing lifestyle behavior changes during the COVID-19 pandemic and age, Body Mass Index (BMI), as well as the duration of diabetes illness and other demographic and anthropometric characteristics. (Table 5)

Table 5. The rating of participants on the scale assessing changes in lifestyle behavior during the COVID-19 pandemic according to their demographic information.

		Scoring in the questionnaire of lifestyle behaviour		P
		(SD)	**Median (Ind. Range)**	
Sex	Boy	-0.1(0.3)	-0.2 (-0.3–0.1)	**0.015+**
	Girl	-0.3(0.3)	-0.3 (-0.5- -0.1)	
Education level	Primary school	-0.2(0.3)	-0.2 (-0.4–0)	0.452‡

	Junior High school	-0.1(0.4)	-0.1 (-0.3–0.2)	
	High school	-0.3(0.3)	-0.3 (-0.5- -0.2)	
Greek nationality	Yes	-0.2(0.3)	-0.2 (-0.4– 0)	0.461+
	No	-0.4(0.5)	-0.2 (-0.6- -0.1)	
Live in Attica or Thessaloniki?	Yes	-0.2(0.4)	-0.2 (-04–0)	0.613+
	No	-0.3(0.3)	-0.2 (-0.4- -0.1)	

‡ ANOVA + Student's t-test.

A statistically significant difference (p = 0.015) in the scores on the lifestyle change rating scale during the COVID-19 pandemic was observed based on gender. Specifically, a more significant change in participants lifestyle behavior during the COVID-19 pandemic was observed in boys compared to girls, with an average score on the lifestyle change assessment scale during the COVID-19 pandemic of mean = -0.1 (SD = 0.3) for boys versus mean = -0.3 (SD = 0.3) for girls. Therefore, girls had a worse lifestyle during the pandemic compared to boys.

The scale for evaluating lifestyle behavior changes during the COVID-19 pandemic showed a statistically significant correlation between those who achieved and those who did not achieve glucose levels within the target range after the lockdown (p=0.023). Specifically, participants whose glucose levels were on target after the lockdown showed greater improvements in lifestyle behavior during the COVID-19 pandemic (questionnaire score -0.1) compared to those whose glucose levels were off target after the lockdown (questionnaire score -0.3). In other words, their behavior improved, as indicated by the questionnaire score.

4. Discussion

The results of this study demonstrate an improvement in glycemic control among children with Type 1 Diabetes Mellitus during the COVID-19 pandemic's restrictive measures compared to before. Specifically, we observed significantly higher rates of children maintaining their glucose values within the target range, resulting in reduced time spent above and below the target range. However, there was a slight increase in episodes of hypoglycemia. Notably, this improvement persisted even after the lifting of restrictive measures compared to the period before the lockdown.

When comparing TIR and TAR values in our study between the period before and after the lockdown, we observed an improvement in glycemic control, but we also noted a significant increase in episodes of hypoglycemia. Remarkably, participants who maintained their glucose levels within the target range after the lockdown exhibited more pronounced changes in their lifestyle behavior during the COVID-19 pandemic than those whose glucose levels remained of target. The long-term changes in children's behavior and improved glycemic control during the lockdown can also be attributed to increased vigilance from parents. It is worth to note that due to the lockdown, many parents worked from home and dedicated more time to monitoring their children's glycemic regulation. In our point of view parents are responsible for coordinating, guiding, and supporting their child in adopting proper habits and daily activities related to diabetes management. Conversely, when a family's routine does not support the child's treatment plan and hinders compliance, it may lead to negative emotions and reactions that directly impact glycemic control. The statistically significant differences that emerged from our study can be highlighted as follows:

- Significantly higher percentages of normal TIR values (Time In Target) were observed during the lockdown than before the lockdown (p=0.003), as well as during the lockdown than after the lockdown (p=0.016).
- Higher percentages of normal TAR (Time Above Target) values were observed during the lockdown compared to before (p=0.035).

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- Furthermore, higher percentages of normal TBR (Time Below Target) values were observed during the lockdown compared to the post-lockdown period (p=0.016).
- Finally, statistically significant increases in the rates of hypoglycemic episodes were observed during the lockdown compared to before (p=0.006), both in relation to the rates of increase in hypoglycemic episodes after the lockdown compared to before (p=0.006) and with the rates of increase in hypoglycemic episodes after the lockdown compared to those who experienced hypoglycemic episodes during the lockdown (p=0.010).

Many decades back, according to Newbrough J.R. et. al (1985) and Anderson B.J. et. al (1980) noted that parental characteristics indirectly influence child's glycemic control. Specifically, anxious, overprotective, or uncaring parents can contribute to poor disease management [8,9].

Additionally, the reduction in physical activity among children affected more than half of the population, as sports facilities and group activities were suspended. UK guidelines recommend that children engage in at least 60 minutes of moderate to vigorous physical activity daily, aiming to improve cardiovascular health, maintain a healthy weight, promote bone health, and boost self-confidence [10].

For children with Type 1 Diabetes, physical exercise is an essential component of their treatment plan, and adherence is crucial for their well-being. However, Chimen M. et a., (2012) indicate that physical activity levels in children, including those with Type 1 diabetes, are often insufficient. This disparity may be due to the lack of clarity regarding the type, duration, and intensity of physical activity recommended for children with Type 1 Diabetes. Therefore, there is an urgent need to promote physical activity in this population [11].

On the other hand, sedentary time and screen time increased significantly across nearly the entire sample. The increased time spent on sedentary activities such as watching TV, using computers, and playing video games has been linked to an elevated risk of obesity and an unfavorable glycemic profile [12]. Excessive screen time is associated with increased snacking between meals, higher food consumption, reduced physical activity, and less rest. Additionally, the literature reports a correlation between increased screen time and heightened depressive symptoms [13].

Hossan MM et. al (2022) across their review reported that some important factors associated with child and adolescent mental health (CAMH) are age, gender, place of residence, educational attainment, household income, sedentary lifestyle, social media and internet use, comorbidities, family relationships, parents' psychosocial conditions, COVID-19 related experiences, closure of schools, online learning, and social support [14]. Another study has also observed that older children tend to spend more time in sedentary activities compared to younger children [15].

Changes in dietary patterns, including skipping main meals, altering mealtimes, and consuming certain types of foods, appeared to affect children's glycemic regulation. Frequent consumption of fast food and high-glycemic-index foods, combined with skipping regular meals, can disrupt glucose metabolism and lead to elevated postprandial sugar levels in subsequent meals [16]. Furthermore, increased consumption of ready-made meals has been linked to higher levels of glycosylated hemoglobin [17]. Meal composition plays a critical role in blood glucose control for individuals with type 1 diabetes. Postprandial sugar levels, especially after lunch and dinner, influence daily glucose control to some extent. Diets rich in fiber and with a low glycemic index promote a more stable metabolic profile, whereas high-fat and high-protein diets can impact glycemic stability. Changes in eating habits were observed during the lockdown, both in the general population and among individuals with type 1 diabetes. These changes were primarily attributed to movement restrictions and emotional shifts such as stress, sadness, isolation, and anxiety. Interestingly, some individuals with type 1 diabetes demonstrated improved eating habits characterized by more regular meal and snack schedules based on healthier dietary patterns, possibly due to increased time spent at home preparing meals [18].

Simultaneously, alterations in glycemic control were influenced by changes in sleep and wake habits resulting from school interruptions. In our sample, nearly 65% reported an increase in sleep hours. Perfect M.M. et al., (2012) have shown that individuals with type 1 diabetes experience more

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frequent and prolonged awakenings, which have been associated with increased glucose variability during the night. Specifically, in children with type 1 diabetes, frequent awakenings lead to daytime sleepiness, lower quality of life, symptoms of depression, and poorer academic performance [19] Additionally, research by Donga et al. (2010) concluded that sleep duration plays a significant role in insulin sensitivity in patients with type 1 diabetes [20].

A significant proportion of our sample reported increased levels of stress and anxiety, which can have detrimental effects on glycemic control. An earlier study conducted by Wiesli P. et al. (2005) demonstrated that acute mental stress led to a delayed decrease in postprandial glucose concentrations [21]. Similarly, in another correlational study by Griffith L.S. et al. (2005), it was found that individuals experiencing high stress levels and lacking social support faced three times more complications compared to those with lower stress levels and strong social support within the diabetes community [22]. Despite, Paula, J.S et al. (2017) identified a positive correlation between diabetes quality of life and mean glucose levels [23].

In our study, gender was also found to be significantly correlated with the rating score on the Lifestyle Changes Rating Scale during the COVID-19 pandemic, with girls exhibiting worse lifestyles during this period. The differences in diabetes management between genders have intrigued researchers. Setoodeh A. et al. (2011), following a cross-sectional study, concluded that female gender is a risk factor for poor glycemic control and complications in Type 1 Diabetes Mellitus, recommending more vigilant disease management for females [24]. Gerstl EM et.al, (2008) have also shown a significant correlation between glycemic control and gender, with girls having higher levels of glycosylated hemoglobin compared to boys [25]. This difference was attributed to higher rates of psychological problems and depression in girls, particularly during adolescence, as well as reduced insulin sensitivity [26].

Our study included children with Type 1 Diabetes who were able to monitor their condition remotely using glucose monitors, embracing new technologies. During the lockdown and the associated restrictive measures, there was an inconsistency in clinic visits for diabetes monitoring due to movement restrictions and concerns about overcrowding. However, patients who had access to remote monitoring, benefited from immediate data sharing with their treatment teams and received prompt guidance to adjust their treatment plans. The sense of commitment that patients feel when they receive real-time updates on their disease course may motivate them to adhere consistently to their treatment regimens. So many new users turned to technology for their safety, and the use of continuous glucose monitoring (CGM) for informing therapeutic and treatment decisions related to hypoglycaemia or hyperglycaemia, and glucose variability [27].

After all, as the number of individuals using new technologies increases, we believe that continuous monitoring and immediate intervention for changes in personalized disease management will become more accessible and transparent improving glycemic control and, subsequently, the quality of life for patients.

5. Conclusions

The findings from our study underscore the importance of continuous education and a strong emphasis on children's adherence to their treatment plans, especially during times of crisis. These efforts are essential for maintaining normoglycemia in pediatric patients with Type 1 Diabetes Mellitus.

Furthermore, our results highlight the advantages of utilizing new technologies such as glucose monitors. These technologies make monitoring easier, facilitate the sharing of glycemic profiles, and contribute to optimal glycemic control. As such, their adoption should be encouraged to improve the overall management of diabetes in children and adolescents.

6. Limitations

One of the most important limitations of our study was the use of flash or continuous glucose monitors in the study sample. These new technologies are specifically designed to optimize glycemic control. As a result, the findings of our study may not be applicable to all patients with Type 1

Diabetes Mellitus, but they can serve as valuable insights to improve monitoring conditions for individuals with diabetes.

Additionally, it is important to note that 18.6% of the sample used their glucose monitors for less than 70% of the recommended time, which could potentially impact the reliability of the data. Finally, the small size of the sample, the convenience sampling and snowball sampling, make the results obtained generalizable

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the Nursing Department of UOA, as well as by the Scientific and Administrative Council of the Public Children's Hospital of Athens. Participants and/or their parents were informed about the purpose of the study and completed an informed consent form.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data analyzed during the current study are not publicly available as this is beyond the scope of the ethics approval. The corresponding author may be contacted to provide anonymized data upon reasonable request.

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