

# Dual diagnosis of type 1 diabetes and ADHD

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## Introduction and Objectives

Attention-deficit/hyperactivity disorder (ADHD) is the most common neurobehavioral disorder of childhood and can profoundly affect the academic achievement, well-being, and social interactions of children.

Efficient cognitive skills, especially in the domain of executive functions, are needed for successful management of type 1 diabetes (DM1).

Dual diagnosis of DM1 and ADHD can lead to suboptimal diabetes control with its implications for development of acute complications (hypoglycemia and ketoacidosis) and long-term diabetes complications.

### Objectives of the study:

To compare metabolic control of DM1 patients with ADHD to DM1 patients without ADHD, including HbA1c, time in range, glucose variability.

To compare short term complications (severe hypoglycemia, DKA, hospitalization).

To compare quality of life.

## Methods

DM1 patients aged 6-18 years with a least 6 months duration of diabetes.

The study population comprised two groups:

- 1) The ADHD Group consisted of DM1 patients with previous and formal diagnosis of ADHD that was done by a professional.
- 2) The Control Group comprised DM1 patients without ADHD (after completing DSM5 ADHD questionnaire and ADHD was ruled out).

Diabetes QOL questionnaire was given to parents of all patients.

Diabetes data (glucosensors, glucometer, insulin-pumps) was downloaded to all patients

Data from the patients' files were retrieved.

## Results

The study cohort comprised 111 patients with T1DM: 27 were diagnosed with ADHD (24%) and 84 without ADHD (Control group) (table 1).

Mean±SD age of the ADHD group and Control group was 14.6±2.8 and 12.6±3.3 years, respectively (p=0.006).

Mean HbA1c was significantly higher in the ADHD group, 8.5±1.2 % vs. 7.8±1.0 % (p=0.003).

There was no difference in QOL and in severe hypoglycaemia or DKA events between the groups (table 1).

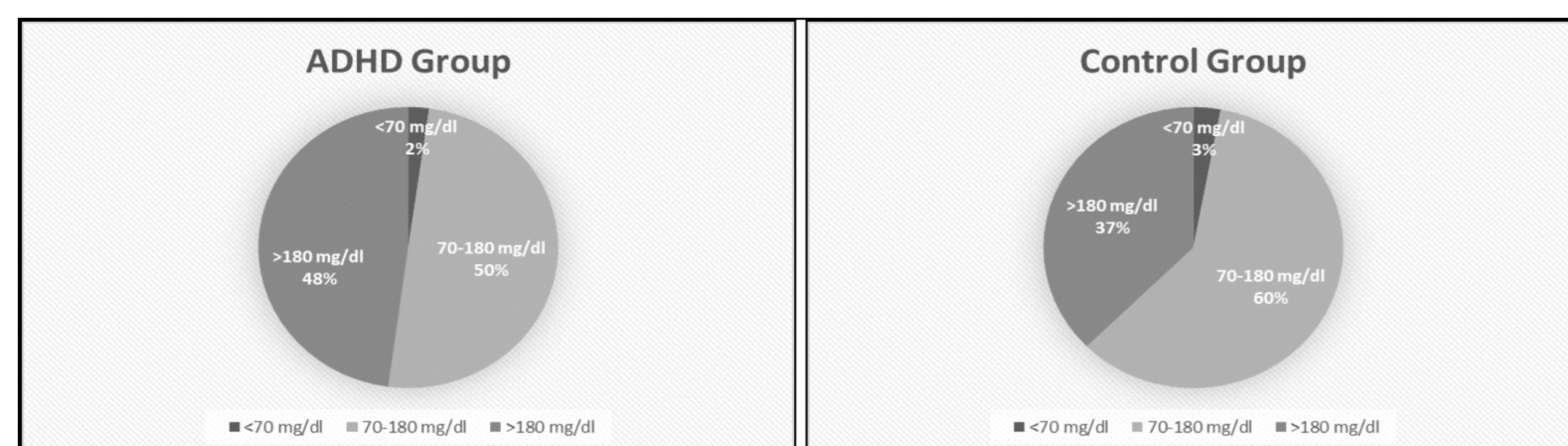
Among patients using CGM time in range (TIR) (70-180 mg/dl) was significantly lower in the ADHD group, 49±17% vs. 59±15% (p=0.05) (figure 1, table 2).

The following parameters retrieved from CGMs were significantly higher in the ADHD group vs. the Control group: mean glucose, SD of glucose, percentage time above 180 mg/dl, percentage time above 240 mg/dl, and in glucose variability parameters: ADRR, HBGI, MAGE (table 2).

### In a sub-analysis comparing between the Control Group, medically treated ADHD patients and medically untreated ADHD patients:

HbA1c was significantly higher in the untreated ADHD group compared to the control group. There were significantly more hospitalizations in the untreated ADHD group compared to the control group, and most of them were d/t DKA (table 3).

Mean SMBG values, SMBG percent values > 180 mg/dl and > 240 mg/dl were higher in the untreated ADHD group than in the treated ADHD group and the Control group



## Discussion

Coexistence of T1DM and ADHD during childhood leads to significantly higher HbA1c, TIR and glucose variability parameters compared to patients without ADHD.

Untreated ADHD patients seem to have worse glucose parameters and more short term complications.

Healthcare providers should be aware of the difficulties of patients with T1DM and ADHD to get organized and to cope with the current intensive treatment of diabetes.

Further studies are needed to examine the importance of medical treatment for ADHD as a strategy to improve diabetes control.

Table 1: Comparison of general measures between the Control group and the ADHD group

	Control N = 84	ADHD N = 27	p - value
Age - yrs	12.6 ± 3.3	14.6 ± 2.8	0.006
Gender male - no. (%)	47 (56)	15 (55.6)	0.971
Age at diagnosis of DM1 - yrs	7.6 ± 3.9	7.8 ± 3.8	0.819
Duration of DM1- yrs (IQR)	4.7 (1.9,7.1)	5.7 (2.8,9.6)	0.059
Pump use - no. (%)	67 (79.8)	23 (85.2)	0.531
CGM use - no. (%)	49 (58.3)	13 (48.1)	0.354
Last year mean HbA1c (%)	7.8 ± 0.98	8.5 ± 1.18	0.003
Severe Hypo - events (%)	2 (2.4)	2 (7.4)	0.223
Hospitalization- events (%)	3 (3.6)	5 (18.5)	0.009
QOL - score (IQR)	151 (134,161)	144 (129,152)	0.116

Table 2: Comparison of CGM data between the Control group and the ADHD group

	Control N = 49	ADHD N = 13	p1 value	p2 value
<b>CGM data</b>				
Mean glucose (mg/dl)	166 ± 28	183 ± 31	0.069	0.024
SD glucose (mg/dl)	64 ± 14	71 ± 15	0.124	0.028
70 - 180 mg/dl (%)	59 ± 15	49 ± 17	0.05	0.015
< 70 mg/dl (%)	2.9 (1.5,6.8)	2.2 (0.8,8.9)	0.510	0.835
< 55 mg/dl (%)	0.3 (0,1.5)	0 (0,1.6)	0.414	0.345
> 180 mg/dl (%)	37 ± 16	47 ± 19	0.073	0.025
> 240 mg/dl (%)	15 ± 11	22 ± 11	0.063	0.015
<b>Glucose Variability</b>				
CGM CV	38.5 ± 5.3	39.3 ± 8.8	0.775	0.422
ADRR	42.4 ± 9.7	46.3 ± 12.1	0.250	0.016
HBGI	29.9 ± 9.6	35.7 ± 10.4	0.073	0.009
LBGI	12.6 ± 6.7	10.7 ± 8.2	0.399	0.752
MAGE	153.3 ± 32.1	167.8 ± 30.3	0.164	0.042

p1 - univariate analysis (t-test and Man-Witney). p2 - between group differences after adjustment to age

Table 3: Comparison of general measures between Control Group, ADHD untreated group and ADHD treated group

	Control n-84	ADHD no Tx n-15	ADHD Tx N-12	P value
Age - years±SD	12.6 ± 3.3 <sup>a</sup>	14.8 ± 2.6 <sup>b</sup>	14.2 ± 3.2 <sup>ab</sup>	0.020
Onset of DM1 - age±SD	7.6 ± 3.9	7.3 ± 4	8.4 ± 3.5	0.075
Duration of DM1- years (IQR)	4.7 (1.9,7.1)	8 (4.6,10.4)	4.7 (2.7,9.5)	0.095
Pump use - number (percent)	67 (79.8)	14 (93.3)	9 (75)	0.396
CGM use - number (percent)	49 (58.3) <sup>a</sup>	4 (26.7) <sup>b</sup>	9 (75) <sup>a</sup>	0.028
Mean HbA1c	7.8 ± 0.98 <sup>a</sup>	8.6 ± 1.23 <sup>b</sup>	8.3 ± 1.15 <sup>ab</sup>	0.009
Last year - percent±SD				
Severe Hypo - events (percent)	2 (2.4)	1 (6.7)	1 (8.3)	0.463
Hospitalization- events (percent)	3 (3.6) <sup>ab</sup>	4 (26.7) <sup>a</sup>	1 (8.3) <sup>b</sup>	0.006
QOL - score (IQR)	151 (134,161)	137 (126,157)	146 (136,150)	0.278

Figure 2: CGM data of one of the treated ADHD patient in the study

