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ORIGINAL ARTICLE

Association between depressive symptoms in mothers and metabolic control in adolescents with type 1 diabetes

Asociación entre síntomas depresivos de las madres y control metabólico en adolescentes con Diabetes Mellitus tipo 1

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What do we know about the subject matter of this study?

Adolescents with Type 1 Diabetes Mellitus have poorer metabolic controls compared to other age groups, a phenomenon with a multifactorial basis. Some studies have shown an association between depressive symptoms in mothers and a poor metabolic control in their adolescent children.

What does this study contribute to what is already known?

In our population, there is a high prevalence of depressive symptoms in mothers of adolescents with Type 1 Diabetes Mellitus, showing also an association between these symptoms and metabolic control in the adolescent.

Abstract

Poor metabolic control in patients with Type 1 Diabetes Mellitus (T1DM) is associated with short- and long-term complications. Adolescents with T1DM present poorer metabolic control than patients of other age groups. Few studies have shown an association between mothers with depressive symptoms and the metabolic control of their adolescent children. **Objective:** To evaluate the association between maternal depressive symptoms and metabolic control of their adolescents with T1DM. **Subjects and Method:** Cross-sectional observational study carried out with adolescents aged between 10 and 18 years, with T1DM diagnosis of at least 1 year ago and their mothers. The Beck Depression Inventory-II and the SALUFAM questionnaire were applied, and sociodemographic data were collected. Glycosylated hemoglobin from capillary blood was used as a marker of metabolic control.

Keywords:
Type 1 Diabetes Mellitus; Depressive Symptoms; Glycated Hemoglobin; Adolescence; Mother

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Results: 86 couples (mother-adolescent children) were studied. The average age of the adolescents was 14.04 years and the average evolution time of T1DM was 5.95 years. 27.325.6% of mothers had depressive symptoms, which was associated with worse metabolic control of their children (HbA1c of 7.66% and 8.91%, p-value <0.001). 17.9% of adolescents had depressive symptoms, which was not associated with maternal depressive symptoms or worse metabolic control. Maternal depressive symptoms were also associated with lower maternal and paternal educational levels, high number of children in the family, presence of other siblings with chronic illnesses, and high health vulnerability (SALUFAM). **Conclusions:** The mother's depressive symptoms can be associated with worst metabolic control in T1MD adolescents. It is fundamental a multidisciplinary family approach to get better metabolic controls in T1DM adolescents.

Introduction

Type 1 Diabetes Mellitus (T1DM) is a chronic metabolic disease characterized by hyperglycemia secondary to insufficient or no insulin secretion by the pancreas. The incidence ranges from 0.5 to 52 per 100,000 inhabitants/year according to the population studied. There has been an exponential increase of T1DM cases worldwide during the last decades, with around 3% of annual growth[1], an increase that has also been observed in Chile[2].

Poor metabolic control in patients with T1DM is associated with micro and macrovascular complications. T1DM represents a cardiovascular risk factor where, in a 27-year follow-up, 15% of patients presented some cardiovascular event[3]. The higher the Glycosylated Hemoglobin (HbA1c), the higher the frequency of cardiovascular events, hospitalizations due to diabetic ketoacidosis[4], vulnerability of developing brain[5], and incidence and severity of microvascular complications, such as retinopathy[6-8], neuropathy, and diabetic nephropathy[9], resulting in a significant disease burden. Poor metabolic control during the initial period of the disease is associated with higher mortality, even in patients who later achieved HbA1c levels similar to other patients, which is known as 'metabolic memory'[10,11]. Therefore, maintaining good metabolic control from the early years of the disease is essential.

Adolescence is a critical stage, representing the period with the worst metabolic controls nationally[12] and internationally, reporting HbA1c levels above the target (> 7.5%) in 86% of Chilean adolescents with T1DM aged between 13 and 19 years[13]. This situation is the result of multiple factors that occur during adolescence, such as increased independence, social influences, decreased adherence to treatment, erratic eating and exercise habits, risk behaviors (alcohol and drug use), puberty hormonal changes, and weight gain[14].

The diagnosis of chronic disease, treatment regimes, and demanding controls, in addition to changes in family dynamics typical of adolescence, affect supervision patterns, resulting in difficulties in family interpersonal relations[15].

About 20% of parents with children diagnosed with T1DM develop major depressive disorder (MDD) and/or anxiety disorder between 1 and 4 years after diagnosis, showing a higher prevalence than the general population[15]. This is associated with increased risk of hospitalization due to acute diabetes complications[16] and risk of psychopathology in their adolescents[15]. Besides that, it has been shown that depressive symptoms are more frequent in pediatric patients with T1DM compared with the general population[17], which is related to worse metabolic control[18].

Other factors that affect HbA1c levels in pediatric patients are the socioeconomic and educational level of the parents[19], nutritional status of the patient, adherence to treatment, use of insulin injections versus insulin pumps[20], less glucose monitoring[12,21], use of antipsychotics drugs[22], less parental knowledge of T1DM[23], and parental fear of hypoglycemia[24].

Few studies, all of them conducted in the US population, have shown an association between parental depressive symptoms with poor metabolic control in adolescents with T1DM[25-28]. Studies have tried to explain how parental depressive symptoms affect metabolic control directly or indirectly. The study of Mackey et al[25] shows that depressive symptoms would decrease adolescent monitoring, which would result in less adherence and therefore worse metabolic control. In addition, Eckshtain et al[27] report that caregivers with T1DM would present excessive involvement in the care of the adolescent, increasing intrafamily conflicts. It is suggested that parental depressive symptoms affect metabolic control, even when the adolescent presents no depressive symptoms, and therefore, would have an effect independently of such symptoms.

The available guidelines for the management of T1DM in pediatric patients[29-31] propose a comprehensive approach of the child and her/his family, focusing

on education and family interventions to optimize cohesion and relationships. However, they do not include screening for parental depressive symptoms.

To date, there are no studies in Latin America, therefore, recognizing psychopathologies in parents may represent an opportunity for intervention that contributes to improving the worrying HbA1c levels observed in adolescents with T1DM in our sphere. The objective of this research is to analyze the association between maternal depressive symptoms and metabolic control in Chilean adolescents with T1DM. The secondary objectives are to establish the prevalence of depressive symptoms in adolescents with T1DM and their mothers, to evaluate factors associated with maternal depression, to determine the association between maternal and child depressive symptoms, and the association between child depressive symptoms and metabolic control.

Subjects and Method

Subjects

Cross-sectional observational study. Adolescents aged between 10 and 17 years, 11 months and 29 days, with a more than a one-year diagnosis of T1DM and their mothers were included for treatment in a public tertiary hospital and a private one in the Metropolitan Region. We excluded those adolescents or mothers diagnosed with a psychiatric disorder other than MDD or anxiety disorder, mother and/or the adolescent with an intellectual disability diagnosis that prevents them from answering the survey, and adolescent with severe comorbidities such as complex heart disease, cerebral palsy, cancer, or chronic use of oral corticosteroids. We used convenience sampling for selecting patients, including those who attended follow-up during the study period.

Assessed variables

Mothers answered the Beck Depression Inventory-II (BDI-II), a self-report questionnaire of depressive symptoms validated in Chile for those subjects over 13 years old[32]. Regarding the result of the BDI-II, it was considered suspicion of depression if the value was > 13, in order to achieve a high sensitivity as screening. The cut-off points for grading severity are mild (14-19), moderate (20-28), and severe (29-63)[33]. In addition, the SALUFAM questionnaire was applied[34], an instrument developed in Chile that measures agreement and family support and allows for the identification of families with greater vulnerability in health. It has been shown that the average cut-off point of 3.7 points differentiates between families with good and poor clinical outcomes in various health conditions.

Adolescents answered the Children's Depression Inventory (CDI), a self-report test of depressive symptoms that is widely used in children and adolescents with T1DM worldwide[35] and it is validated in Chile[36]. We consider 18 points as cut-off score since is the value established in the Chilean standardization. Both the BDI-II and the CDI report the presence of depressive symptoms during the two weeks before adolescents and their mothers answered the questionnaires. In addition, sociodemographic and clinical data were recorded to determine factors associated with maternal depressive symptoms.

HbA1C level was used as an estimate of metabolic control, which is the only validated test to estimate the quality of metabolic control in patients with T1DM and that shows the average glycemic levels over the last three months. In this study, the HbA1c from capillary blood (A1CNow®+, PTS Diagnostic, USA), which shows a good correlation with the HbA1c from venous blood, was measured simultaneously with the questionnaires[37].

Statistical analysis

The statistical analysis was performed using the SPSS V25.0 software (NY, USA). Averages and standard deviation (SD) were used to describe the numerical variables. The Mann-Whitney U test was used for numerical variables and the two-tailed Fisher's exact test for the categorical ones. Averages of HbA1c levels were compared among groups of mothers with and without suspected MDD through the Mann-Whitney U test. The Kruskal-Wallis test and posthoc Dunn's test were used to evaluate HbA1c levels according to the severity of the depressive symptoms.

A binary forward multivariate analysis was performed to adjust the variables (sex, another chronic disease in the adolescent, educational level of the mother, maternal and adolescent depressive symptoms, and health vulnerability) for the outcome of glycosylated hemoglobin (HbA1c) higher than 7.5. For the multivariate analyses, Odds ratio (OR) values were used with 95% confidence interval. Any p-value < 0.05 was considered significant.

The study was approved by the Research Ethics Committee of the Faculty of Medicine of the Pontifical Catholic University of Chile (ID 170222001) and the South East Metropolitan Health Service. This study was carried out under the ethical principles of the Declaration of Helsinki. The mothers signed informed consent and the adolescents signed an informed assent. The mothers and adolescents who obtained a score of suspected depression in the questionnaires were contacted and referred for evaluation in the Mental Health service according to their health insurance system.

Results

Out of 238 subjects that met the inclusion criteria, 86 dyads were selected, 48.8% (42) of the adolescents were women, the mean age was 14.04 years, and the mean history of the disease was 5.95 years. The average age of the mothers was 43.01 years.

According to the BDI-II results, 22 mothers (25.6%) presented depressive symptoms, 10.5% of them were mild, 10.5% were moderate, and 4.6% were severe. When comparing the variables between the groups of mothers with and without depressive symptoms, we observed an association of maternal depressive symptoms with a higher number of children, lower levels of parents' education, presence of another child with chronic illnesses, and greater vulnerability in health ($p < 0.05$) (table 1). The CDI questionnaire ($n = 84$) showed 15 (17.9%) adolescents with depressive symptoms, which were not associated with maternal depressive symptoms ($p = 1$) (table 1).

The HbA1c levels of children of mothers with and without depressive symptoms were 8.91% (± 1.52) and 7.66% (± 1.34) respectively, presenting a significant difference ($p < 0.001$) (Figure 1). When analyzing according to the severity of maternal depressive symptoms, the difference of moderate symptom group has no changes (Figure 2). Maternal depressive symptoms are also associated with increased risk of hospitalization due to acute episodes of decompensated T1DM (OR 4.31 [95% CI 1.25-14.97]).

To eliminate confounders, the variables were adjusted in a multivariate logistic model which showed that maternal depressive symptoms are associated with poor metabolic control in the adolescent (HbA1c > 7.5%) with an adjusted OR 6.23 (95% CI 1.16-33.5). Additionally, the presence of another chronic disease in the adolescent and vulnerability in health once adjusted maintain their association with poor metabolic control (adjusted OR 3.72 (1.08-12.85) and 5.38 (1.003-28.95) respectively) (table 2).

Finally, the average HbA1c levels in the group of adolescents with and without depressive symptoms were 8.07% and 7.91% respectively, without a statistically significant difference ($p = 0.71$) (figure 3).

Discussion

According to this study, 25.6% of mothers of adolescents with T1DM present depressive symptoms, higher than what was described in the general population when compared with the results of the 2016-2017 National Health Survey (*Encuesta Nacional de Salud*, ENS), where the subgroup of women showed 21.7% of depressive symptoms. Although the ENS used another questionnaire (CIDI-SF), it also was a screening tool and not a diagnostic one for MDD[36]. These results are consistent with experiences in other populations where there were higher levels of emotional distress and depressive symptoms when compared with the general population[15]. Knowing the factors that are associated with maternal depressive symptoms (table 1) allows us to identify mothers at higher risk.

This study demonstrates an association between maternal depressive symptoms and poorer metabolic control in adolescents with T1DM, even when adjusted for confounding variables in multivariate analysis. Maternal depression has been described as correlating with lower psychosocial adjustment of the adolescent and worse adherence to treatment[39]. Its mechanism has been explained in several studies, which reported that mothers with MDD would be excessively involved in the management of T1DM and in issues unrelated to T1DM, which would be less beneficial in the adolescent stage since it would not allow a certain degree of autonomy for the young person[27,40]. This, added to the irritability of depressive symptoms, would generate more family conflicts both in general and related to T1DM[41]. Other studies have shown an association between maternal depressive symptoms and reduced monitoring of treatment adherence during adolescence[25].

During adolescence, a smooth transition from direct parental involvement in the management of the disease to parental supervision is essential, but respecting and encouraging the progressive autonomy that the adolescent must assume. Maternal depressive symptoms hinder this process by triggering either excessive involvement or lack of monitoring. All this would eventually correlate with less adherence to treatment, and consequently, worse metabolic control[25].

In this study, 17.9% of the adolescents presented depressive symptoms, which shows a higher prevalence than in adolescents without T1DM, compared with a study in Chilean adolescents that detected depressive symptoms in 8.3%[42]. However our study did not show an association between adolescent depressive symptoms and maternal ones, nor with poor metabolic control, which is not consistent with previous publications where an association between these variables has been evident[15,18]. Given the lower prevalence of depressive symptoms in adolescents, a study with a larger number of cases may be needed to identify such association.

Probably, the impact that T1DM has on mental health is important, for this reason, the percentages of psychopathology are higher than those of the general population, especially during the first year after diagnosis[43]. Therefore, it is essential to educate and support the patient and the whole family since the diagnosis of the disease. When these symptoms are prolonged over time, they should be detected and managed promptly,

Table 1. Clinical and sociodemographic data according to the presence of depressive symptoms in the mothers of adolescents with DM1

Variable	Patients, N° (%)[a] (N = 86)		p value
	Mothers with depressive symptoms (N = 22 [25.6%])	Mothers without depressive symptoms (N = 64 [74.4%])	
Female sex	11 (50)	31 (48.4)	1
Teen age Media (SD). Years	14.4 (2.53)	13.9 (2.22)	0.42
Mother age Media (SD). Years	44.5 (9.52)	42.5 (7.53)	0.51
Evolution time of DM1. Years	5.03 (3.74)	6.27 (3.81)	0.157
Maternal education[b]			
Under 12 years	4 (18.2)	6 (10)	
12 years	9 (40.9)	18 (30)	0.99
Technical study	8 (36.4)	19 (31.7)	0.82
University study	1 (4.5)	17 (28.3)	**0.02***
Maternal work type[b]			
Dependent worker	7 (31.8)	25 (41.7)	0.68
Independent worker	5 (22.7)	13 (21.7)	
Housewife	9 (40.9)	19 (31.7)	
Unemployed	1 (4.5)	3 (5.0)	
Chronically ill mother[b]	10 (45.5)	27 (45.0)	1
Father´s age. Media (SD). years	41.6 (12.83)	43.6 (7.8)	0.43
Paternal education[c]			
Under 12 years	6 (30)	2 (3.8)	
12 years	6 (30)	18 (34.6)	**0.04***
Technical study	6 (30)	15 (28.8)	**0.02***
University study	2 (10)	17 (32.3)	**0.004***
Type of parental work[d]			
Dependent worker	12 (60)	34 (66.7)	0.46
Independent worker	7 (35)	14 (27.5)	
Housewife	0 (0)	1 (2)	
Unemployed	1 (5)	2 (3.9)	
Number of children in the family. Media (SD)	3.45 (1.06)	2.19 (1.19)	**< 0.001***
Number of people living at home. Media (DS)	4.5 (1.14)	4.06 (1.55)	0.11
Per cápita income. Media (SD) $	123.101 (95.684)	322.514 (439.180)	0.099
Brother with chronic disease[e]	7 (33.3)	6 (10.3)	**0.03***
Otra enfermedad crónica en adolescente[f]	6 (28.6)	18 (29.5)	1
Nutritional status[b]			
Malnutrition risk	1 (4.5)	2 (3.3)	0.99
Eutrofhy	16 (72.8)	32 (53.3)	
Overweight	4 (18.2)	19 (31.7)	0.26
Obesity	1 (4.5)	7 (11.7)	0.45
Type of treatment			
Basal/bolus	0 (0)	4 (6.7%)	[j]
Insulin Microinfusor[b]	22 (100%)	56 (93%)	
Hospitalization for DM1 acute descompensation in the last year[g]	5 (23.8)	4 (6.8)	**0.048***
Vulnerability in health according to SALUFAM[h]	15 (68.2)	9 (14.8)	**< 0.001***
Depressive symptoms in adolescents[i]	4 (19)	11 (17.5)	1
Capillary HbA1c	8.91 (1.52)	7.66 (1.34)	**< 0.001***

SD: Standard deviation, OR (Odds ratio), 95% CI (95% Confidence Interval), [a]Data represents the No (%) of patients, unless otherwise specified. [b]Available data for 22 and 60 patients respectively , [c]Available data from 20 and 52 patients respectively, [d]Available data from 20 and 51 patients respectively, [e]Available data from 21 and 58 patients respectively, [f]Available data from 21 and 61 patients respectively, [g]Available data from 21 and 59 patients respectively , [h]Available data for 22 and 61 patients respectively, [i]Available data for 21 and 63 patients respectively, [j]p value not calculated because one or more categories contains zero, *Significant.

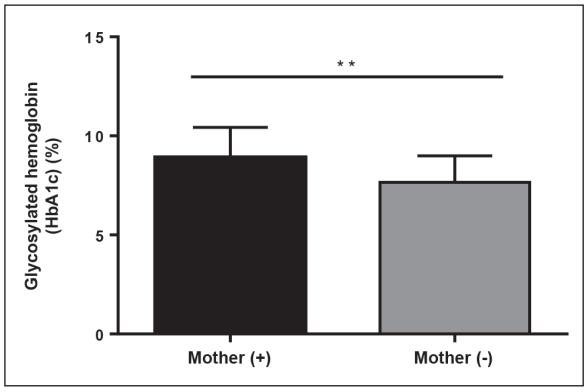

Figure 1. Average HbA1c in patients with a mother with (+) and without (-) depressive symptoms. U Mann-Whitney test, **p < 0.001

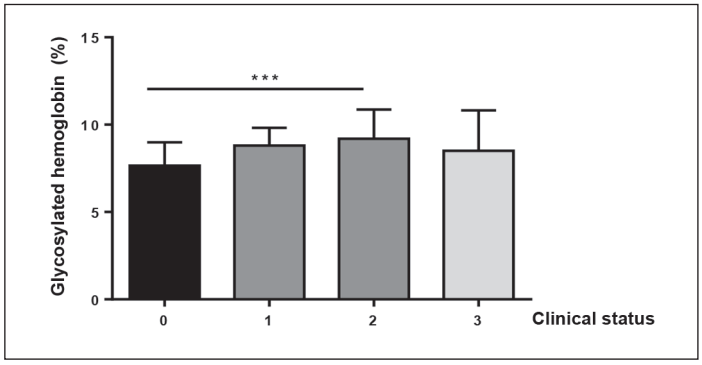

Figure 2. Average HbA1c according to severity of maternal depressive symptoms. 0: No depressive symptoms, 1: Mild, 2: Moderate, 3: Severe. Kruskal – Wallis test and Dunn post test, ***p < 0.001.

as they may be associated with poorer metabolic control, bringing forward the complications associated with T1DM.

Given the cross-sectional characteristics of the study, it is not possible to assess causality, therefore, the data should be analyzed carefully, and it would be ideal to conduct prospective studies to establish causality, and eventually to establish whether the detection and treatment of maternal depressive symptoms improve metabolic control. We used the convenience-sampling method, thus there could be selection bias, considering that those patients with poor adherence to controls might present depressive symptoms more often. It is also necessary to emphasize that both BDI-II and CDI are screening methods, not diagnostic ones of MDD.

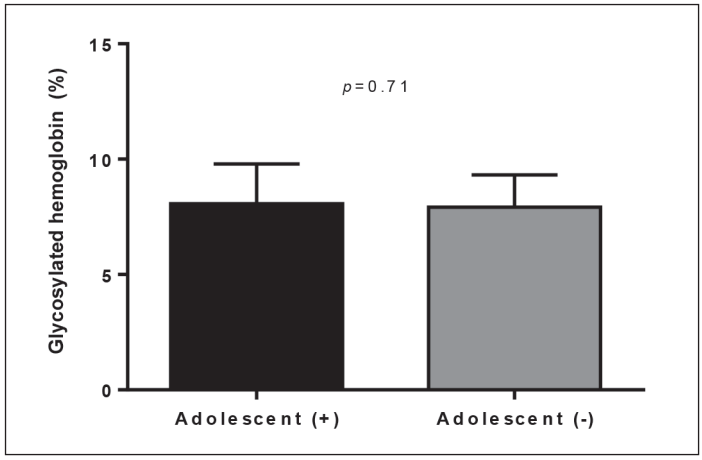

Figure 3. HbA1c average in patients with (+) and without (-) depressive symptoms. U Mann-Whitney test.

Conclusions

In this cross-sectional study, the depressive symptoms of the mothers are associated with poorer metabolic control of their adolescent children with T1DM. A family approach is needed for the health care of adolescents with T1DM, creating programs that provide multidisciplinary interventions for the family to reduce distress, improve interpersonal relationships, and the way they deal with the grieving process in the initial period of the disease. It is also essential to support parents in the transition period of adolescence that implies a gradual increase in the autonomy of the adolescent, maintaining some degree of supervision until the adolescent can completely take charge of her or his illness in adulthood[44,45]. It is crucial to create programs focused on the prevention of psychopathology in parents and adolescents.

Considering our results and the ones of the literature on the high prevalence of depressive symptoms in mothers of adolescents with T1DM, we propose that universal screening for depressive symptoms in both mothers and adolescents would be beneficial. Although it is not possible to demonstrate causality in our work, we believe that detecting those patients and mothers who present these symptoms is fun-

Table 2. Significant adjusted OR for HbA1c levels> 7.5% (multivariate analysis)

Variable	Adjusted OR	CI Adjusted OR
Other chronic adolescent disease	3.72	1.08-12.85
Health vulnerability according to SALUFAM	5.38	1.003-28.95
Maternal depressive symptoms	6.23	1.16-33.5

Variables included in multivariate analysis: sex, presence of another chronic disease in the adolescent, mother's educational level, presence of maternal and adolescent depressive symptoms and vulnerability in health. Those variables that did not give a significant result are not included in the table

damental in order to timely refer them and thus receive counseling and treatment, which will improve their quality of life and could result in an improvement in metabolic control.

Ethical Responsibilities

Human Beings and animals protection: Disclosure the authors state that the procedures were followed according to the Declaration of Helsinki and the World Medical Association regarding human experimentation developed for the medical community.

Data confidentiality: The authors state that they have followed the protocols of their Center and Local regulations on the publication of patient data.

Rights to privacy and informed consent: The authors have obtained the informed consent of the patients and/or subjects referred to in the article. This document is in the possession of the correspondence author.

Conflicts of Interest

Authors declare no conflict of interest regarding the present study.

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