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ORIGINAL ARTICLE

Metabolic Risk in Children and Adolescents With Type 1 Diabetes Mellitus and Associations With Socioeconomic Factors and Lifestyle in the Context of the Covid-19 Pandemic

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Highlights

1. The Covid-19 pandemic has harmed the treatment of patients with diabetes.
2. Metabolic risk was associated with moderate and severe food insecurity.
3. Metabolic risk was associated with reduced levels of physical activity.

ABSTRACT

The aim of the present study was to determine metabolic risk in children and adolescents with type 1 diabetes mellitus and investigate associations with socioeconomic, demographic and lifestyle characteristics in the context of the Covid-19 pandemic. A case-series study was conducted with 98 outpatients under treatment in 2021. Metabolic risk was assessed by the sum of z-scores of the body mass index (BMI), estimated average blood glucose, total cholesterol, HDL-c, LDL-c and triglycerides. Adolescents (81.4%) and time since diagnosis ≥ three years (61.0% of the participants) predominated in the sample. Most participants had a family income *per capita* less than the monthly minimum wage (68.6%), some degree of food insecurity (FI) (85.6%) and received some type of benefit during the pandemic (70.3%). Most (57.6%) reported changes in the eating routine, the main causes of which were confinement (38.2%) and financial difficulties (35.3%). Significant associations were found between metabolic risk and moderate to severe FI as well as reports of the non-practice of physical activity. No significant correlations were found between metabolic risk and sociodemographic, anthropometric, laboratory or lifestyle factors when controlled for pubertal stage and FI status. In conclusion, food insecurity and the non-practice of physical activity were associated with metabolic risk in this sample of children and adolescents with type 1 diabetes mellitus in the context of the COVID-19 pandemic.

Keywords: Diabetes mellitus; metabolic control; food security.

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INTRODUCTION

Type 1 diabetes mellitus (DM1) is one of the most common metabolic diseases in childhood and adolescence, with the incidence increasing by around 3% a year, particularly in the 10-to-14-year-old age group[1]. Data from the International Diabetes Federation (2021)[2] show that Brazil occupies third place in the ranking of the ten countries with the highest number of cases of DM1 in individuals younger than 19 years of age (n = 92,300), behind only India (229,400) and the Unites States (157,900).

The Covid-19 pandemic brought significant changes with regards to food intake and the practice of physical exercises. This change in lifestyle may be one of the factors associated with the aggravation of chronic noncommunicable diseases[3]. Moreover, the economic crisis and consequent food insecurity (FI) exert a negative influence on the management of these diseases[4].

In June of 2022, data from the 2nd National Survey on Food Insecurity in the Context of the Covid-19 Pandemic in Brazil[5] showed the more than half of the Brazilian population had some degree of FI and 33.1 million were classified as having severe FI (suffering chronic hunger).

FI can predispose individuals with DM1 and a low socioeconomic status to the deterioration of glycemic control and an increase in metabolic risk. To date, however, there are no data on metabolic risk in children and adolescents with DM1 in the context of the Covid-19 pandemic in Brazil. Therefore, the aim of the present study was to determine metabolic risk in children and adolescents with type 1 diabetes mellitus and investigate associations with socioeconomic, demographic and lifestyle factors in the context of the Covid-19 pandemic.

METHODS

A cases-series study was conducted involving 98 children and adolescents with DM1 under treatment in the year 2021 at the Pediatric Endocrinology Clinic of the hospital affiliated with *Universidade Federal de Pernambuco* (Ufpe). The study population comprised a convenience sample of patients at the clinic who agreed to participate. Individuals with Cushing syndrome, those undergoing hormone therapy (except insulin) and those with other serious diseases were excluded.

Data were collected on socioeconomic, demographic, clinical, laboratory, anthropometric, dietary and lifestyle characteristics. The Brazilian Food Insecurity Scale[6] was also administered.

Metabolic risk was investigated using the metabolic risk score proposed by Andersen et al.[7] and used by Mota et al.[8], Burgos et al.[9] (2015) and Todendi et al.[10], which consists of the sum of Z-scores of each of the following: body mass index (BMI), systolic blood pressure, estimated average blood glucose, total cholesterol, HDL-cholesterol (multiplied by -1 due to the inverse relationship with cardiovascular risk factors), LDL-cholesterol and triglycerides. Due to the lack of reference values, the data were expressed in tertiles, with individuals in the third tertile classified as having high metabolic risk. The calculation was adapted, as there were not available data on blood pressure and laboratory findings were collected from the patient records. Glycemic control was investigated considering glycated hemoglobin (HbA1c) collected from the patient records and using the cutoff point recommended by the American Diabetes Association (2023)[11], with < 7% considered indicative of adequate glycemic control.

The Brazilian Food Insecurity Scale[6] was used to characterize FI status. This scale enables a direct assessment of the perception and experience of food insecurity and hunger on the household level. For statistical purposes, FI status was dichotomized as "without FI or mild FI" and "moderate to severe FI".

The anthropometric characteristics (weight and height) were determined following the recommendations of the Brazilian Health Ministry[12]. Weight was measured using a Filizola® digital scale with a capacity for 180 kg and precision of 100 g. The participants were weighed barefoot and wearing light clothes and positioned on the platform of the scale with the arms extended in front of the body. Height was measured using a portable WCS stadiometer® with a capacity for 216 cm and precision of 1 mm. The children were barefoot, with feet together, standing erect on the platform, gazing forward, arms alongside the body, with head, back and buttocks in contact with the vertical plane of the stadiometer. Weight and height were used for the calculation of BMI, which is a component of the metabolic risk score, and height was considered in the assessment of height deficit, which is an indicator of an adverse nutritional past. Growth curves of the World Health Organization[13] for children older than five years of age and adolescents were used, employing the WHO AnthroPlus® program, version 3.2.2. Abdominal obesity was investigated based on waist circumference measuring using a non-elastic metric tape with a capacity for 150 cm and precision of 0.1 cm, with the participants in the standing position, abdomen relaxed, arms alongside the body, feet together and weight distributed evenly between both legs. The tape was placed horizontally at the midpoint between the lower edge of the last rib and the iliac crast.[14] The classification proposed by Taylor et al.[15] was used. All measurements were performed twice and repeated when the two weight measurements differed by more than 100 g and the two height and waist measurements differed by more than one 1 cm. The average of the two closest measurements was recorded.

Eating habits were investigated through questions addressing the pre-pandemic period and changes that occurred during the period of social isolation, the reason for these changes, adherence to the diet and reasons for non-adherence. The questionnaire also had items addressing the quantity of food portions consumed daily. The "Ten Steps to a Healthy Diet" of the Health Ministry[16] was used as reference, which offers practical orientations and food portions for healthy individuals older than two years of age. The following food groups were investigated: vegetables, fruits, legumes, cheeses and yogurts, meats, fish and eggs, oils and fats.

Sedentary behavior was investigated based on the time spent on activities such as watching television and using the internet, considering two or more hours per day for each activity as excessive.[17] The weekly practice of physical exercise was also investigated.

This study received approval from the Human Research Ethics committee of the Ufpe hospital (certificate number: 51792721.1.0000.8807). The databank was constructed in the Epi Info program, version 6.04 (CDC/WHO, Atlanta, GE, USA). The data were entered twice and verified using the Validate module to check the consistency and validation. Statistical analyses were performed with the aid of the Statistical Package for the Social Sciences (SPSS), version 13.0 (SPSS Inc., Chicago, IL, USA).

Analyses of associations between metabolic risk and socioeconomic-demographic, clinical, anthropometric, dietary and lifestyle characteristics were controlled for sex, pubertal stage, food security status and nutritional status. As the variables exhibited normal distribution, Pearson's correlation test was used to determine the strength of correlations between variables. Qualitative variables were expressed as proportions and compared using Pearson's chi-square test, the linear trend chi-square test or Fisher's exact test. A p-value <0.05 was considered indicative of statistical significance.

RESULTS

Adolescents (81.6%), the female sex (51.0%) and individuals with more than three years since the diagnosis (65.2%) predominated in the sample. Nearly 70.0% of the children and adolescents were from homes with a family income ≤ the monthly minimum wage and 67.3% reported receiving some type of governmental assistance. A total of 32.7% of the participants were in situations of moderate to severe FI and 61.2% reported not following their diets (Table 1). Moreover, 96.6% did not have adequate glycemic control (HbA1c ≥ 7.0%).

Tables 1, 2 and 3 display the socioeconomic-demographic and dietary characteristics according to the occurrence of metabolic risk. Significant associations were found between metabolic risk and moderate to severe FI as well as reports of the non-practice of physical exercise. Table 4 displays the correlations between metabolic risk and socioeconomic-demographic, anthropometric, laboratory and lifestyle characteristics controlled for pubertal stage and FI status, no statistically significant correlations were found.

Table 1 – Socioeconomic-demographic and dietary characteristics according to occurrence of metabolic risk in children and adolescents (n = 98) with type 1 diabetes mellitus under care in 2021 with one year of the pandemic at the Pediatric Endocrinology Service, UFPE hospital, Recife – PE

Variables	Total			High metabolic risk			
	n	%	$CI_{95\%}$ ▪	n	%	$CI_{95\%}$ ▪	p-value*
Sex							0.886
Male	48	49.0	38.8 - 59.2	17	35.4	22.5 - 50.6	
Female	50	51.0	40.8 - 61.2	16	32.0	19.9 - 46.8	
Age							0.389
Children (< 10 years)	18	18.4	11.5 - 27.7	04	22.2	7.4 – 48.1	
Adolescents (≥10 years)	80	81.6	72.3 - 88.5	29	36.3	26.0 - 47.8	
Pubertal stage							0.766
Prepubescent	21	21.4	14.0 - 31.1	06	28.6	12.2 - 52.3	
Postpubescent	77	78.6	68.9 - 86.0	27	35.1	24.8 - 46.9	
Time since diagnosis							0.982
< three years	34	34.7	25.5 - 45.0	22	64.7	46.5 - 79.7	
≥ three years	64	65.3	54.9 - 74.4	43	67.2	54.2 - 78.1	
Mother's schooling							0.357
High school/Univ/College	64	65.3	54.9 - 74.4	45	70.3	57.4 - 80.7	
Primary school	34	34.7	25.5 - 45.0	20	58.8	40.8 - 74.9	
Nº of persons in family							0.398
≤ 4	72	73.5	63.4 - 81.6	50	69.5	57.3 - 79.5	
> 4	26	26.5	18.4 - 36.6	15	57.7	37.2 - 76.0	
Family income							0.457
≤ monthly min. wage	68	69.4	59.1 - 78.1	43	63.2	50.6 - 74.3	
≥ 2 x monthly min. wage	30	30.6	21.9 - 40.8	22	73.3	53.8 - 87.0	
Governmental benefit							0.741
Yes	66	67.3	57.0 - 76.3	45	68.2	55.4 - 78.8	
No	32	32.6	23.7 - 43.0	20	62.5	43.3 - 78.3	
Change in dietary routine							0.311
Yes	56	57.1	46.7 - 67.0	40	71.4	57.6 - 82.3	
No	42	42.8	33.0 - 53.2	25	59.5	43.3 - 73.9	
Adherence to diet							0.569
Yes	38	38.8	29.3 - 49.2	27	71.1	53.9 - 84.0	
No	60	61.2	50.8 - 70.7	38	63.3	49.8 - 75.1	
Food insecurity							**0.031**
Absent or mild	66	67.3	57.0 - 76.3	17	25.8	16.1 - 38.2	
Moderate to severe	32	32.7	23.7 - 43.0	16	50.0	32.2 - 67.7	

▪ 95% confidence interval *chi-square test ▫ participants in third tertile of risk scores considered as having high metabolic risk

Table 2 – Lifestyle and anthropometric characteristics according to occurrence of metabolic risk in children and adolescents (n = 98) with type 1 diabetes mellitus under care in 2021 with one year of the pandemic at the Pediatric Endocrinology Service, UFPE hospital, Recife – PE

Variables	Total			High metabolic risk♦			
	n	%	$CI_{95\%}$ ■	n	%	$CI_{95\%}$ ■	p-value*
Physical exercise							**0.008**
Yes	54	55.1	44.7 - 65.0	12	22.2	12.5 - 35.9	
No	44	44.9	34.9 - 55.2	21	47.7	32.7 - 63.1	
Hour/day – internet							0.222º
> 2 hours	58	59.2	48.8 - 68.9	26	31.0	32.0 - 58.4	
≤ 2 hours	07	7.1	3.2 - 14.6	07	50.0	56.1 - 100	
Hour/day – TV							0.101
> 2 horas	28	28.6	20.1 - 38.7	20	41.7	51.1 - 86.0	
≤ 2 horas	37	37.7	28.3 - 48.2	13	26.0	20.7 - 52.6	
Low height							0.406º
Yes	06	6.12	2.5 - 13.4	03	50.0	13.9 - 86.0	
No	91	92.8	85-3 - 96.8	30	33.0	23.7 - 43.7	
Abdominal obesity							0.157
Yes	22	22.4	14.9 - 32.2	10	45.5	25.1 - 67.3	
No	75	76.8	66.7 - 84.2	22	29.3	19.7 - 41.2	

*chi-square test   º Fisher's exact test   ♦ participants in third tertile of risk scores considered as having high metabolic risk

Table 3 – Dietary characteristics according to occurrence of metabolic risk in children and adolescents (n = 98) with type 1 diabetes mellitus under care in 2021 with one year of the pandemic at the Pediatric Endocrinology Service, UFPE hospital, Recife – PE

	Total			High metabolic risk			
Daily intake (portions)	N	%	$CI_{95\%}$ **	N	%	$CI_{95\%}$ **	p-value*
Fruits							0.416
None	12	12.2	6.7 - 20.8	06	50.0	22.3 - 77.7	
1 to 3	55	56.1	45.7 - 66.0	18	32.7	21.0 - 46.8	
> 3	31	31.6	22.8 - 41.9	09	29.0	14.9 - 48.2	
Vegetables							0.155
None	28	28.6	20.1 - 38.7	13	46.4	28.0 - 65.8	
1 to 3	48	49.0	38.8 - 59.2	12	25.0	14.1 - 39.9	
> 3	22	22.4	14.9 - 32.2	08	36.4	18.0 - 59.2	
Dairy products							0.843
≤ 3	69	70.4	60.2 - 79.0	22	31.9	21.5 - 44.3	
> 3	29	29.6	21.0 - 39.8	11	37.9	21.3 - 57.6	
Meats, fish and eggs							0.551°
1 to 3	95	97.0	90.7 - 99.2	63	66.3	55.8 - 75.5	
> 3	03	3.0	0.79 - 9.33	01	33.3	1.7 - 87.5	
Legumes							0.347
≤ 3	73	74.4	64.5 - 82.5	27	37.0	26.2 - 49.5	
> 3	25	25.5	17.5 - 35.5	06	24.0	10.2 - 45.5	
Oils and fats ■							0.301
None	32	32.6	23.7 - 43.0	08	25.0	12.1 - 43.7	
> 1	66	67.3	57.0 - 76.3	25	37.9	26.5 - 50.7	

*chi-square test ◊linear trend chi-square test ° Fisher's exact test ♦ participants in third tertile of risk scores considered as having high metabolic risk. ■ 1 teaspoon of olive, soybean, canola, corn or sunflower seed oil and butter or margarine. □ 1 table spoon of refined sugar.

Table 4 – Correlations between metabolic risk and demographic-socioeconomic, anthropometric, laboratory and lifestyle variables controlled for pubertal stage and food insecurity status in children and adolescents (n = 98) with type 1 diabetes mellitus under care in 2021 with one year of the pandemic at the Pediatric Endocrinology Service, UFPE hospital, Recife – PE

	Correlation with metabolic risk by sex*			
	Boys		**Girls**	
Variables	Prepubescent n = 13	Postpubescent n = 35	Prepubescent n = 10	Postpubescent n = 40
	r	r	r	R
Age	0.524	0.260	0.129	0.032
Time since diagnosis	-0.367	0.057	-0.121	0.053
Family income	-0.207	-0.150	-0.447	0.142
*Height	0.508	-0.203	0.119	-0.093
Waist circumference	0.165	0.106	0.246	0.019
Physical activity – min/day	-0.123	-0.220	-0.182	-0.209
TV (hours/day)	0.505	0.088	0.235	0.133
Cell phone (hours/day)	-0.100	-0.180	-0.025	0.040
	Correlation of metabolic risk by food insecurity *			
	Boys		**Girls**	
	Mild/ absent n = 31	Moderate/ severe n = 17	Mild/ absent n = 36	Moderate/ severe n = 14
Age	0.218	0.272	0.298	0.243
Time since diagnosis	-0.032	0.222	0.132	0.187
Family income	-0.162	0.152	0.078	0.488
Height	-0.064	-0.069	0.264	0.010
Waist circumference	0.146	0.237	0.286	0.257
Physical activity – min/day	-0.112	-0.250	-0.224	-0.032
TV (hours/day)	0.063	0.474	-0.034	0.090
Cell phone (hours/day)	-0.158	-0.045	0.246	0.074

* Pearson's correlation test – No statistically significant correlations.

DISCUSSION

The Covid-19 pandemic posed numerous challenges with regards to the treatment and control of chronic diseases. Social distancing made specialized outpatient follow-up difficult and confined individuals tend to be more sedentary and susceptible to excessive food intake of low nutritional quality[18]. Moreover, many individuals are vulnerable to eating disorders due to the economic crisis and consequent food insecurity (FI)[4].

In the present study, 95% of the children and adolescents exhibited inadequate glycemic control, which increases metabolic risk, especially in diabetic patients. Evidence shows that the severity of duration of exposure to hyperglycemia contribute to an increase in metabolic risk, resulting in tissue damage, the loss of function and the failure of different organs, which can lead to the development of complications in the long term, especially macro- and microvascular complications. Metabolic risk is characterized by factors that can lead to the development of cardiometabolic diseases, such as hyperlipidemia, hyperglycemia and obesity[19]. Thus, the maintenance of a healthy weight as well as adequate lipid and blood glucose levels is essential, as large fluctuations in glycemic variability are related to an increase in oxidative stress.

According to Andersen et al.[7], the metabolic risk score was developed due to the difficulty in diagnosing metabolic syndrome in childhood. Similar variables as those for adults are used (systolic blood pressure, HDL, TG and glucose), but the score also includes LDL and does not include waist circumference, likely due to the lack of a specific cutoff point for children and adolescents. Due to the absence of reference values, we could not infer the magnitude of metabolic risk in the present study.

Most of the families of the children and adolescents analyzed had some degree of FI. Moreover, the participants in situations of moderate to severe FI had higher HbA1c, estimated average blood glucose and total cholesterol levels, demonstrating a greater risk of cardiometabolic complications in this group. FI can predispose patients with DM1 and a low socioeconomic status to the deterioration of glycemic control and increased metabolic risk.

A population-based study found that patients with DM1 in the lower socioeconomic strata had higher glycated hemoglobin levels[20]. Another study found that children and adolescents in situations of severe FI had worse cardiometabolic profiles in comparison to their counterparts in situations of food security.[21] Mendoza et al.[22] found that FI in youths with DM1 was associated with worse glycemic control (increase in HbA1c), but only mild to moderate levels of FI, whereas higher levels of FI were associated with lower HbA1c (likely to the fasting state) as well as higher rates of hospitalization and visits to the emergency room. Another recent study found no association between FI and cardiometabolic risk factors in adolescents from families with a low income[23]. The divergent results may be due to different methods used for measuring food security, which may not adequately reflect the actual situation of some families.

Besides FI, metabolic risk in the children and adolescents of the present study was associated with a low physical activity level. It is well established in the literature that the practice of physical activity and reduction in the sedentary time improve cardiovascular risk factors in children and adolescents. These benefits are seen as the intensity of physical activity increases, with moderate to intense activity levels related to a healthier cardiometabolic profile[24].

The Cardiovascular Prevention Guideline of the Brazilian Cardiology Society[25] recommends ≥ 60 minutes a day of intense to vigorous physical activity as well as muscle strengthening exercises at least three times a week for children and adolescents six to 17 years of age. Moreover, preschool children should remain active throughout the day with activities of different intensity levels.

Although this study was conducted with methodological rigor, some limitations should be considered. Data from the pre-pandemic period were collected from patient records, whereas data in 2021 were collected during in-person appointments. Thus, metabolic risk and FI could only be assessed in 2021. Recall bias constitutes another possible limitation, as some data collection instruments used in the study required retrospective information on the lifestyle of the participants. Thus, information that depended on the participant's memory may be questionable. To minimize this bias, the participants were stimulated to consider the questions carefully and were given the time necessary to be sure of their answers. Moreover, the participants may have omitted some information related to income and access to foods.

In conclusion, poor glycemic control was found in nearly the entire sample of the present study and metabolic risk was associated with both food insecurity and a lack of physical activity in the context of the Covid-19 pandemic.

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