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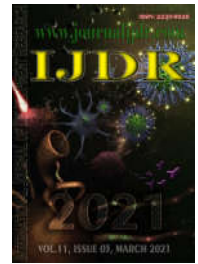
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RESEARCH ARTICLE

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EVALUATION OF CAPILLARY AND URINARY GLUCOSE LEVELS IN PATIENTS WITH TYPE I MELLITUS DIABETES

Anne Karoline Ortega Monteiro¹; Suellen Aparecida Varandas¹; Rachel Gomes Eleutério¹; Lara Cristina Casadei Ubeda¹; Sandra Maria Barbalho^{1,2,3}; Chymenny Aulua Lascas Cardoso de Moraes¹; Denize Maria Galice Rodrigues¹; Walter Roberto Schiller¹; Jesselina F. Santos Haber¹; Elizandra Ap. de Oliveira Lopes^{1,4*}

¹Department of Biochemistry and Pharmacology, University of Marília (UNIMAR), Avenida Higino Muzzi Filho, 1001, Marília, São Paulo, Brazil; ²School of Food and Technology of Marília (FATEC) – Marília – SP, Brazil.

³Postgraduate Program in Structural and Functional Interactions in Rehabilitation - UNIMAR - Marília – SP, Brazil; ⁴Serviço de Controle de Qualidade em Hemocomponentes do Hemocentro da Faculdade de Medicina de Marília (FAMEMA) –Marília – SP, Brazil

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*Corresponding author: *Elizandra Ap. de Oliveira Lopes,*

ABSTRACT

Diabetes Mellitus (DM) is currently considered a worldwide epidemic that directly affects glucose metabolism due to insufficient or inexistent insulin. It is characterized by marked hyperglycemia, glycosuria, negative nitrogen balance, hyperlipidemia, and ketonemia. Given the importance of therapeutic monitoring of patients with DM1, this study aimed to compare capillary and urinary glucose measurement in patients with DM 1. The capillary glycemia and urine samples were obtained from patients from twenty municipalities linked to the University of Marília / Unimar - São Paulo, Brazil, with DM1 aged between 1 and 18 years. Our sample showed that the higher percentage was of girls (64%). Most patients had hyperglycemia, considering that it was not always accompanied by glycosuria. Most subjects showed high levels of capillary glucose and urinary glucose, which was expected due to the pathophysiology of the disease. A percentage of patients have only glycosuria. Our results showed that the patient who presents high capillary glucose would also be accompanied by glycosuria. However, the latter may be present, even in the absence of capillary glucose elevation, which is why it is vitally important to always check the urinary glucose of DM1 patients as a prophylactic measure, avoiding the extension of kidney damage.

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INTRODUCTION

Diabetes Mellitus (DM) is currently considered a worldwide epidemic that directly affects glucose metabolism due to insufficient or inexistent insulin. It is characterized by marked hyperglycemia, glycosuria, negative nitrogen balance, hyperlipidemia, and ketonemia. This disease represents 8% of the world's mortality causes based on data from the World Health Organization. Of all DM cases, 5% to 10% are type 1 (DM1) (ZACCARDI et al., 2016; ALSSEMA et al., 2021; ARORA et al., 2021). Diabetes represents a significant healthcare burden, and patients' treatment with this condition costs

billions of dollars worldwide every year (KUMAR et al., 2018; BELETE et al., 2021). DM1 is developed by an autoimmune mechanism, which destroys the beta cells of the islets of Langerhans through circulating autoantibodies such as anti-glutamic acid decarboxylase (anti-GAD), anti-islets, and anti-insulin, thus being the synthesis of insulin is impaired causing hyperglycemia, so the individual in question becomes insulin-dependent (BENDER et al., 2020; HEMMINGSEN et al., 2021). Usually, insulin-dependent patients have adverse manifestations in renal behavior, such as glycosuria and ketonuria. Glycosuria occurs due to the high glucose level in the blood due to the insulin deficit that directly impairs glucose absorption by the cell. Thus, glycemia increases and the proximal glomerulus cannot reabsorb all excess glucose, so glucose

starts to be excreted in the urine (BREW-SAM *et al.*, 2021; FLATT *et al.*, 2021; VON SCHOLTEN *et al.*, 2021). Therapeutic monitoring is vital since patients with DM1 belong to the age group corresponding to childhood or adolescence, and several biological changes may occur in these stages (growth/height/age/hormonal changes, and puberty). Due to these changes, patients often face difficulties establishing glycemic control due to the increased resistance of glucose metabolism caused by the hyperactivity of growth hormone secretion (DRUCKER, 2021; GURGEL PENAFORTE-SABOIA *et al.*, 2021; PERKINS *et al.*, 2021). Given the importance of therapeutic monitoring of patients with DM1, this study aimed to compare capillary and urinary glucose measurement in patients with DM1 by correlating oscillations.

METHODOLOGY

Thirty-two patients were included in this study. As these patients included in this study are under 18 years old, their guardians signed the Informed Consent Form for inclusion in the study. This study only started after the Ethics Committee's approval of human beings at the Universidad de Marília - UNIMAR - São Paulo - Brazil. The urine samples were collected from patients of twenty municipalities linked to the University of Marília / Unimar - São Paulo, Brazil, with DM1 aged between 1 and 18 years. The patients were assisted by a multidisciplinary team composed of professionals from Medicine, Nursing, Nutrition, Physical Education Professionals, Biomedicine, and Psychology. The duration of the study was four months (June to September 2019). After collection, the samples were immediately sent to the Clinical Analysis Laboratory of the University of Marília - São Paulo - Brazil, where the analyses were performed. For the evaluation of capillary blood glucose, a glucometer was used (capillary blood glucose was collected immediately before urine collection).

RESULTS AND DISCUSSION

Our sample showed that the higher percentage was of girls (64%) (Figure 1).

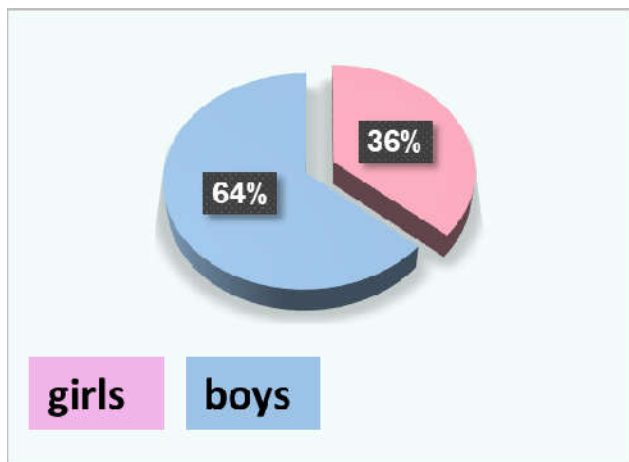


Figure 1. Percentage of male and female included in the sample.]

Table 1 shows the results of the evaluation of capillary glycemia and glycosuria in the patients included in the study. From the analysis of this table, it can be seen that most patients had hyperglycemia, considering that it was not always accompanied by glycosuria. This occurred because many patients did not feel like urinating at puncture; others went out to eat, used insulin, and returned to collect the urine. Thus, most of the time, the glycosuria could be positive, even if the blood glucose level was average at that time. The elimination of glucose depends mostly on the reabsorption by the proximal glomerulus, and when the plasma glucose exceeds the concentration of 180 mg/mL, the kidney cannot reabsorb all this excess glucose, with which it begins to be excreted in the urine

Table 1. Assessment of glycemia and glycosuria of patients included in the study

Sex	Glycemia (mg/dL)	Glycosuria (mg/dL)
M	205	790
M	90	46
M	147	8,4
F	313	5963
M	226	115
M	149	2,8
F	85	8,6
M	309	9446
M	187	782
M	189	24
M	118	15
F	129	10,6
M	217	13
F	239	86
M	285	1452
F	127	340
M	193	620
M	90	0
M	258	3700
F	206	520
M	169	0
F	200	380
F	287	5780
F	229	3060
M	155	20
M	207	220
F	153	420
M	95	0
F	232	1460
F	242	160
M	182	380
M	171	1740
M	138	120

M: male; F: female.

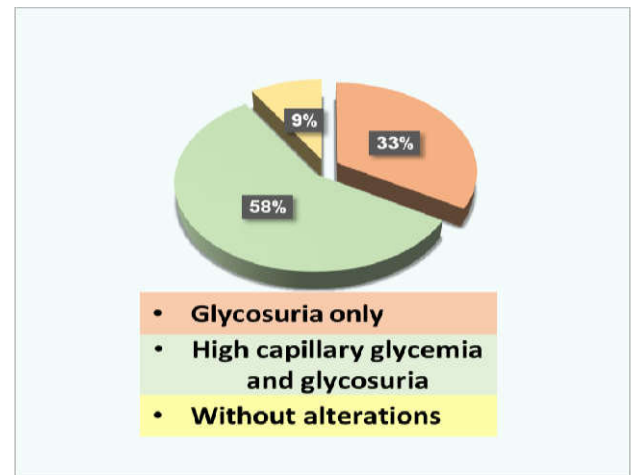


Figure 2. DM1 patients who had a high index for capillary and urinary glucose.

(LYTVYN *et al.*, 2015; MINGUENEAU *et al.*, 2015; ADEYINKA e KONDAMUDI, 2021) (Figure 2). The inhibition of Sodium-glucose co-transporter (SGLT) could reduce the blood glucose levels through an insulin-independent mechanism, leading to a decrease in renal glucose reabsorption followed by an augmented urinary glucose excretion (CHAO e HENRY, 2010; WATADA *et al.*, 2019). It is observed that most patients have high levels of capillary glucose and urinary glucose, which was expected due to the pathophysiology of the disease. A percentage of patients have only glycosuria, which may be related to the nephron receptors' failure to recognize glucose and promote resorption. Renal glycosuria can happen without any other abnormality in kidney function or as part of a generalized defect in the proximal tubule function (Fanconi syndrome).

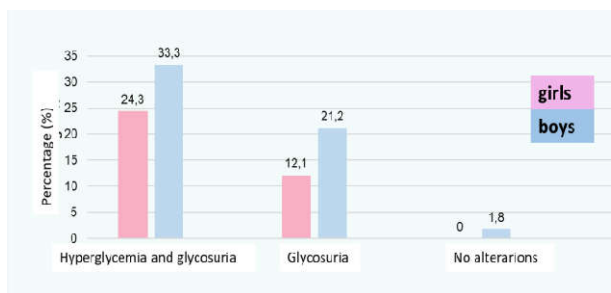


Figure 3. Relationship between sex of DM1 patients who had a high capillary and urinary glucose index

They can also occur with several systemic diseases, including cystinosis, Wilson's disease, hereditary tyrosinemia, and brain-renal syndrome (SCARAMUZZA *et al.*, 2014; LYTUVYN *et al.*, 2015; ADEYINKA e KONDAMUDI, 2021). Inadequate control of glycemia can result in acute conditions such as ketoacidosis and further chronic complications such as nephropathy, retinopathy, and cardiovascular disease (CVD). If compared with the general population, the risk of CVD is about eight times higher in DM1 patients, and the augmented mortality risk for CVD is even greater (KLEIN *et al.*, 2009; DE FERRANTI *et al.*, 2014; NORDWALL *et al.*, 2015; SHIMADA *et al.*, 2018). A small part of the patients do not seem to present renal alteration, which is probably due to the regularization of DM1 with the use of insulin; thus, glucose metabolism usually occurs, with no increase in capillary glucose and much less manifestation of glycosuria (DELLEPIANE *et al.*, 2018). Figure 3 shows that male patients have higher percentages of hyperglycemia and glycosuria or just glycosuria. This factor may be related to specific personal habits, lack of care with the maintenance of the hyperglycemic condition, and family factors. Our results show the importance of evaluating glycosuria, in addition to capillary glycemia, which has already been adopted as a requirement for maintaining blood glucose levels. Therefore, we suggest that it would be ideal to adopt urine glucose measurement in DM1 patients periodically. Similar to other studies, our results showed that the patient who presents high capillary glucose would also be accompanied by glycosuria. However, the latter may be present, even in the absence of capillary glucose elevation, which is why it is vitally important to always check the urinary glucose of DM1 patients as a prophylactic measure, avoiding the extension of kidney damage. These variations may be associated with nutritional, hormonal, or genetic factors associated with secondary diseases, which develop similar conditions.

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