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Original Article

The correlation of body mass index and skin hydration in diabetic patients

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Abstract

Diabetes Mellitus (DM) affects approximately 9.8% of the global population, with type 2 DM as the most common case in the world. Excess body weight and obesity are significant risk factors for type 2 DM. Previous studies have reported that obese diabetic mice show a reduction of stratum corneum water content and lipid content in the skin. Our study aims to further evaluate the correlation between BMI and skin hydration in type 2 DM patients. This study was an observational study with a cross-sectional design. All study subjects underwent skin hydration measurement with CM 825 corneometer®, while the anthropometric measurement was done using Charder Medical Scale® (MS 4900). The correlation between BMI and skin hydration was analyzed using the Chi-Square test and was significant if the p-value <0.05. The majority of type 2 DM patients were female (61.9%), with BMI ≥25 kg/m^2 (62.9%) and dry skin hydration (93.8%). The results of this study showed that there was no correlation between BMI and skin hydration in type 2 DM patients (p=0.236). There was no correlation between BMI and skin hydration in type 2 DM patients.

Keywords: diabetes mellitus, skin hydration, body mass index.

Introduction

Diabetes Mellitus (DM) affects approximately 537 million individuals worldwide, or 9.8% of the global population. Type 2 DM contributes to 90–95% of DM cases worldwide [1, 2]. Insulin abnormality and hyperglycemia in DM patients cause disorders of various organs, including the skin, with the commonest diseases being skin infections, xerosis cutis, and pruritus [3–7]. Those associated cutaneous disorders may occur because of alteration in epidermal function. Epidermal function is reflected through the biophysical properties of the stratum corneum, such as stratum corneum hydration and transepidermal water loss (TEWL) [8].

Skin hydration presents water content in the stratum corneum. Water retention in the stratum corneum is affected by 2 components mainly, such as: (1) natural moisturizing factor (NMF), which is formed from filaggrin protein, and (2) lipids intercellular in the form of ceramides [9]. The moisture content of the stratum corneum, which is less than 10%, disrupts the integrity of the skin barrier, which is the basis of xerosis cutis [10]. A study regarding stratum corneum hydration and type 2 DM was performed on an animal model of long-standing hyperglycemia and showed a decrease in stratum corneum hydration in DM model mice [11].

Body mass index (BMI) is a measurement based on a person's height and weight, which allows the classification of individuals into categories such as obese or overweight [12]. The World Health Organization (WHO) Asia-Pacific region defined BMI ≥23 kg/m^2 as overweight and ≥25 kg/m^2 as obese [13]. Excess body weight and obesity are significant risk factors for type 2 DM [14]. Previous studies have reported that obese diabetic mice show a reduction of stratum corneum water content and lipid content in the skin [15, 16]. Our study aims to evaluate the correlation between BMI and skin hydration in diabetic patients.

Material and methods

Study design and patients

This was an observational study with a cross-sectional design to assess the correlation between BMI and skin hydration in diabetic patients. This study was carried out between November 2023 and February 2024 at the outpatient unit of the Internal Medicine Department of Prof. Dr. Chairuddin Panusunan Lubis Universitas Sumatera Utara Hospital. The inclusion criteria for this study were type 2 DM patients aged ≥45–60 years old without any history of using moisturizers in the last 1 week. All patients who were willing to participate in the study had signed the informed consent. The exclusion criteria in this study were pregnancy, suffering from primary cutaneous disorders such as psoriasis, atopic dermatitis, or skin infection, and patients with comorbidities, such as liver and renal function abnormalities, as well as malignancy.

Laboratory, anthropometric and clinical data collection

The patient's body weight and height were measured by using Charder Medical Scale® (MS 4900). Skin hydration was measured with CM 825 corneometer® by Courage & Khazaka by placing the probe perpendicularly against the examination areas, which were right and left forearm extensors. Measurements on each area were carried out three times, on one-third proximal, one-third medial, and one-third distal of the forearm extensor. The patient's skin hydration is taken from the average of all measurements, with the interpretation of dry hydration (≤45 arbitrary units) and good hydration (>45 arbitrary units).

Statistical analysis

The data were collected and analyzed statistically using the computer program Statistical Product and Service Solutions (SPSS v. 26.0; SPSS Inc., Chicago, IL, USA). Data processing was carried out using univariate analysis to analyze the characteristics of one variable by conducting descriptive tests, followed by bivariate analysis to analyze the relationship between variables, in this case, to determine the relationship between BMI and skin hydration in type 2 DM patients using the Chi-square test and considered statistically significant if p-value<0.05.

This study was conducted after obtaining ethical clearance from the Research Ethics Committee of the University of Sumatera Utara (No. 1047/KEPK/USU/2023) and from Prof. Dr. Chairuddin Panusunan Lubis Universitas Sumatera Utara Hospital Research Permit (No. 5359/UN5.4.1.1.3/KPM/2023). All procedures were conducted in accordance with the Helsinki Declaration of 1975, as revised in 2013.

Results

The majority of the subjects were female (n=60; 61.9%), with a BMI ≥25 kg/m^2 (n=61; 62.9%) and dry skin hydration (n=91; 93.8%). The characteristics of the subjects are listed in Table 1.

Table 1: The characteristics of the participants in the study.

	Total
Sex (n)	97 (100%)
Male	37 (38.1%)
Female	60 (61.9%)
BMI (kg/m^2)	97 (100%)
Normal (<23 kg/m^2)	13 (13.4%)
Overweight (23–24.9 kg/m^2)	23 (23.7%)
Obese (≥25 kg/m^2)	61 (62.9%)
Skin hydration (n)	97 (100%)
Good	6 (6.2%)
Dry	91 (93.8%)

Note: SD – standard of deviation.

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Table 2 shows that out of 61 obese patients, there were 58 patients (95.1%) with dry skin. From the 23 overweight patients, there were 20 people (87%) with dry skin, while from the 13 patients with normal BMI, there were 13 people (100%) with dry skin. Our study results show that the majority of the subjects were obese, and the skin hydration tended to be dry. The correlation between BMI and skin hydration in type 2 DM patients was evaluated by using the Chi-square test with a value of p=0.236 (p>0.05), which means there is no statistically significant correlation between BMI and skin hydration in type 2 DM patients (Table 2).

Discussion

Our study showed that the majority of type 2 DM patients had a BMI ≥ 25 kg/m^2. This result is in line with a study by Teufel *et al.*, which reported an increased risk of diabetes at a BMI of 23 kg/m^2 or above [17]. The categorization of BMI is variable regionally. Therefore, we used the WHO Asia-Pacific classification, which is more suitable for Indonesian people.

The majority of type 2 DM patients in our study had dry skin hydration. Various studies concerning the skin function of type 2 DM, either human or animal subjects, also reported a reduction of skin hydration [18–21]. Various alterations in epidermal function contribute to decreased hydration of the stratum corneum. First, the lipid component of the stratum corneum, consisting of cholesterol, free fatty acids, and ceramides, is one of the main determinants of skin hydration. The lipid content is reduced by more than 60% in patients with type 2 DM [8, 21]. Second, the reduction of filaggrin protein, which is a natural moisturizer of the stratum corneum. Hyperglycemia inhibits keratinocyte proliferation and protein synthesis, including filaggrin, resulting in decreased stratum corneum hydration. Third, decreased expression levels of aquaporin 3 (AQP 3) play a role in transporting water and small molecules in the stratum corneum [8, 22].

Our study found no statistically significant correlation between BMI and skin hydration in type 2 DM patients, with a p-value of 0.236. However, the trend found in most subjects tend to be obese with dry skin hydration. Obesity can contribute not only to systemic metabolic abnormalities such as glucose and lipid metabolism disorders but also to increased oxidative stress and inflammation. It also contributes to insulin resistance, which is the major mechanism in type 2 DM. A current study reported that the insulin resistance associated with obesity is involved in obesity-related skin function impairment. A study that analyzed mice with diet-induced obesity and insulin resistance revealed impaired barrier function through keratin dysfunction that can be attributed to structural fragility and decreased AQP3 via imbalanced glycerol metabolism [23, 24] Mori *et al.* reported that the characteristics of obesity-associated skin were reduction of the barrier and moisturizing function accompanied by intercellular lipid imbalance, increased redness accompanied by hemodynamic changes, and surface roughness. The water content in stratum corneum was lower by 12% in obese patients than the non-obese patients [25]. Those alterations mentioned in obese patients can further worsen the epidermal dysfunction in diabetic patients.

Studies observing skin function in obese diabetic patients are not available. One study by Ibuki *et al.* reported that obese-diabetes patients have decreased stratum corneum hydration, increased TEWL, higher skin advanced glycation end-products, and decreased dermal collagen fiber density compared with normal-weight subjects. These results suggest that obese diabetes patients have a disrupted skin barrier function that leads to decreased skin hydration.16 In obesity with type 2 DM, excessive macrophage infiltration

Table 2: The correlation of BMI and skin hydration in type 2 DM patients.

BMI	Skin hydration						p-value
	Good		Dry		Total		
	n	%	n	%	n	%	
<23 kg/m^2	0	0	13	100	13	100	
23–24.9 kg/m^2	3	13	20	87	23	100	0.236*
≥25 kg/m^2	3	4.9	58	95.1	61	100	
Total	6	6.2	91	93.8	97	100	

Note: * – significant if p-value<0.05 by Chi-Square test.

between the enlarged fat cells and release of inflammatory cytokines that can activate the mast cells, which subsequently release histamines. This, in turn, promotes the activity of hyaluronidase, which degrades hyaluronic acid, causing incomplete moisture retention and subsequent skin dryness [26]. However, our study found no statistically significant correlation between BMI and skin hydration in type 2 DM patients. Further research with multicenter studies and a larger sample size is required to identify the relationship between BMI and skin hydration in a wider scope.

Conclusion

There is no significant correlation between BMI and skin hydration in patients with type 2 DM. However, further research with multicenter studies and a larger sample size is required to confirm the relationship between BMI and skin hydration in a wider scope. Controlled BMI might be beneficial for ameliorating skin function impairment, especially skin hydration. Thus, it can reduce cutaneous disorders due to dry skin hydration and improve patients' quality of life.

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Conflict of interest

The authors declared no conflict of interest.

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