

## Original Article

# The Presence of Demodex Folliculorum in Various Obese Groups According to BMI Levels

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## Abstract

**Background:** This study aimed to detect the presence of the parasite *Demodex folliculorum* (DF) in various obese groups according to BMI Levels.

**Materials and Methods:** A total of 182 patients (40.8 ± 14.8 years, min-max age 19 – 73 years) were enrolled in the study, of those 65 (35.7%) were female and 117 (64.3%) were male. They had previously applied to Mustafa Kemal University (Faculty of Medicine, Endocrine Outpatient Clinic) during 2012. A standardized skin surface biopsy method was used to research the existence of DF. Patients were classified into four main groups, including: obese (n = 89), overweight (n = 31), normal (n = 32), and underweight (n = 30).

**Results:** There was no significant difference between groups in terms of age and sex. The total DF positivity was 19 (21.3%) in obese patients. Among those with positive DF, the mean BMI was 35.7 ± 12.1 kg/m<sup>2</sup>, while those with negative DF had a mean BMI of 29.2 ± 9.2 kg/m<sup>2</sup>. There was a significant difference between two groups ( $P = 0.002$ ). Also, the underweight group has significantly higher DF positivity in comparison to the normal weight group.

**Conclusion:** The DF positivity was significantly higher in obese patients in accordance with the physiopathologic nature of the disease.

**Keywords:** BMI, demodex folliculorum, obesity, overweight, underweight

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## Introduction

Today, obesity is one of the most important health problems in developed and developing countries. It has become a widespread, and epidemic problem in Turkey and throughout the world.<sup>1-3</sup> World Health Organization<sup>4</sup> defines obesity as “abnormal or excessive fat accumulation in the body in an amount to deteriorate health”, and reported that in 2015 there could be 700 million obese and 2.3 billion overweight individuals in the world.<sup>4</sup> Body mass index (BMI) is usually used to define obesity by estimating body mass relative to height, but it does not provide information on fat distribution in the body. Fat tissues form an average mass of 15% – 20% in adult males and 25% – 30% in adult females. Obesity occurs when the ratio is over 25% in men, and over 30% in women.<sup>5</sup>

Currently, it is known that obesity causes many health problems due to its negative effects on organ systems and psychosocial status.<sup>6,7</sup> There are also a few studies about obesity’s effects on skin pathologies. It has been discovered that obesity can deteriorate the protective function of the skin, and can cause various pathologies in the sebaceous glands, sweat glands, lymphoid system, wound healing, blood circulation, and subcutaneous tissue of the skin.<sup>8-10</sup> Seborrhic dermatitis, achrochordons, candidiasis, bacterial cellu-

lite, and intertrigo (owing to the increased amount of skin) are common lesions seen in obese patients.<sup>11</sup>

Fat tissue is not only a depot for lipid accumulation, it is also an organ in which endocrine, metabolic and inflammatory signals have connections to each other. It affects the immune system by releasing several inflammatory and pro-inflammatory substances. Adipokines (leptin and resistin), and pro-inflammatory cytokines (TNF- $\alpha$  and interleukin-6) are supposed to have more complex roles in cutaneous physiology and pathophysiology, since they activate some modulators of insulin resistance, inflammation and wound healing.<sup>12,13</sup> Previous studies suggested that the association between obesity and changes in skin physiology may be related to an increase in sweat gland activity; dry skin; high trans-epidermal water loss (TEWL); altered collagen structure and function; as well as impaired wound healing.<sup>14,15</sup>

Demodicosis is a parasitic skin disease caused by the follicular parasites, including *Demodex folliculorum* (DF) and *Demodex brevis* (DB).<sup>16,17</sup> These species are located on the face, at the bottom of hairs, in hair follicles, inside the skin’s lipid release glands, as well as on the eyelashes, forehead, nose, ears and genital areas. The *Demodex* species uses sebum for feeding; particularly, the fat-and-protein-rich liquid medium of the inflamed follicles which is an excellent source of nutrition for them. Although it’s pathogenic mechanism is not fully known, the medical importance of these parasites-which spread by close contact-is still a matter of discussion. Cellophane lamina, skin scraping, punch biopsy, and standard skin surface biopsy (SSSB) are being used for the diagnosis.<sup>18,19</sup> Determination of *Demodex* spp density/cm<sup>2</sup> is essential for detecting the pathogenicity of the parasite.<sup>20</sup> Because they are obligatory parasites, and can be found in various parts of the body, it is hard to detect their pathogenicity in human. They can be found in healthy skin, hair follicles, and lipid glands with-

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out any pathogenic effects. However, when skin cleaning is not performed appropriately, lesions can appear where the immune system is suppressed. Pus-dermatitis, keratosis and epithelioma in hair follicles and lipid glands, acne, and rosacea can arise.<sup>21,22</sup> In the absence of immunity, the frequency of the parasite increases and it provokes skin lesions in abnormal immune reactions.<sup>23</sup> In the literature, it has been stated that in cases that are immune suppressed, the DF density may increase.<sup>24</sup> It has also been reported that the infestation can become intense in patients whose immune systems are suppressed, those who use immunosuppressive drugs, or those who have low immunologic reactivity.<sup>21,23,25–27</sup>

This study aimed to detect the DF frequency in the subject groups classified according to their BMI. This study was based on the relationships between the excessive fat tissues and its negative effects on the immune system. Physiologic conditions in obesity cause several changes on the skin which result in DF being an opportunistic skin parasite living in the sebum.

## Material and Methods

### Study groups

A total of 182 patients ( $40.8 \pm 14.8$  years; min–max age 19 – 73 years) were included in the study [65 (35.7%) were females and 117 (64.3%) were males]. They had previously applied to Mustafa Kemal University (Faculty of Medicine, Endocrine Outpatient Clinic) during 2012 for obesity problems. The patients with systemic diseases (malignancy, diabetes mellitus, hypertension, autoimmune diseases, cardiac, metabolic, and central nerve ischemia), who use systemic and/or local corticosteroids, or who had any dermatologic problems (such as like erythematous papule, pustule and skin type etc.) were excluded. The data on age, gender, height, and weight were recorded from the patient files. The research was approved by Mustafa Kemal University Ethical Committee.

The study groups were divided into six subgroups according to their BMIs ( $\text{kg}/\text{m}^2$ ). The individually BMI classifications were matched to the WHO criteria as underweight (BMI  $< 18.5 \text{ kg}/\text{m}^2$ ); normal weight (BMI of  $18.5 - 24.99 \text{ kg}/\text{m}^2$ ); overweight (BMI of  $25.0 - 29.99 \text{ kg}/\text{m}^2$ ); obese class I (BMI of  $30.0 - 34.99 \text{ kg}/\text{m}^2$ ); obese class II (BMI of  $35.0 - 39.99 \text{ kg}/\text{m}^2$ ); and morbid obesity/obese class III (BMI  $\geq 40.0 \text{ kg}/\text{m}^2$ ).<sup>2,28</sup>

### Sample collection and detection of demodex mites

Standard skin surface biopsy technique was used to detect DF in subjects. Samples from the forehead, nose, cheeks, and chin were taken by adhesive containing cyanoacrylate glue. It was ensured that the patients did not have creams, lotions, etc. on their faces. Sampling location was cleaned with alcohol and waited until it dried. A circle of about  $1 \text{ cm}^2$  was drawn by a glass pen on one

surface of the lamina. Then, one drop of cyanoacrylate containing adhesive was dropped within the circular image on the other surface. This surface was then contacted with the skin of the patient and held for a minute. At the end of this period, the lamina was slowly removed. A drop of Hoyer's solution was dropped onto the sample, covered with lamella, and examined under a lighted microscope using  $\times 40$  and  $\times 100$  zoom lenses. The DF density in  $\text{cm}^2$  was then observed. A diagnosis of five or more DF per  $\text{cm}^2$  was considered as positive.

### Statistical analysis

The data were analyzed using SPSS software. A two-tailed “*P*-value” less than 0.05 were considered significant. The One Way Anova test, posthoc tukey test, and the Fisher's exact test were used for the statistical analysis.

## Results

Among the 182 patients who participated in the current study, 117 (64.3%) were female, and 65 (37.3%) were male. Their ages varied from 19 to 73 years old (mean:  $40.8 \pm 14.8$  years). In this study, 89 patients were enrolled in the obese groups (class 1, 2, 3), 31 in the overweight group, 32 in the normal weight group, and 30 in the underweight group (Table 1). DF was positive in 26 patients (8 males (30.8%) and 18 females (69.2%)) (Table 2, Figure 1). The total DF positivity rate was 19 (21.3%) in patients with BMIs of 30 and over (obese groups) (Table 2, Figure 2). We detected that 14.28% of obese patients with allergic symptoms like itching have DF positivity on their face.

DF positive and negative subjects were compared in terms of gender, age, and BMI. There was no significant difference between males and females due to DF positivity. Among those with positive DFs, the mean age was  $44.4 \pm 14.5$  years, and patients with negative values had a mean age of  $40.3 \pm 14.8$  years. There was no significant difference in terms of the mean age between these two groups. Among patients with positive DFs, the BMI average was  $35.7 \pm 12.1$ , while patients with negative DFs had a BMI average of  $29.2 \pm 9.2$ , and there was a statistically significant difference between these two groups ( $P = 0.002$ ).

When the DF occurrence was evaluated according to BMI groups, a significant difference was observed between two groups ( $P = 0.04$ ) (Table 2). The results of this study reveal that increased BMI effects on the DF occurrence rates (Figure 1). Nevertheless, high rates of DF positivity were also found in patients who were considered underweight (13.3%) (Table 2, Figure 1). No significant difference was found when the mean age of BMI groups was compared (Table 1). In addition, no significant differences were detected among BMI groups in terms of gender.

**Table 1.** Average ages between groups according to BMI

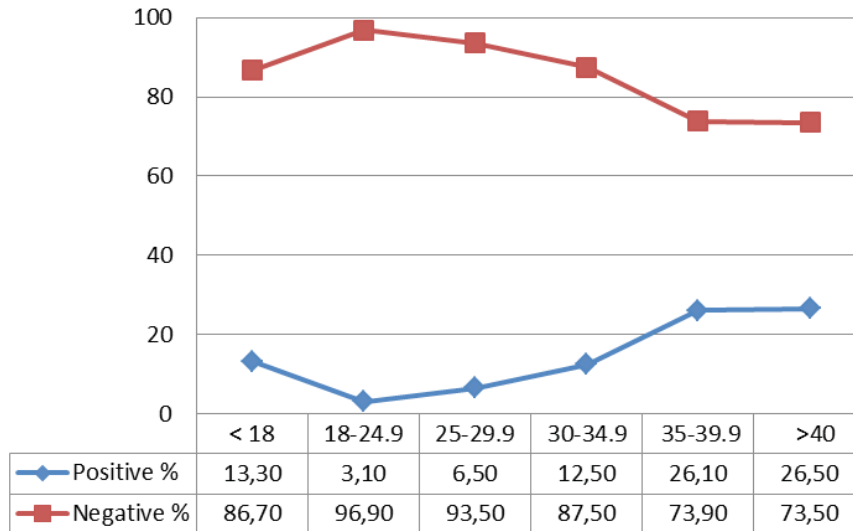
BMI	n (%)	Age mean (SD)	<i>P</i> *
< 18	30 (16.48)	$40.40 \pm 15.77$	
18–24.9	32 (17.58)	$37.28 \pm 13.51$	
25–29.9	31 (17.03)	$37.74 \pm 13.78$	
30–34.9	32 (17.58)	$45.0 \pm 17.93$	
35–39.9	23 (12.63)	$42.21 \pm 14.56$	0.258
> 40	34 (18.68)	$42.79 \pm 12.43$	

\*The comparison of the age values using the One Way Anova test.

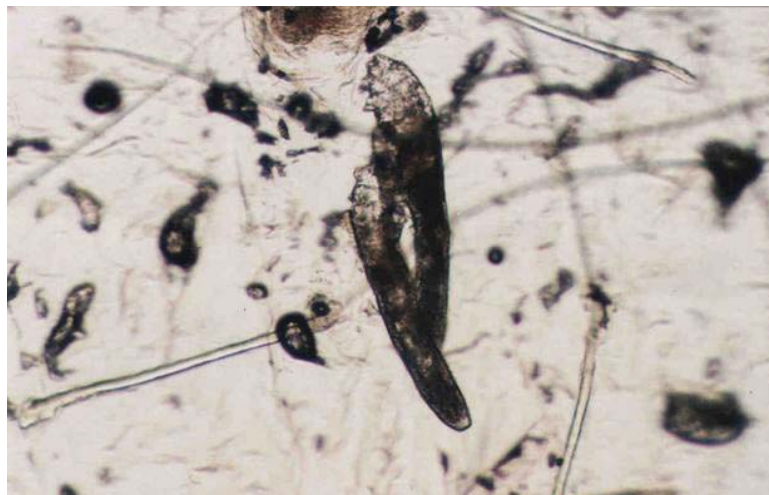
**Table 2.** *D. folliculorum* occurrence according to BMI groups

<i>D. folliculorum</i>	Body Mass Index - n (%)						P
	< 18	18-24.9	25-29.9	30-34.9	35-39.9	> 40	
Positive	4 (13.3)	1 (3.1)	2 (6.5)	4 (12.5)	6 (26.1)	9 (26.5)	
Negative	26 (86.7)	31 (96.9)	29 (93.5)	28 (87.5)	17 (73.9)	25 (73.5)	
<b>Total</b>	<b>30</b>	<b>32</b>	<b>31</b>	<b>32</b>	<b>23</b>	<b>34</b>	<b>0.038*</b>

\* The comparison of positive and negative values using the Fisher's exact test.



**Figure 1.** *D. folliculorum* occurrence distribution graphic, according to BMI groups.



**Figure 2.** Adult mites of *D. folliculorum*-standard surface skin biopsy (Original magnification ×40).

## Discussion

Obesity prevalence and obesity-related chronic diseases tend to increase, especially in developed countries. On the other hand, obesity is seen less in African and Asian countries due to socio-economic conditions. Gender variations in obese groups have been reported to be related to geographic locations. The prevalence of being overweight in European adults ranged between 32% and 79% in men and between 28% and 78% in women.<sup>29</sup> According to Gültekin, et al. obesity prevalence was found to

be 34.2% for women, and 20% for men in Turkey. According to another study, 1496 individuals were examined, 483 (32.3%) had normal body weight, 575 (38.4%) were overweight, and 438 (29.3%) were obese. The average body mass index (BMI) was higher in women. They also reported that, the prevalence of obesity increased with age and the presence of diabetes mellitus. Postmenopausal period and low educational level also increased the risk for obesity.<sup>24</sup> In the current study of obese patients with BMIs of 30 and over, the gender ratios were found to be 34.2% (male) and 65.8% (female). According to a research conducted

by Turkey Diabetes, Hypertension, Obesity and Endocrinological Diseases Prevalence (TURDEP) study group, the obesity prevalence was the highest in central Anatolian (25.0%) and lowest in eastern Anatolian (17.2%) regions of the country. The remaining results were 24% (Southern Anatolia), 23.5% (Northern Anatolia), and 21.6% (Western Anatolia).<sup>30</sup>

Today, obesity etiology is thought to be multifactorial, and it is an important risk factor in the pathogenesis of many diseases, including cardiovascular and dermatologic disorders. Moreover, there is a higher frequency of several bacterial, viral, and mycological infectious diseases in obese population.<sup>31</sup>

A higher incidence of cutaneous infections has been reported in obese population as compared with non-obese patients. Intertrigo, furunculosis, candidiasis, tinea cruris, folliculitis, and erythrasma are frequent skin infections among obese patients.<sup>32</sup> Also, fungal foot infections, like tinea pedis and onychomycosis are more common in obese patients than non-obese patients.<sup>33</sup> Obesity may predispose to acute bacterial cellulitis of the lower extremities.<sup>34</sup> Although there are limited data on the pathogenesis and parasitic factors in the literature, there is no data to report the relationship between the obesity and DF. It has been reported that the SSSB technique, which is a diagnostic method for DF infestation defined by Marks and Dawber, facilitates the diagnosis and the detection of the parasite amount in one cm<sup>2</sup>.<sup>35</sup> This is due to the complete gathering of the follicle content within the surface of the skin's corneal layer, where the DFs are located.<sup>21</sup> Therefore, this technique has been preferred in researches of the parasite.

DF is a saprophytic skin parasite that mainly affects the face and its highest concentration can be found in regions where sebaceous glands are high in number and sebum production is significant. It can also be found on the skin of healthy subjects. This skin parasite is an opportunistic parasite in immune suppressive individuals, and DF has been reported to have an increased frequency in patients with AIDS, leukemia, rheumatoid arthritis, and dialysis patients.<sup>23,25-27</sup> Moreover, obese patients have larger skin folds, and sweat more profusely after becoming overheated because of the thick layers of subcutaneous fat. Also, enhanced local corticosteroid usage on the skin in obese patients leads to hyperactivity of local immunosuppressive mechanisms. For example, adipokines (such as IL-6 and leptin), which are mainly synthesized in fat tissues, are increased with obesity.<sup>36</sup> IL-6 improves insulin resistance, stimulates CRH, and increases ACTH release.<sup>37</sup> ACTH is known as a trigger of corticosteroids production, which have immunosuppressive effects. In addition, sebaceous hyperplasia with oily or mixed skin seems to favor DF proliferation.<sup>11</sup>

In our study, the BMI of the DF positive patients were found to be significantly higher when compared to negative ones ( $P = 0.002$ ). It is suggested that this high positivity has occurred in obese patients due to the previously mentioned pathophysiologic mechanisms. The results of the current study reveal that increase in BMI affects DF appearance rates. Increase in DF frequency prompts us to assume that this indicates a beginning of DF colonization leading to infection. In our study, due to the similarity in sampling groups, there was no significant difference between ages and gender ratios of the study groups. In addition, high rates of DF positivity (13.3%) were found in underweight patients. Obesity is known to change the immune responses related to cellular responses such as malnutrition, and it is related to many skin symptoms and skin diseases. Nevertheless, the relationship of demodicosis with obesity and malnutrition is not well known.

There are still many in vitro and in vivo studies that need to be accomplished.

Further studies with a larger sample size are needed to clarify this association. Also, further analysis with BMI as a quantitative variable is needed.

In conclusion, 14.28% of obese patients with allergic symptoms like itching, have DF positivity on their face. Therefore, we further believe that these findings must be supported with extensive, planned, and randomized clinic studies covering obese children- especially emphasizing experimental research. Studies for enlightening the dermal pathophysiologic features of obese people will provide much greater information on the pathogenesis and treatment of skin diseases caused by infectious agents.

Due to the significant level of DF positivity in obese patients, in compliance with the physiopathologic nature of the disease, we think it must be considered under the patient management, especially for obese patients with clinical symptoms.

### Conflict of Interest

*We state that neither the author nor any of the co-author has any potential conflict of interests related to the publication of this paper.*

### Ethical Approval

*The research was approved by Mustafa Kemal University Ethical Committee.*

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### Abbreviations

*DF: Demodex folliculorum; BMIs: Body mass indexes; WHO: World Health Organization; TEWL: High trans-epidermal water loss; DB: Demodex brevis; SSSB: Standard skin surface biopsy; TURDEP: Turkey Diabetes, Hypertension, Obesity and Endocrinological Diseases Prevalence.*

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