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International Journal of Dermatology and Clinical Research

ISSN: 2455-8605 DOI CC By

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Dates: Received: 08 April, 2017; **Accepted:** 24 April, 2017; **Published:** 25 April, 2017

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Keywords: Skin disorders; Overweight; Obesity

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Research Article

Skin Disorders in Adult Obese Egyptian Patients: A Comparative Study

Abstract

Background: Obesity is a major public health concern worldwide. Limited number of studies on the relationship between obesity and skin disease are available

Objective: We aimed to determine the prevalence of various cutaneous disorders in obese patients and to compare them with patients with a normal body mass index (BMI).

Materials and Methods: The study included adult patients with skin diseases recruited from Dermatology outpatient clinic, Assiut University Hospital and El-eman General Hospital. Assiut, between January 2014 and December 2014. Full history taking, height and body weight measurement for Body Mass Index (BMI) calculation, blood pressure measurement and complete dermatological examination were done for each patient. Blood investigations including fasting blood sugar levels and lipid profile were done for all patients.

Patients were categorized as normal weight, overweight, obese I, or obese II/III using BMI cut-points. Skin conditions were classified according to the International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10).

Results: A total of 361 adult patients (202 females/159 males), with mean age 36.83 years. According to BMI, 31.3% were normal weight, 23.3% were overweight, 21.8% in the obese I category, and 23.5% in obese categories II/III. Among skin disease categories, only pigmentation disorders showed significant difference between obese and non-obese patients; being less frequently found in obese group (10.48% versus 19.47%; P=0.02). No significant difference was found in the prevalence of psoriasis, acne vulgaris, contact dermatitis, atopic dermatitis and alopecia areata in the two groups. However, vitiligo showed significantly lower prevalence and lower odds ratio in obese (OR=0.43, P=0.04) compared with non-obese subjects. Among skin infections, only parasitic skin infestations showed increasing prevalence with increased levels of BMI (trend P = 0.02). Plantar hyperkeratosis (P=0.046), simple intertrigo (P= 0.045), varicose veins (P=0.0001), skin tags (P=0.046) and striae (P<0.0001) were significantly more frequent in obese patients. Except for intertrigo, all these cutaneous manifestations showed significant linear association with BMI.

Conclusion: Obesity is associated with cutaneous disorders including plantar hyperkeratosis, intertrigo, varicose veins, skin tags and striae but lower rates of pigmentation disorders, predominantly vitiligo.

Abbreviations

BMI: Body Mass Index, WHO: World Health Organization, TG: Triglycerides, HDL: High Density Lipoprotein, NCEP-ATP III: National Cholesterol Education Program's Adult Treatment Panel III, ICD-10: International Statistical Classification of Diseases and Related Health Problems 10th Revision, AN: Acanthosis Nigricans, OR: Odds Ratio, MHC: Melanin-Concentrating Hormone, MCHR: Melanin-Concentrating Hormone Receptor.

Introduction

Obesity is emerging as an important health problem worldwide. Body mass index (BMI) is the most widely used method to define obesity. It is a ratio of weight in kilograms divided by height in meters squared (kg/m^2). In clinical terms, a BMI of 25-29 kg/ m^2 is called overweight, higher BMI (30kg/ m^2 or greater) are called obesity [1,2].-

Obesity has become a major public health problem in Egypt, with marked rise over the past 30 years. With nearly 70 % of

Citation: Abdel Maguid EM, Awad SM, Saad MM (2017) Skin Disorders in Adult Obese Egyptian Patients: A Comparative Study. Int J Dermatol Clin Res 3(1): 001-007. DOI: http://doi.org/10.17352/2455-8605.000018

its adult population overweight or obese, Egypt is the fattest African country and is the 14th fattest country in the world, as estimated by WHO in 2010 [3].

The impact of obesity on the skin has received little attention. Various skin problems may occur due to hormonal changes, skin stretching, and increased moisture, venous pressure and altered cutaneous sensation and temperature regulation. Many of such problems almost resolve with a healthy diet and subsequent weight loss [4].

Altered skin physiology can also occur secondary to obesity; leading to changes in the skin barrier, sweat glands and collagen structure, as well as alterations in inflammation and sebum production. In addition, obesity affects wound healing, microcirculation, and subcutaneous fat [5,6].

Moreover, multiple cutaneous manifestations are frequently observed in obese patients including: acanthosis nigricans and skin tags (due to insulin resistance), hyperandrogenism and hirsutism, striae distensae due to over extension, stasis pigmentation due to peripheral vascular diseases, lymphedema, plantar hyperkeratosis, cellulitis, and skin infections. In addition, several preexisting dermatological conditions can be aggravated by obesity such as skin infections, psoriasis, eczema and acne [4].

Despite physiologic studies suggesting links between obesity and cutaneous disorders, there have been few studies on the prevalence of cutaneous disorders associated with obesity. With a rising incidence of obesity, we conducted such study to determine the frequency of various dermatoses related to obesity and compare them with normal weight in the Egyptian population.

Materials and Methods

Study Sample

A cross-sectional study was conducted including 361 adult patients (202 females/159 males), aged above 18 years visiting the Dermatology outpatient clinic of Assiut University Hospital and El-eman General Hospital, Assiut, between January 2014 and December 2014. An informed consent was taken from every patient and the study was approved by the Ethics Committee of Assiut Faculty of Medicine.

Sample size estimation of the studied patients:

Sample size calculation was carried out using G-power software version 3.1 [7]. A sample of 290 patients was needed to detect an effect size of 0.3 between the two groups regarding the proportion of patients with any skin disorder, with a p-value < 0.05 and 95% power. Sample size was increased to obtain adequate number of patients within subgroups.

Clinical Evaluation

Demographic details such as age, sex, residence, personal of diabetes mellitus and hypertension, and family history of obesity were recorded. A thorough dermatological examination was performed.

Body height was measured to the nearest 0.1 cm in the standing erect position, without shoes, and with buttocks, shoulders, and occiput touching the wall by marking the point of top of head on a carton scale attached to the wall. Body weight was measured to the nearest 0.1 kg with an auto-calibrated measuring scale. Body Mass Index (BMI) was calculated as weight in kilograms divided by the square of height in meters. Based on the values of BMI (in kg/m2), patients were classified in accordance with the international classifications of adult, into the following categories: normal weight (BMI 18.5 –24.99), overweight (BMI 25-29.9), obesity I (BMI 30 - 34.9), obesity II (BMI 35 - 39.9), and obesity III (BMI ≥ 40), using cut-offs recommended by World Health Organization Consultation on Obesity [8] also advised by National Institute of Health Care and Excellence [9]. Patients who were underweight (BMI <18.5) were excluded from the study.

Blood pressure was measured with a sphygmomanometer after a 15-min rest in the semi-sitting position at least three times at the right upper arm and the mean was used in the analyses.

Five ml of venous blood were collected in the morning after 12-hour fasting. Fasting blood glucose and lipid profile including serum total cholesterol, triglycerides (TG) and high density lipoprotein (HDL) were measured.

Participants were categorized as having or not metabolic syndrome using the criteria modified from those of the National Cholesterol Education Program's Adult Treatment Panel III (NCEP-ATP III) revised criteria [10,11] and the World Health Organization [12], which requires the presence of at least 3 criteria of the following: 1) fasting glucose 100 mg/dL or greater (or receiving drug therapy for hyperglycemia); 2) blood pressure 130/85 mmHg or higher (or receiving drug therapy for hypertension); 3) triglycerides 150 mg/dL or higher (or receiving drug therapy for hypertriglyceridemia); 4) HDL cholesterol (high density lipoprotein cholesterol) less than 40 mg/dL in men or less than 50 mg/dL in women (or receiving drug therapy for reduced HDL); and 5) body mass index > 30 kg/m^2. The main difference between NCEP ATP III definition and WHO classification is that the latter uses BMI > 30 kg/m2 instead of waist circumference as diagnostic criteria because of different cut off levels for waist circumference in different ethnic groups.

Forty nine skin conditions were detected by dermatological examination. These conditions were grouped into 8 categories according to The International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10), as classified by WHO [13]. These categories include infections of the skin and subcutaneous tissue, connective tissue and vesiculobullous disorders, dermatitis and eczema, papulosquamous disorders, urticaria and erythema, pigmentation disorders, disorders of skin appendages and the remaining skin diseases were listed as others.

The study was approved by the Ethics Committee of Assiut Faculty of Medicine and informed consent was obtained from all patients before enrollment in the study.

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Statistical Analysis

Data was analyzed using STATA intercooled version 12.1. Quantitative data was represented as mean ± standard deviation. Qualitative data was presented as number and percentage. The Student's t-test for independent samples was used in the analysis of the quantitative variables. Chi-square test with Yate's correction or Fisher's exact test was used to compare qualitative data. Odds ratios from separate logistic regression models were used to examine association of the BMI categories with skin conditions treated as dichotomous variables. The association of BMI with skin conditions was assessed by a test for trend, using the logistic regression analogue to the Mantel-Haenszel extension test. P value was considered significant if it was less than 0.05.

Results

The study included 361 patients; 202 females (56.96%) and 159 males (44.04%), with mean age 36.83 years. According to BMI, the patients were divided into two groups; the normal weight (non-obese) (BMI 18.5 – 24.99 kg/m2) which included 113 (31.30%) patients and the overweight/obese group (BMI≥25 kg/m2) which included 248 (68.69%) patients. Within the latter group, 84 (23.27%) patients were overweight (pre obese), 79 (21.88%) were obese class I, 80 (22.16%) were obese class II, and 5 (1.39%) were obese class III. Because of small numbers, obese classes II/III were combined in one group.

The demographic and clinical characteristics of the studied patients are shown in (Table 1). There was statistically significant association between obesity and increasing age, living in urban areas, hypertension, dyslipidemia and metabolic syndrome, while no significant difference was found between obese and non-obese patients regarding sex, skin type, and family history of obesity and diabetes mellitus.

Among the 8 skin disorder groups, disorders of pigmentation were significantly less common in the obese patients (10.48%) compared with non-obese (19.47%) (P=0.02). Otherwise, there were no significant differences between the two groups regarding other cutaneous disorder categories (Table 2). Moreover, it was shown that the prevalence of pigmentation disorders decreases with increasing BMI with lowest risk in obese class II/III (OR=0.49, P=0.04) (Table 3).

Regarding individual skin diseases, obese patients showed lower prevalence of vitiligo with lower odds ratio (OR=0.43, P=0.04) compared with non-obese patients. Meanwhile, no association with obesity was observed for psoriasis, acne vulgaris, contact dermatitis, atopic dermatitis, and alopecia areata. There was no significant difference between the two groups in prevalence of bacterial, fungal, viral or parasitic skin infections. Obese patients showed a higher proportion of plantar hyperkeratosis, intertrigo, varicose veins, skin tags and striae than subjects with a normal BMI. None of normal weight patients had acanthosis nigricans (AN), while 5 cases were detected in obese patients. However statistical significance could not be assessed (Table 4).

When the associations of BMI categories with skin disorders was assessed, there were statistically significant (p < 0.05) trends of increased prevalence associated with higher BMI for parasitic skin infestations, plantar hyperkeratosis, varicose veins, skin tags and striae (Table 5). The strongest associations (odds ratio [OR] > 3 for obese category II/III compared to normal weight) were observed for varicose veins (OR =13.6), skin tags (OR=5.6), and striae (OR =3.56). Although the prevalence of parasitic infestation was not significantly different in obese and non-obese groups, parasitic skin infestation showed increasing prevalence with increasing BMI; showing the highest prevalence in obesity class II/III (OR= 3.8). There was a significant inverse association with vitiligo; with lowest risk in obese class II/III (OR=.0.11).

Discussion

Obesity is emerging as a global epidemic and is implicated in many dermatoses. Its rising incidence ensures that obesity-

Table 1: Demographic and clinical characteristics of obese and control groups

Characteristics	Controls n=113	Overweight/ obese n=248	Odds ratio (95% CI)	P value*
Age (years), mean (SD)	34.03 (11.25)	38.10 (11.60)		**0.002**
Sex, n (%) Females Males	71 (62.83%) 42 (37.17)	131 (52.82%) 117 (47.18%)	1.51 (0.95-2.39)	0.08
Residence, n (%) Rural Urban	82 (72.57%) 31 (27.43%)	153 (61.69%) 95 (38.31%)	1.64 (1.01-2.67)	**0.04**
Family history of obesity, n (%) No Yes	45 (39.82%) 68 (60.18%)	95 (38.31%) 153 (61.69%)	1.07 (0.68-1.68)	0.78
Skin type, n (%) 2 3 4	16 (14.16%) 70 (61.95%) 27 (23.89%)	35 (14.11%) 136 (54.84%) 77 (31.05)	1 0.88 (0.45-1.72) 1.30 (0.62-2.73)	 0.72 0.48
BMI (kg/m²), mean (SD)	22.17 (1.69)	31.99 (4.19)		**<0.0001**
Metabolic comorbidities DM, n (%) No Yes	85(75.22%) 28(24.78%)	180(72.58%) 68(27.42%)	1.15 (0.69-1.91)	0.60
Hypertension, n (%) No Yes	103 (91.15%) 10 (8.85%)	183 (73.79%) 65 (26.21%)	3.67 (1.77-7.54)	**0.0002**
Dyslipidemia, n (%) No Yes	89(78.76%) 24 (21.24%)	170(68.55%) 78(31.45%)	1.14 (0.67-1.86)	**0.042**
Metabolic syndrome, n (%) No Yes	91 (80.53%) 22 (19.47%)	132 (53.23%) 116 (45.77%)	3.63 (2.10-6.29)	**<0.0001**

BMI: Body mass index; DM: diabetes mellitus
*Student t-test was used to compare the mean difference between the two groups. Chi-square test analysis was used to compare the difference in proportions between the two groups

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related skin diseases will represent an increasing proportion of dermatologist's work load [14]. In the present study, we described the pattern of skin diseases among obese patients compared with a control group of normal weight patients.

On comparing skin disorder groups between obese and normal weight patients, there was no significant difference except in pigmentation disorders; where obesity was associated with lower risk of pigmentation disorders. There was also significantly lower frequency of vitiligo in obese compared to non-obese. To our knowledge, this is the first report showing an inverse relationship between vitiligo and obesity. A previous study [15] reported no significant difference in BMI between vitiligo group and control group. The authors suggested that although insulin resistance is increased in patients with vitiligo, different mechanisms other than obesity may be responsible for insulin resistance in such patients.

A potential explanation for this inverse relationship may be that melanin-concentrating hormone (MHC), the appetite regulating neuropeptide, might be dysregulated in vitiligo patients. This is evidenced by the presence of melanin-concentrating hormone receptor (MCHR) autoantibodies in vitiligo patients which were shown to induce damage to human melanocytes, suggesting their potential role in the pathogenesis of vitiligo [16]. In support of this hypothesis, MHC has been shown to regulate feeding in rodent; mice lacking MHC are lean and hypophagic, whereas MCH overexpression causes obesity [17,18]. Melanin-concentrating hormone (MHC) and its receptors MCHRI were found both in primary human and mouse islets [19]; providing additional evidence for a potential link between MCHR auto-antibodies and BMI in patients with vitiligo. Further studies with a larger sample size are needed to clarify the relationship between obesity and vitiligo.

In the present study, although the frequency of acne in obese patients (10.48%) was higher (6.8%) or nearly similar (11.2%) to the rates reported by previous studies in Egypt [20,21], no significant difference was shown in acne prevalence when compared to non-obese group. In agreement with our findings, similar acne prevalence was found between obese and non-obese in some studies [21,22]. On the other hand, other studies [23, 24] reported an association between increased body mass index and acne. It is likely that obesity influences the severity rather than the incidence of acne. Acne is clearly exacerbated by obesity associated disorders such as hyperandrogenism, insulin resistance and hirsutism [25].

Previous studies [26] stated that obesity in adults is associated with increased eczema prevalence and severity, and a number of studies supported the presence of positive association between obesity and atopy [27-29]. However, we found no association between obesity and atopic dermatitis, which is also consistent with other studies [30, 31]. The inconsistency of the results may be possibly related to environmental, racial and ethnic factors in different populations.

Although the association between obesity and psoriasis has been demonstrated by several studies [21, 32-34], we found that the prevalence of psoriasis was nearly equal in obese and non-obese. Similar results were reported by Ahsan et al. [34] and Boza et al. [22]. Furthermore, Al-Mutairi [35] found that there was no relation between degree of obesity and severity of psoriasis. Boza et al. [22] stated that a variety of factors were found to be related to this skin disease, because after the control for diabetes, dyslipidemia and metabolic syndrome, the relationship with obesity was no longer significant.

Table 2: Prevalence of skin disease categories in obese and control groups

Skin disease group	Controls n=113	Overweight/ obese n=248	OR (95% CI)	P value*
Infections of the skin and subcutaneous tissue	38 (33.63%)	76 (30.65%)	0.87 (0.54-1.40)	0.57
Connective tissue and vesiculobullous disorders	3 (2.65%)	12 (4.84%)	1.86 (0.51-6.76)	0.36
Dermatitis and eczema	13 (11.50%)	36 (14.52%)	1.31 (0.66-2.57)	0.44
Papulosquamous disorders	9 (7.96%)	21 (8.47%)	1.07 (0.47-2.42)	0.87
Urticaria and erythema	1 (0.88%)	6 (2.42%)	2.78 (0.33-23.48)	0.33
Pigmentation disorders	22 (19.47%)	26 (10.48%)	0.02 (0.26-0.90)	0.02
Disorders of skin appendages	22 (19.47%)	46 (18.55%)	0.94 (0.53-1.66)	0.84
Other skin disorders	5 (4.42%)	25 (10.08%)	2.42 (0.89-6.54%)	0.07

OR: Odds Ratio, CI:Confidence Interval
*significance obtained by chi-square with Yates correction or Fisher exact test. Significant p value bolded.
Odds ratios adjusted for age, residence, presence of hypertension, diabetes, dyslipidemia and metabolic syndrome.

Table 3: The association between BMI categories and skin disease groups

Skin diseases groups	Odds ratio of BMI (kg/m2) categories with skin conditions				
	Normal weight n, % (OR)	Overweight n, % (OR)	Obese I n, % (OR)	Obese II & III n, % (OR)	P for trend
Infections of the skin and subcutaneous tissue	38, 33.63 (1)	17, 20.23(0.53)	32,40.50(1.21)	27,31.76(0.97)	0.62
Connective tissue and vesiculobullous disorders	3, 2.65 (1)	2, 2.38(1.35)	4, 5.06(1.96)	6, 7.05(2.96)	0.22
Dermatitis and eczema	13, 11.50 (1)	11, 13.09(1.16)	12, 15.18(1.52)	13,15.29(1.26)	0.46
Papulosquamous disorders	9, 7.96 (1)	9, 10.71(1.74)	7, 8.86(0.95)	5, 5.88(0.57)	0.30
Urticaria and erythema	1, 0.88 (1)	3, 3.57(4.14)	1, 1.26 (0)	2, 2.35(4.09)	0.44
Pigmentation disorders	22, 19.47 (1)	10, 11.90(0.55)	8,10.12(0.49)	7, 8.23(0.40)	0.04
Disorders of skin appendages	22, 19.47 (1)	19, 22.6(1.38)	15, 18.98(0.81)	12,14.11(0.68)	0.22
Other skin disorders	5, 4.42 (1)	11, 13.09(1.96)	6, 7.59(1.77)	8, 9.41(3.55)	0.02

OR: Odds Ratio. Significant p trend bolded
Odds ratios adjusted for age, age, residence, presence of hypertension, diabetes, dyslipidemia and metabolic syndrome

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The present study did not show an association between obesity and alopecia areata, which is in agreement with an Egyptian study [21]. Another study showed an association between alopecia areata and insulin resistance, despite similar BMI in patients and controls [36]. Such association might result from increased inflammatory cytokines and hypothalamic-pituitary-adrenal axis activation; possibly secondary to altered immune response in alopecia areata. Further studies with larger sample sizes may give additional information on the relationship between alopecia areata and obesity.

Increased frequency of skin infections in obese individuals has been recognized in the literature [22,37]; owing to increased areas and depth of skin folds which leads to increased moisture and friction and appears to contribute to the development of fungal and bacterial infections in this population [22]. In the present study, 30.65% of obese patients had skin infections. However, there was no significant difference between obese and non-obese patients regarding prevalence of bacterial and fungal infections. This may be attributed to bad hygienic conditions and low immunity in our community which lead to high rate of such skin infections regardless of BMI. Our finding is in accordance with some other studies [34,38] which showed no association of obesity with skin infections. Characteristically, parasitic infestations (scabies and pediculosis) showed increasing prevalence with increasing obesity grade. This might be explained by obesity induced pathophysiological alterations in the skin which may favor parasitic infestation especially in severe obesity. There is no data reporting the relationship between the obesity and parasitic skin infestation. A previous study reported an increased frequency of the parasite Demodex folliculorum in obese patients, which has been assumed to result from pathophysiologic effects of obesity on skin [39]. These findings need to be supported by further studies to provide more information on the potential link between parasitic infestation and obesity.

Table 4: Prevalence of skin diseases in obese and control groups

Skin diseases	Controls	Overweight/ obese	OR (95% CI)	P value*
Psoriasis	9 (7.96%)	18 (7.26%)	0.90 (0.39-2.08)	0.81
Acne	12 (10.62%)	26 (10.48%)	0.99 (0.48-2.03)	0.97
Contact dermatitis	4 (3.54%)	11 (4.44%)	1.26 (0.39-4.07)	0.69
Atopic dermatitis	6 (5.31%)	9 (3.63%)	0.67 (0.23-1.94)	0.46
Vitiligo	12 (10.62%)	12 (4.84%)	0.43 (0.18-0.99)	0.04
Alopecia areata	4 (3.54%)	10 (4.03%)	1.44 (0.82-3.74)	0.82
Bacterial infections	9 (7.96%)	17 (6.85%)	0.85 (0.37-1.97)	0.71
Viral infections	16 (14.16%)	19 (7.66%)	0.50 (0.25-1.02)	0.053
Fungal infections	17 (15.04%)	35 (14.11%)	0.92 (0.49-1.74)	0.82
Parasitic infestations	3 (2.65%)	9 (3.63%)	1.38 (0.37-5.21)	0.63
Plantar hyperkeratosis	29 (25.66%)	90 (36.29%)	1.65 (1.00-2.71)	0.046
Simple intertrigo	26 (23.01%)	83 (33.47%)	1.68 (1.01-2.81)	0.045
Varicose veins	3 (2.65%)	43 (17.34%)	7.69 (2.26-26.06)	0.0001
Skin tags	7 (6.19%)	33 (13.31%)	2.32 (0.99-5.45)	0.046
Striae	17 (15.04%)	91 (36.69%)	3.27 (1.81-5.92)	<0.0001
Acanthosis nigricans	0	5 (2.02%)	___	___

OR= Odds Ratio, CI= Confidence Interval
*significance obtained by chi-square with Yates correction or Fisher exact test.
Significant p value bolded
Odds ratios adjusted for age, age, residence, presence of hypertension, diabetes, dyslipidemia and metabolic syndrome

Table 5: The associations of BMI categories and different skin conditions.

Skin diseases	Odds ratio of BMI (kg/m2) categories with skin conditions				
	Normal weight n, % (OR)	Overweight n, % (OR)	Obese I n, % (OR)	Obese II & III n, % (OR)	P for trend
Psoriasis	9, 7.96(1)	11, 13.09(1.74)	4, 5.06(0.62)	3, 3.52(0.42)	0.11
Acne	12, 10.62(1)	10, 11.90(1.27)	8, 10.12 (0.95)	8, 9.41(0.76)	0.52
Contact dermatitis	4, 3.54(1)	4, 4.76 (1.36)	4, 5.06(1.45)	3, 3.52(0.99)	0.93
Atopic dermatitis	6, 5.31(1)	2, 2.38 (0.43)	3, 3.79 (0.70)	4, 4.70(0.88)	0.88
Vitiligo	12, 10.62(1)	6, 7.14 (0.65)	5, 6.32(0.53)	1, 1.18(0.11)	0.046
Alopecia areata	4, 3.54(1)	3, 3.57 (1.01)	4, 5.06 (1.45)	3, 3.52(1.00)	0.86
Bacterial infections	9, 7.96(1)	3, 3.57(0.43)	7, 8.86(1.30)	7, 8.23(0.88)	0.83
Viral infections	16, 14.16(1)	7, 8.33(0.55)	8,10.12(0.68)	4, 4.70(0.30)	0.16
Fungal infections	17, 15.04(1)	10,11.9(0.76)	14,17.72(1.22)	11, 12.94(0.84)	0.94
Parasitic infestations	3, 2.65(1)	(0)	1, 1.26(0.47)	8, 9.41(3.80)	0.02
Plantar hyperkeratosis	29, 25.66(1)	24,28.75(1.30)	31,39.24(1.97)	35, 41.17(1.75)	0.03
Simple intertrigo	26, 23.01(1)	29,34.52(1.86)	33,41.77(2.27)	21, 24.70(1.09)	0.49
Varicose veins	3, 2.65(1)	6, 7.1 (3.33)	14,17.72(7.22)	23, 27.05(13.60)	0.0001
Skin tags	7, 6.19(1)	8, 9.52(1.59)	2, 2.53(0.39)	23, 27.05(5.61)	0.0002
Striae	17, 15.04(1)	25,29.76(2.53)	33,41.77(3.84)	33, 38.82 (3.56)	0.0001
Acanthosis nigricans	0, 0(1)	1, 1.19(NA)	2, 2.53(NA)	2, 2.35 (NA)	NA

OR: Odds Ratio. Significant p trend bolded
Odds ratios adjusted for age, age, residence, presence of hypertension, diabetes, dyslipidemia and metabolic syndrome

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The low prevalence rate of AN compared to previous reports [34,35,37,38] might be attributed to the variation in the severity of obesity among the studied subjects. A positive association has been demonstrated between AN and obesity grades in some studies [22,40]. In the present study, the number of class III obese patients was very low; which may account for the low prevalence of AN. Furthermore, AN is considered a cutaneous marker for hyperinsulinemia in obese individuals rather than a marker of obesity itself [41].

Similar to previous studies [22, 42, 43], including an Egyptian study [21], we found higher prevalence of plantar hyperkeratosis in obese groups, as well as an association for plantar hyperkeratosis with obesity grades. Varicose veins were much more frequent in obese and showed a strong linear association between varicose veins and severity of obesity. This is in agreement with a previous study which showed that over half of subjects with superficial varicose veins were overweight and obese [44]. In keeping with other studies [21,22,34,35,42], skin tags and striae were also more frequent in obese and strongly correlated with the obesity grades. Such skin disorders could therefore, serve as markers of obesity and its severity. Although the prevalence of intertrigo was higher in obese, as reported by other studies [21,22], it showed no linear association with severity of obesity.

The present study has a number of limitations. First, the sample was limited to one particular local government organization, which may limit extending the results to the general population. Also, because BMI was used to define obesity, we were not able to distinguish central obesity from peripheral obesity in this study. Nevertheless, several studies have consistently documented strong correlation of BMI with waist circumference and body fat measured by dual-energy X-ray absorptiometry [45,46]. Another limitation is the relatively small number of cases for some skin disorders which might not allow detection of an association between obesity and some skin diseases. A larger cohort is necessary for validating the findings. Lastly, this is a cross-sectional analysis, so the direction of effect cannot be discerned. However, the objective of this study was to characterize the burden of obesity on skin regardless of the mechanism of effect.

In conclusion, obesity is associated with a number of cutaneous disorders including plantar hyperkeratosis, intertrigo, varicose veins, skin tags and striae which matched the results of some previous cross-sectional studies. Paradoxically, pigmentation disorders, specifically vitiligo, were seen with less frequency in obese subjects. To our knowledge, this is the first report of an inverse correlation between obesity and vitligo, which is an intriguing finding that worth further study. Parasitic skin infestation (scabies and pediculosis) were increased with severe obesity. Further studies are required to determine the pathogenic link between obesity and parasitic skin infestations.

Therefore, obesity has a multifaceted impact on skin. It appears to alter the physiological function of the skin causing diverse pathological complications and may influence the incidence of some dermatoses. Large-scale multi-centered studies should be conducted to further establish the relationship between obesity and skin diseases in Egyptian patients.

Acknowledgements

The authors are grateful to all paramedical personnel and technicians who aided in the conduction of the research.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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Citation: Abdel Maguid EM, Awad SM, Saad MM (2017) Skin Disorders in Adult Obese Egyptian Patients: A Comparative Study. Int J Dermatol Clin Res 3(1): 001-007. DOI: http://doi.org/10.17352/2455-8605.000018

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