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ORIGINAL PAPER

Demodex prevalence in mine, textile and food factory workers with dermatosis: a cross-sectional, multicenter study

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Abstract

Demodex, a type of mite, lives in human hair follicles. They can multiply very quickly in some conditions and then start to irritate the skin by causing skin disorders. This study aims to investigate if working environment conditions affect the prevalence of Demodex. A cross-sectional, multicenter study was conducted with three different occupational groups: mine, textile and food factory workers ($n=102$). Determined industry workers who applied to our outpatient dermatology clinics with the complaint of dermatosis in three different cities were included in the study. Demodex positivity was checked by dermoscopy. Differences between categorical variables examined with Chi-square analysis and T test was used to compare continuous variables between groups. 50% Demodex positivity was found in mine workers, 45.3% in food factory workers and 66.7% in textile manufacturing workers. A high rate of Demodex positivity was observed in all three occupational groups. Although the highest positivity rate was observed in textile manufacturing workers, no significant difference was found between the groups ($p=0.320$). The overall prevalence of Demodex in female workers was statistically significantly higher than in male workers ($p=0.029$). Exposure of workers to a wide variety of factors in work environments such as textile factories and the fact that women are more sensitive to external factors may have caused the prevalence of Demodex to be higher in these groups. So, a change in the work environment or the use of suitable protective equipment may benefit the treatment of diseases caused by Demodex. But, further studies are needed with larger and various industry groups to make more certain views.

Keywords Demodex · Dermatosis · Miner · Textile manufacturing · Food factory · Skin health

Introduction

Demodex is a type of mite and lives in human hair follicles, especially in the T region of the face and in areas where sebaceous glands are dense [1, 2]. Although many species belonging to the genus Demodex have been described so far, two main species of Demodex live on humans: Demodex folliculorum (DF) and Demodex breves (DB) [3]. DF usually lives in smaller hair follicles, especially in eyelashes; DB lives near the oil glands in hair follicles [3]. It is common and normal to have small amounts of them in adults because of their benefits like removing dead skin cells, oils and hormones. Although they may remain on intact skin, hair follicles and sebaceous

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glands without causing any disease, they can multiply very quickly and become pathogenic if the immune system is suppressed, if the patient has skin disorders such as rosacea, acne, dermatitis or if poor physical conditions occurs causing unhygienic, oily, impaired pH skin [4, 5]. In fact, psychological conditions such as depression, which can impair the immune system, may also be a risk factor for increased Demodex [6].

Clinical findings of infestation depends on the age of the host, the intensive use of cosmetic products, the increase in sebum production, the carelessness of the skin, the suppression of the immune system, the use of steroids, the developmental stage of the lesions and the immune response to the parasite itself [4, 5, 7].

Demodex infestation in children is rare due to low sebum production at young ages [8]. The age range of 20–30 years, when sebum production is at its highest, is the period when infestation is most common [9, 10].

Demodexes thought to have a role in the etiopathogenesis of rosacea, acne vulgaris, seborrheic dermatitis, pustular folliculitis, pityriasis folliculorum, papulopustular lesions of the scalp, pustular lesions of AIDS and chronic blepharitis [7, 11]. Some authors also reported that Demodexes have a place in the etiology of androgenetic alopecia, madarosis, lupus miliaris disseminatus facies, dissecting cellulitis, Grover's disease, eosinophilic folliculitis and papulopustular scalp eruption [12].

Demodicosis (cutaneous disease caused by Demodex mites) can be primary (idiopathic), but may also be secondary to a different disease. The major etiologic agent of primary demodicosis is DF [13]. It is characterized by erythematous scaly rashes on the T region of the face. Seasonal exacerbations occur in half of patients. The cause of secondary demodicosis is usually DB. It is characterized by symmetrical papules and pustules in the malar region. It is thought to be due to the underlying secondary cause such as leukemia, AIDS, chronic renal failure, use of topical calcineurin inhibitors and topical corticosteroids [13]. Itching begins after exacerbation of lesions, erythema remains unchanged after treatment. In most patients, complaints are intense during the summer season [14].

In the diagnosis, methods such as cellophane tape for the face, skin scraping, punch biopsy, standardized skin-surface biopsy (SSSB), dermoscopy, sebum examination with comedones extractor and examination of purulent material with KOH (potassium hydroxide) are used [13]. In our study, we used the dermoscopy method for diagnosis of demodicosis. The dermoscopic picture of the patients with demodicosis is characterized by dilated follicular openings, gray–brown plugs with Demodex tails and dilated blood vessels seen horizontally [15]. For diagnosis, while some authors stated that the mite density of ≥ 5 mites/cm^2 can be a diagnostic criteria, some authors suggested that a certain density may not be an appropriate criterion and mite density is only important for disease severity [16, 17].

The number of mites increases with the increase of air temperature in summer [18]. This is thought to be caused by the increase in sebum production with climatic activation [5]. Environmental factors such as exposure to the sun (including ultraviolet rays) or environmental pollution may also affect the mites count. In a study, a higher prevalence of Demodex was observed in people who worked indoors in generally enclosed and dust-rich environments [19].

In this study, we aimed to examine and compare whether changes in working conditions affect the prevalence of Demodex. Mine, textile and food factory workers are selected for different environmental and psychological working conditions and they are compared with each other in terms of demodicosis.

Materials and methods

Study design and participants

A cross-sectional, multicenter study was carried out among mine (coal), food factory (biscuit) and textile manufacturing (denim) workers who applied to dermatology outpatient clinics with the complaints of dermatosis. All patients were over the age of 18 and participated in the study voluntarily. The study was conducted in three different cities leading their own industries: Zonguldak Ataturk State Hospital for miners, Denizli State Hospital for textile manufacturing workers, Karaman Faculty of Medicine for food factory workers. The study was carried out over a period of 3 months in April–June 2022. The occupations of the patients were questioned and those working in the determined industries for more than 12 months were included in the study. Demodicosis diagnoses have been made by dermatologists in their own clinics with the diagnostic criteria of ≥ 5 mites/cm^2 mite density. Demodex positivity was checked by dermoscopy from the lesional area from forehead, cheek and chin area of the patients, where the parasite is most frequently located.

Outcome variables

Sociodemographic characteristics were assessed by gender, age, occupation and time they are in their job. Demodex positivity was checked by physicians with dermoscopy. Patients were also asked whether they used drugs or had additional diseases that could increase Demodex density. Dermatological diagnoses and eye involvement of demodicosis were also noted.

Statistical analysis

The data were analyzed with the SPSS 22.0 package program. Continuous variables were given as mean ± standard deviation and categorical variables as numbers and percentages. Differences between categorical variables were examined with Chi-square analysis. *T* test was used to compare continuous variables between groups, and binary logistic test was used for further analysis of the significance of the difference between groups. Statistical significance was accepted as $p < 0.05$.

Results

In our study, 12 mine, 15 textile and 75 food factory workers were included. The mean age of 102 participants was 36.56 ± 7.975, and the average working time of the workers was 15.10 ± 2.651 months. 60 (58.8%) of the workers were male and 42 (41.2%) were female. The sociodemographic characteristics of the workers are shown in Table 1.

The mean age of workers with Demodex positivity was 36.21 ± 7.58, and 36.92 ± 8.42 for those without. There was no significant difference between those with and without Demodex in terms of mean age ($p = 0.587$). The general prevalence of Demodex positivity was 61,9% in women and 40% in men. A significantly higher number of Demodex positivity was detected in women ($p = 0.029$) (see Table 2).

81 workers who applied to the outpatient clinics had facial dermatosis. Among these workers, there were seven patients with acne, 45 with rosacea, 7 with perioral dermatitis and 22 with seborrheic dermatitis. There were 21 workers who did not have facial dermatosis but had dermatological complaints in other parts of their body (non-facial dermatosis). Generally, significantly more Demodex was detected in those with facial dermatosis (55.6%) than in those without (23.8%) ($p = 0.010$) (see Table 2).

12 (11.8%) of the workers had blepharitis and/or conjunctivitis findings and complaints in addition to Demodex positivity (eye involvement). 2 (16.7%) of mine workers, 6 (8%) of food factory workers, and 4 (26.7%) of textile manufacturing workers were in this group of 12 patients. No significant difference was found between these three occupation groups in terms of eye involvement ($p = 0.104$).

When the chronic diseases affecting the presence of Demodex were questioned among the workers, only diabetes mellitus was detected as a risk factor of increased Demodex. However, there was no statistically significant difference between diabetes and Demodex positivity ($p = 0.427$) (see Table 2). When the use of drugs that could have an effect on Demodex positivity was evaluated, two topical

Table 1 The sociodemographic characteristics and dermatosis types of 102 workers

	n	%
Gender		
Female	42	41.2
Male	60	58.8
Age groups		
18–30	25	24.5
30>	77	75.5
Occupation		
Mine worker	12	11.8
Food factory worker	75	73.5
Textile worker	15	14.7
Dermatosis		
NFD	21	20.6
Acne vulgaris	7	6.9
Rosacea	45	44.1
Perioral dermatitis	7	6.9
Seborrheic Ddrmatitis	22	21.6

NFD Non-facial dermatosis

Table 2 The comparison of Demodex positivity according to the variables

	Demodex				
	Positive		Negative		
	n	%	*n*	%	*p*
Gender					
Female	26	61.9	16	38.1	0.029
Male	24	40.0	36	60.0	
Occupation					
Mine worker	6	50.0	6	50.0	0.320
Food factory worker	34	45.3	41	54.7	
Textile worker	10	66.7	5	33.3	
Total	50	49	52	51	
Drug effect on demodex					
Ineffective	24	39.3	37	60.7	0.058
Reducing	7	63.6	4	36.4	
Increasing	19	63.3	11	36.7	
Additional disease effect on Demodex					
Ineffective	45	47.9	49	52.1	0.427
Increasing	5	62.5	3	37.5	
Dermatosis					
Non-facial	5	23.8	16	76.2	0.010
Facial	45	55.6	36	44.4	
Eye involvement					
Has	12	92.3	1	7.7	0.001
Not	38	42.7	51	57.3	
Age groups					
18–30	13	52.0	12	48.0	0.732
30>	37	48.1	40	51.9	

metronidazole users, one topical permethrin user, two topical retinoid users and three systemic retinoid users were detected among drugs that could reduce Demodex. Also, there were 30 workers who used topical steroids that could increase Demodex. The distribution of use of drugs did not differ statistically in the three worker groups ($p=0.764$), and when evaluated within themselves, no significant correlation was found between Demodex positivity and drug use ($p=0.058$) (see Table 2).

In our study, we found the prevalence of Demodex to be 49% in selected occupation groups who have facial or non-facial dermatosis (see Table 2). Among these occupations, 50% Demodex positivity was found in mine workers, 45.3% in food factory workers and 66.7% in textile manufacturing workers. When three occupational groups compared with each other, no significant difference was found between the groups in terms of Demodex positivity ($p=0.320$). The comparison of Demodex positivity according to the variables is shown in Table 2.

When the workers who have used drugs or have additional diseases that can affect the Demodex density are excluded, 16.7% Demodex positivity were found in miners, 38.1% in food factory workers and 54.5% in textile manufacturing workers. There was no significant difference between occupation groups ($p=0.412$) (see Table 3).

While mine and textile manufacturing workers had similar results in terms of facial Demodex positivity (mine 66.6%, textile manufacturing 69.2%), food factory workers were found to have lower positivity (51.6%). But, no significant difference was found between them ($p=0.424$). Similarly, no significant difference was found in terms of non-facial dermatosis ($p=0.477$) (see Table 4).

Table 3 Demodex positivity after ignoring the factors (drugs and additional diseases) affecting Demodex density

	Demodex		Total	*p*
	Positive	Negative		
Occupation				
Mine worker				
n	1	5	6	0.412
%	16.7%	83.3%	100.0%	
Food factory worker				
n	16	26	42	
%	38.1%	61.9%	100.0%	
Textile worker				
n	6	5	11	
%	54.5%	45.5%	100.0%	
Total				
n	23	36	59	
%	39.0%	61.0%	100.0	

Discussion

Demodexes (DF and DP) are in high prevalence in healthy people even in those who have no skin complaints. In a study, the prevalence of Demodex among healthy individuals without any complaint was found to be 37% [20]. There are different opinions about the pathology and clinical symptoms caused by these mites in humans. While it has been stated that the mites in pilosebaceous follicles may be harmless, some authors have stated that they may have a role in the etiopathogenesis of some facial skin diseases [3]. The findings of studies emphasize that facial dermatoses such as acne vulgaris, rosacea, perioral dermatitis and seborrheic dermatitis are significantly associated with Demodex infestation [21, 22]. As the damaged skin structure may cause an increase in the number of Demodex, the increased number of Demodex can also disrupt the skin structure. In our study, we selected the workers with facial or non-facial dermatosis in which Demodex may have been the cause or effect. Thus, we were able to compare the groups with similar characteristics in terms of dermatosis.

There are only a few studies in the literature on occupation and the presence of Demodex. In a case report, a severe Demodex infestation of a coal miner was discussed [23]. The miner used to bathe with hot water and multiple cleaners twice a day. Authors mentioned that these types of extreme cleaning habits may have made his skin more prone to Demodex infestation by either diminishing the skin barrier function or causing contact dermatitis. But some studies suggest that good hygiene practice might reduce the chances

Table 4 The comparison of workers' facial and non-facial dermatosis

Dermatosis	Demodex												p^a
	Mine worker				Food factory worker				Textile worker				
	Positive		Negative		Positive		Negative		Positive		Negative		
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
Facial	4	66.6	2	33.4	32	51.6	30	48.4	9	69.2	4	30.8	0.424
Non-facial	2	33.4	4	66.6	2	15.4	11	84.6	1	50	1	50	0.477

[a]*p* values: comparison of positivity in facial and non-facial dermatosis

of demodicosis and Demodex infestation [22]. In another study conducted in different occupational groups, Demodex mite was investigated on the face of 1077 people with 9 different occupations using the SSSB method [20]. Butchers and cooks reported higher Demodex infestation with 44.3% compared to other occupational groups (restaurant owner, night club hostess, bakery worker, market worker, canteen worker, food factory worker, manager). The lowest Demodex rate was found in food factory workers with a rate of 31.1%. They could not detect a statistically significant difference between mite positivity and occupational groups. However, they state that the reason for the general high Demodex rate of these occupation groups (37%) may be close physical contact with customers during the work hours.

In our study, the total prevalence was 49% in selected occupations (see Table 2). Demodex positivity was found 50% in mine, 66.7% in textile manufacturing and 45.3% in food factory workers (see Table 2). The high rate was probably due to the fact that our patients had dermatosis. Therefore, it would be more accurate to compare the occupations among themselves. Although the highest positivity was observed in textile manufacturing workers, no significant difference was found between the groups when compared to each other ($p=0.320$). The high positivity in textile workers may be due to physical or psychological effects in the work environment but this can only be proven by more detailed studies in larger groups. However, it can be predicted that risky processes such as weaving, dyeing, sandblasting, spinning, printing and ironing in the textile industry may increase the prevalence of Demodex. Cotton dust, chemicals, fiber elements and heat can be potential risks that can affect Demodex positivity and density. Of course, other occupations have their own risks such as dust, gasses and humidity in mines, and chemicals, biological agents and maybe extreme cleaning habits in food factories. But mine and food factory workers seem to be less risky than textile manufacturing workers in terms of demodicosis. As mentioned before, statistically significant results obtained as a result of extensive studies with larger and various groups will provide clearer information.

In the study of Zhao et al., the prevalence of Demodex was 43.0% in facial and non-facial dermatosis patients. And the Demodex positivity of these patients with facial dermatosis were about 51%, while the non-facial dermatosis were about 31% [22]. In our study, the Demodex positivity was 55.6% in facial dermatosis and 23.8% in non-facial dermatosis (see Table 2). Within the selected occupations, Demodex positivity was 66.6% in mine, 69.2% in textile manufacturing and 51.6% in food factory workers, among those with facial dermatosis (see Table 4). The relationship between facial dermatosis and Demodex seems to be more prominent in textile and mine workers. It can be thought that the reason for this low rate in the food factory is due to the more hygienic work environment. Although the rates give us a prediction, the fact that there is no statistically significant difference between the occupation groups with facial or non-facial dermatosis enables us to conclude that there is no or minimal difference between them in terms of Demodex positivity. But, considering that personal factors are very important in Demodex positivity and density, it is possible to obtain different results with the studies to be conducted in larger groups to minimize personal factors.

There are very limited studies on the effect of environmental conditions on Demodex that may be related occupational exposure. In the study of Gutiérrez et al. with 680 people, higher mite densities have been detected in people working in dust-rich environments such as theaters, libraries, and administrative offices [19]. They reported that temperature change and air pollution also cause changes in the mite population and disrupt the skin microbiota. We paid attention to the fact that the occupations we chose in our study were in different environmental conditions.

Zhao et al. reported that Demodex infestation rates increased with age among the 12−30 years old patients and remained stable amongst the older patients [22]. And in their study, the average infestation rates between the patients with dermatosis aged 31−84 years were significantly higher than 12−30 years. They attributed this result to the maturation of the skin after the age of 18 years and the increase in sebaceous gland activity with age, creating a suitable environment for the feeding of Demodex mites. In our study, mite positivity was found at the rate of 52% in 18–30 ages, 48,1% in > 30 ages. Although these similar results in age groups can be evaluated as the effect of the work environment rather than personal factors, it is more likely that the low number of young workers is due to the effect on the statistical data.

While some studies in the literature stated that more Demodex mites were detected in women, some studies reported that they were detected more frequently in men. In the study conducted by Isa et al. with a group of 390 healthy students, they found a higher rate of parasites in males (21.54%) than females (12.82%) [24]. They stated that men may be more prone to infestation due to the fact that they are more active during the day, so sebum and sweat secretions are higher than women, and men use less facial moisturizer. In our study, Demodex positivity was found in 26 (61.9%) of 42 female patients, while it was found in 24 (40%) of 60 male patients. There was significantly more Demodex positivity in women ($p=0.029$) (see Table 2). Due to the no female miner and low number of female textile workers ($n=5$), a comparison between occupations could not be made. But generally, it can be concluded that female workers may be more prone to Demodex, and therefore to some skin diseases, because they may be more sensitive to physical effects and feel more stress in the work environment.

Demodex infestation is also a potential cause of ocular inflammatory diseases such as blepharitis, conjunctivitis and chalazia [25]. In the study of Vargas-Arzola et al. with 1010 individuals, prevalence of Demodex in eyelashes was 20% and half of them (10%) had ocular symptoms [26]. The workers with eye involvement in our study were evaluated as ocular symptomatic and those with facial Demodex. As a result, the rate of Demodex positivity in the eyelashes in our workers is expected to be close to the rate we stated or slightly lower. So, the prevalence of ocular symptomatic group in the study of Vargas-Arzola et al. (10%) may provide an opinion for the rates of our study. In our study, relevant eye involvement diagnoses were made as a result of eye symptoms and examinations of the workers. 12 (11,8%) workers had both ocular findings (blepharitis and/or conjunctivitis) and facial Demodex. If we evaluate the results within our study, although eye involvement was found at a higher rate in mine (16.7%) and textile manufacturing (26.7%) workers, no significant difference was found between these three occupation groups ($p = 0.104$). Of course, more accurate comparisons can be made in a study where Demodex was analyzed in eyelashes, including healthy control groups.

Demodex is frequently seen in cases with immunosuppressive conditions like leukemia, HIV and immunosuppressive drug users including topical steroid and calcineurin inhibitors [27]. Also some chronic diseases such as diabetes and allergic rhinitis increase the prevalence of Demodex [28]. On the other hand, some drugs (metronidazole, ivermectin, retinoids, permethrin, etc.) reduce the Demodex density [29]. In our study, we questioned the factors that could increase or decrease the prevalence of Demodex to rule out some personal factors. While diabetes mellitus and topical steroid use were detected as increasing factors, topical metronidazole, topical permethrin and retinoid use were detected as reducing factors. But, none of these factors were statistically significant for our study regarding Demodex positivity (see Table 2). This may be due to the effect of the work environments or the low number of patients.

When we ignored the increasing and decreasing factors in order to observe the effect of the work environments as much as possible, the renewed results were as in Table 3. According to the results, although there is no statistically significant difference between occupation groups, the highest Demodex positivity rate was found in textile manufacturing workers, while more Demodex positivity was found in food factory workers than miners. Exclusion of five out of six Demodex positive mine workers due to the use of drugs or having a disease that affects Demodex positivity caused the miners to show Demodex positivity at a lower rate. Of course, studies with larger groups will yield more comprehensive results.

Conclusion

Demodex mites, which have an important role in the etiopathogenesis of many dermatological diseases such as rosacea, acne vulgaris, seborrheic dermatitis, blepharitis, etc., have a big potential to be affected by the working conditions (dust, temperature, hygiene, chemicals, stress, etc.). Exposure of workers to a wide variety of factors in work environments such as textiles and the fact that women are more sensitive to physical and psychological effects may have caused the prevalence of Demodex to be higher in these groups. Studies that will be carried out by considering the density of Demodex as well as the positivity in different occupational groups will yield more comprehensive results. If it is known with new studies that Demodex causes more skin diseases in a certain occupational group, this situation can be easily treated with a change in work environment or the use of protective equipment.

Limitations

Our study was multicenter, but the number of patients could not reach the desired level because mine and textile manufacturing workers with dermatosis who applied to our dermatology outpatient clinics were in low numbers.

Although our study aimed to compare workers with dermatosis, adding healthy workers as a control group and performing on-site Demodex screening in workplaces could have added a wider perspective to the study.

In our study, we grouped Demodex as positive and negative. Similar to the literature, Demodex mite density of ≥ 5 mites/cm^2 was considered positive (diagnostic criteria). But, comparing the parasite density per cm^2 in workers could have enriched the study.

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Data availability The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of Pamukkale University (Date: 15.03.2022/No: 05/Number: E-60116787-020-184699).

Consent to participate Informed consent was obtained from all individual participants included in the study.

Consent for publication Given by all patients and all authors.

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