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Intake of Probiotic and Prebiotic Foods in Psoriasis Patients: A Case-Control Study in Romania

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RESEARCH ARTICLE

Abstract

Psoriasis is a chronic, inflammatory skin disease which highly impacts the quality of life of psoriatic patients. Although the pathogenesis of psoriasis is multifactorial, recent evidence suggest that alterations in the intestinal microbiome play an important role suggesting a clear status of dysbiosis associated with the disease. This study aimed to assess the frequency of probiotic and prebiotic food consumption in psoriasis patients in Romania (n = 122), with an emphasis on potential dietary risk or protective factors linked with psoriasis. The results showed that consuming fermented and probiotic foods, such as fermented dairy products, kombucha, whole grains, fruits, and vegetables, may have an essential role in limiting or alleviating psoriasis symptoms. Future research should also investigate this relationship, considering other food groups, such as fish, meat, and fats, using a national validated food frequency questionnaire.

Keywords: psoriasis; prebiotic food; probiotic foods;

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INTRODUCTION

Psoriasis vuglaris is a chronic inflammatory skin disease characterized by erythematous and pruritic plaques that commonly affect the scalp, trunk, knees, and elbows (Rendon & Schäkel, 2019). The incidence of psoriasis is higher in industrialized and high-income countries (Parisi et al., 2020), with an increase in the elderly population (Burshtein et al., 2020). The prevalence of psoriasis in Romania is approximately 5%, and the patients appear to be diagnosed around the age of 55, with first symptoms occurring around the age of 50 (Nicolescu et al., 2021). Dietary factors such as red meat, alcohol, simple carbohydrates, and saturated fatty acids activate inflammatory molecules, exacerbating psoriasis symptoms (Kanda et al., 2020). On the other hand, dietary compounds enclosed in a healthy diet, particularly polyunsaturated omega-3 fatty acids, probiotics, which are living microorganisms that can be found in fermented foods, and dietary fibre, such as fructooligosaccharides, inulin, or galactooligosaccharides that promote the development of beneficial bacteria in the intestinal microbiota, suppress the inflammatory pathways involved in psoriasis, having an essential role in alleviating psoriasis symptoms and comorbidities (Barrea et al., 2015;

Kanda et al., 2020).

In the recent years, studies evaluating the intestinal microbiota of psoriasis patients revealed contradictory results in terms of taxonomic distribution, making it difficult to construct a comprehensive picture of the psoriatic intestinal microbiota (Buhaş et al., 2022; Hidalgo-Cantabrana et al., 2019). However, the gut microbiota dysbiosis was noticed in most of psoriasis subjects, characterized by a lower abundance of *Akkermansia muciniphila*, *Bacteroidetes spp*., and *Firmicutes spp.* (Schade et al., 2022; Sikora et al., 2020).

Although the relationship between diet and psoriasis is extensive ongoing research (Castaldo et al., 2020; Guida et al., 2014; Naldi et al., 2014), there is lack of data in our country. Therefore, this study aimed to assess the frequency of probiotic and prebiotic food consumption, such as fermented dairy, fermented vegetables, whole grain products, legumes, fruits and vegetables, in psoriasis patients in Romania, with an emphasis on potential dietary risk or protective factors linked with psoriasis.

MATERIALS AND METHODS

Ethical consideration

According to Helsinki Declaration, the Amsterdam Protocol, and Directive 86/609/EEC, we obtained the approval of the Ethical Commission of the" Iuliu Haţieganu" University of Medicine and Pharmacy Cluj-Napoca for this study (number 266/06.30.2021).

Study design and population

A case-control study has been designed that included patients recruited online during May 2022-July 2022. Patients diagnosed with *Psoriasis vulgaris* between 18 and 55 from Romania were included in the case group. Controls were selected randomly from generally healthy adults living in Romania. Controls included patients without inflammatory diseases, in the present and the past, aged 18 to 55 years, being on a regular diet (those on particular diet either by choice or by medical reasons were excluded from the study). Subjects under 18 and those above the age of 56 were excluded from the study. A total of 112 adults for the control group and 122 adults for the case group were approached and responded to the questionnaire. All subjects in the study consent to the data provided in the questionnaire being anonymously used for research purposes.

Data collection

The questionnaire was self-administered, online and the questions aimed to assess the frequency of consumption of prebiotic and probiotic foods using four possible response categories that ranged from "less than one time a week" to "more than 5 times a week". Based on weekly intake, participants were asked to report their frequency of consumption of fermented products, fresh fruits and vegetables, whole grains, and legumes. In the lack of a validated national tool for assessing food intake, members of the research team developed the applied questionnaire using models from other countries and from other studies assesing frequency of consumption (Buscemi et al., 2015; De La Fuente-Arrillaga et al., 2010; Deschamps et al., 2007). The questionnaire also included questions related to demographic characteristics (age, sex, living area), anthropometric data (height, weight), lifestyle data (smoking history, level of physical activity, sleeping schedule, frequency of alcohol consumption), and self-reported clinical data (psoriasis stage, associated pathologies, antipsoriatic treatment, frequency of antibiotic use, probiotic or prebiotic supplementation) (Boboia et al., 2020; Subtirelu et al., 2019).

Statistical analysis

SPSS software (Statistic Package for Social Sciences) version 20 has been used to perform the statistical analyses. The characteristics of the cases and controls were compared by the chi-squared ($\chi 2$) test. A Mann Whitney U test was used to detect differences between groups in terms of frequency of consumption of specific foods and food groups. A p-value less than 0.05 was considered statistically significant (Boboia et al., 2021; Gavrilaş et al., 2018; Turcu-ştiolică et al., 2018).

RESULTS AND DISCUSSIONS

Comparison of general characteristics and lifestyle habits between cases and controls

General characteristics

Table 1 shows a comparison of overall characteristics between psoriasis and control groups. There was no significant difference in BMI (Body Mass Index) and education level (p>0.05); however, psoriasis patients were more likely to have a higher BMI compared to controls, which is known to be a risk factor for psoriasis and psoriatic arthritis (Llamas-Velasco et al., 2021; Ramírez et al., 2021; Rodríguez-Cerdeira et al., 2019). Regarding living area

distribution between the two groups, psoriasis patients were more likely to originate from a rural setting, than controls, which may influence their lifestyle and eating habits (p<0.05).

Table 1. Comparison of general characteristics and lifestyle habits between participants in the study group

Parameter	Control (n=112)	Case (n=122)	P value
Sex			
Female	97 (86.60%)	88 (72.13%)	-
Male	15 (13.39%)	34 (27.86%)	
Age (years)	31.1 ± 9.98	36.7 ± 14.05	-
BMI[1] (kg/m^2)			
<24.9	72 (64.28%)	67 (54.91%)	
25.0-29.9	31 (27.67%)	35 (28.68%)	0.06
>30	9 (8.04%)	20 (16.39%)	
Education			
≤ Secondary school	1 (0.89%)	8 (6.55%)	
Completed high school or equivalent	25 (22.32%)	31 (25.40%)	0.057
Bachelor degree or higher	86 (76.78%)	83 (68.03%)	
Living area			
Urban	98 (87.50%)	92 (75.40%)	0.01
Rural	14 (12.50%)	30 (24.59%)	
Smoking			
YES	49 (43.75%)	35 (28.68%)	0.016
NO	63 (56.25%)	87 (71.31%)	
Diagnosis of inflammatory bowel disease			
YES	7 (6.25%)	14 (11.47%)	0.162
NO	105 (93.75%)	108 (88.52%)	
Physical activity (frequency/week)			
<1	37 (33.03%)	68 (55.73%)	
1-2	39 (34.82%)	33 (27.04%)	0.004
3-5	33 (29.46%)	19 (15.57%)	
>5	3 (2.67%)	2 (1.63%)	
Sleep (hours/night)			
<6	7 (6.25%)	18 (14.75%)	
6-8	92 (82.14%)	94 (77.04%)	0.089
>8	13 (11.60%)	10 (8.19%)	
Alcoholic beverages (frequency/week)			
<1	69 (61.60%)	96 (78.68%)	
1-2	30 (26.78%)	18 (14.75%)	
3-5	11 (9.82%)	7 (5.73%)	0.042
>5	2 (0.01%)	1 (0.81%)	
Antibiotic use (frequency/year)			
<1	79 (70.53%)	75 (61.47%)	
1-2	27 (24.10%)	29 (23.77%)	
3-5	5 (4.46%)	8 (6.55%)	0.05
>5	1 (0.89%)	10 (8.19%)	
Probiotic or prebiotic supplementation			
YES	47 (41.96%)	25 (20.49%)	< 0.001
NO	65 (58.03%)	97 (79.50%)	

Note: [1]Body Mass Index

Lifestyle habits

In our study, there was a significant difference in smoking history (p<0.05), with psoriasis patients having a negative smoking status. In line with previous studies that reported a negative association between physical activity and psoriasis prevalence (Frankel et al., 2012; Zheng et al., 2018), in our study, psoriasis subjects had a lower level

of physical activity compared to controls (p<0.05). Increased physical activity has previously been linked to reduced psoriasis severity in overweight and obese subjects (Naldi et al., 2014). One mechanism explaining the beneficial effect of physical exercise in overweight or obese patients with active psoriasis may be related to the reduction in adiposity, inflammation, and oxidative stress, all of which have previously been linked to psoriasis (Snekvik et al., 2017; Wilson et al., 2012). Based on our findings, there was no association between the two groups regarding the number of hours slept per night; however, controls used to consume alcohol with a higher weekly frequency compared to the psoriasis group (p<0.05).

Although we observed no significant difference between the two groups in terms of inflammatory bowel disease diagnosis (p>0.05), psoriasis subjects used to take antibiotics more frequently than the control group (p<0.05) and had a significantly lower frequency of probiotic and prebiotic supplementation (p<0.001). Antibiotic use is one of the most substantial risk factors implicated in gut microbial dysbiosis (S. Zhang et al., 2019), and just like earlier research has revealed, it has a possible impact on psoriasis pathophysiology (Dei-Cas et al., 2020), as most psoriasis patients present dysfunction of the intestinal barrier and a disturbed equilibrium between the microbiota and immune system (Richetta et al., 2020; Sikora et al., 2018). Moreover, several experimental and clinical studies presented a positive correlation between the gut microbiota dysbiosis in psoriasis and the inflammation-related indicators, especially interleukins, cytokines, and T helper cells, resulting in an inflammatory immune response (Zákostelská et al., 2016; X. Zhang et al., 2021). Probiotic and prebiotic supplementation is one of the most potent modifying agents in the context of dysbiosis of the gut microbiota, enhancing intestinal microbiota homeostasis by protecting gut barrier integrity and modulating immune response (Liu et al., 2022). As essential sources of beneficial microorganisms and dietary fibres, the supplementation with probiotics and prebiotics was shown to reduce the psoriasis area and severity (PASI) index and inhibit the inflammation levels by regulating immune cells and the composition of gut microbiota in psoriasis subjects (Lu et al., 2021; Zeng et al., 2021).

Medical characteristics of psoriatic patients

Although the epidemiological research findings comparing the incidence of psoriasis between men and women are conflicting (Armstrong et al., 2021; Guillet et al., 2022; Murer et al., 2020), our data showed that psoriasis was more common in females (n=88) than in males (n=34). As presented in Table 2, in our case sample, there were no significant differences between male and female subjects in terms of psoriasis stage and the level of life impairment caused by psoriasis (p>0.05). Regarding psoriatic arthritis and antipsoriatic treatment, there were significant variations between individuals (p<0.05).

Table 2. Medical characteristics of psoriatic patients

Parameter	Case (n=122)		*P* value
	F[1] (n=88)	M[2] (n=34)	
Psoriasis Stage			
Mild (<3%)	44 (50.00%)	16 (47.05%)	0.631
Moderate (3-10%)	29 (32.95%)	12 (35.29%)	
Severe (>10%)	15 (17.04%)	6 (17.54%)	
Psoriatic arthritis			
YES	10 (11.36%)	9 (26.47%)	0.039
NO	78 (88.63%)	25 (73.52%)	
Psoriatic treatment			
Local treatment	70 (79.54%)	23 (67.64%)	0.043
Phototherapy	1 (1.13%)	2 (5.88%)	
Systemic treatment	1 (1.13%)	4 (11.76%)	
Biological treatment	6 (6.81%)	1 (2.94%)	
I'm not on any treatment	10 (11.36%)	4 (11.76%)	
Affected quality of life due to psoriasis			
No	14 (15.90%)	5 (14.70%)	0.610
Mild (It bothers me to uncover my skin, but it doesn't stop me from doing any kind of activity)	49 (55.68%)	17 (50.00%)	
Modarate (Occasionally, I avoid going to sports, swimming pool / swimming pool, seaside)	15 (17.04%)	9 (26.47%)	
Severe (I have anxiety episodes, depression, I cannot carry out my daily activities)	10 (11.36%)	3 (8.82%)	

Note:[1]Females, [2]Males

Dietary intake

Probiotic foods. Even if overall weekly consumption of fermented vegetables and soy-fermented foods was similar between groups (p>0.05), in our study, participants in the control group were more likely to consume fermented dairy products (p<0.001) and kombucha drinks (p<0.001) (Table 3). *In vivo* studies have shown that the intake of kombucha, made from a symbiotic culture of bacteria and yeasts, reduces inflammation and can modulate the gut microbiota by reducing intestinal dysbiosis (Costa et al., 2021).

Table 3. Frequency of consumption of probiotic food

Parameter	Control (n=112)	Case (n=122)	P value
Fermented vegetables (servings/week)			
<1	77 (68.75%)	85 (69.67%)	0.84
1-2	28 (25.00%)	31 (25.40%)	
3-5	7 (6.25%)	4 (3.27%)	
>5	0 (0.00%)	2 (1.63%)	
Fermented dairy (servings/week)			
<1	6 (5.35%)	52 (42.62%)	<0.001
1-2	31 (27.67%)	41 (33.60%)	
3-5	54 (48.21%)	26 (21.31%)	
>5	21 (18.75%)	3 (2.45%)	
Soy-fermented foods (servings/week)			
<1	106 (94.64%)	115 (94.26%)	0.92
1-2	3 (2.67%)	5 (4.09%)	
3-5	2 (1.78%)	2 (1.63%)	
>5	1 (0.89%)	0 (0.00%)	
Kombucha drink (servings/week)			
<1	97 (86.60%)	121 (99.18%)	<0.001
1-2	7 (6.25%)	1 (0.81%)	
3-5	5 (4.46%)	0 (0.00%)	
>5	3 (2.67%)	0 (0.00%)	

As part of a healthy diet, fermented products are rich sources of probiotics and bioactive dietary compounds, known to modulate the gut microbiota and promote an anti-inflammatory effect (Şanlier et al., 2017; Shahbazi et al., 2021; Stiemsma et al., 2020). The relationship between fermented product consumption and psoriasis is yet an active research field, but results from studies reviewing the effects of *Lactobacillus* spp. and *Bifidobacterium* spp. supplementation in psoriasis patients showed promising outcomes (Antiga et al., 2015; Buhaş et al., 2022). For instance, Jalal Moludi et al. (Moludi et al., 2021) confirmed that the supplementation with *Lactobacillus acidophilus*, *Bifidobacterium bifidum*, *Bifidobacterium lactis* and *Bifidobacterium langum* 1.8×10^9 colony forming units in psoriasis patients resulted in a decreased PASI score, Interleukin-6 (IL-6) levels, and C reactive protein, together with an improvement in the DLQI (Dermatology Life Quality Index) and total antioxidant capacity. Moreover, the potential protective and anti-inflammatory effects of probiotics were also supported by *in vivo* and *in vitro* studies, indicating a potential role in ameliorating psoriasis symptoms by inhibiting TNF-α (Tumor Necrosis Factor-alpha) through the NF-κB (Nuclear Factor kappa-B) pathway, as well as decreasing the release of inflammatory factors associated with the IL-23/Th17 axis (Deng et al., 2021; Lu et al., 2021).

Prebiotic foods. From our data, the intake of fresh fruits (p<0.05), fresh vegetables (p<0.001), whole grains (p<0.001) and legumes (p<0.001) were significantly higher in participants from the control group compared to psoriasis subjects (Table 4). As part of the Mediterranean diet, these food groups are powerful sources of dietary fibers and bioactive dietary compounds that may be protective against psoriasis (Korovesi et al., 2019; Phan et al., 2018).

Overconsumption of simple carbohydrates, such as those found in refined grain products, has been associated with an increase in psoriasis symptoms as well as an increase in oxidative stress. In contrast, a high fiber diet, mainly consisting of fresh fruits, fresh vegetables, whole grain products and legumes, can support an intestinal and systemic anti-inflammatory effect while reducing oxidative stress (Garbicz et al., 2021; Kanda et al., 2020). Furthermore, experimental investigations have revealed a link between a high fiber diet and psoriasis, with altered gut microbiota composition and improved psoriasis dermatological symptoms, such as dermatitis and scratching behaviours (Kanda et al., 2020; Takahashi et al., 2020). In psoriasis patients, adherence to the Mediterranean diet, rich in fruits, vegetables, legumes and whole grain products, was linked to lower PASI score and lower levels of C reactive protein (Barrea et al., 2015). However, the favourable effects of the Mediterranean diet in psoriasis patients could also be

explained by a high intake of extra virgin olive oil and fish, which was not investigated in our study. As patients with psoriasis have a dysbiotic taxonomic and functional gut microbiota (Todberg et al., 2022), increasing fiber intake could be a valuable approach in alleviating pathological symptoms (Garbicz et al., 2021).

Table 4. Frequency of consumption of prebiotic foods

Parameter	Control (*n*=112)	Case (*n*=122)	*P* value
Fresh fruits (servings/week)			
<1	6 (5.35%)	21 (17.21%)	
1-2	27 (24.10%)	37 (30.32%)	0.011
3-5	43 (38.39%)	37 (30.32%)	
>5	36 (32.14%)	27 (22.13%)	
Fresh vegetables (servings/week)			
<1	4 (3.57%)	24 (19.67%)	
1-2	15 (13.39%)	31 (25.40%)	<0.001
3-5	54 (48.21%)	41 (33.60%)	
>5	39 (34.82%)	26 (21.31%)	
Whole grains (servings/week)			
<1	28 (25.00%)	56 (45.90%)	
1-2	29 (25.89%)	39 (48.36%)	<0.001
3-5	34 (30.35%)	15 (12.29%)	
>5	21 (18.75%)	12 (9.83%)	
Beans (servings/week)			
<1	37 (33.03%)	67 (54.91%)	
1-2	39 (34.82%)	32 (26.22%)	<0.001
3-5	32 (28.57%)	19 (15.57%)	
>5	4 (3.57%)	4 (3.27%)	

Resveratrol is a natural polyphenol found in fruits and vegetables and is known for its preventive properties regarding oxidative stress and inflammation (Meng et al., 2021). The molecular mechanism underlying resveratrol's protective properties may be explained by its ability to down-regulate the tolllike-receptor 4 mRNA in the intestine, lowering the production of key inflammatory compounds such as IL-1β and TNF-α while enhancing immunoglobulin secretion (X. Chen et al., 2022; Gan et al., 2019). Experimental data further suggest resveratrol as an effective tool in alleviating inflammation and psoriasis symptoms by altering the expression of retinoic acid-stimulated genes, IL-17 signalling pathways, IL-17A, and IL-19 (Kjær et al., 2015).

In accordance with prior research that found a link between plant-based food consumption and a lower severity status in psoriasis (Afifi et al., 2017), quercetin from fruits and vegetables and β-glucans from cereals and mushrooms remain one of the most outstanding dietary active compounds, with studies showing their anti-inflammatory and immune modulating activities (Li et al., 2016; Żyła et al., 2021). In animal experiments, pustulan, a 1,6-β-glucan, showed protective activity against psoriasis and psoriasis severity by downregulating autoimmune inflammation (Fahlquist-Hagert et al., 2022). Moreover, in imiquimod-induced mice, quercetin reduced PASI score, lowered keratinocyte proliferation, and improved psoriatic plaques, while decreasing serum TNF-α, IL-6, and IL-17 levels via the NF-κB pathway (H. Chen et al., 2017; S. Chen et al., 2017). Due to the fact that prebiotic foods, particularly fruits and vegetables, are also rich sources of resveratrol and quercetin, increasing prebiotic food consumption through the adherence to a vegetable-rich diet may provide additional benefits to psoriasis subjects.

This study is limited by the relatively small sample size (Boboia et al., 2017; Boboia & Polinicencu, 2012), which is not representative for the entire population group. Also, more participants from the psoriasis group came from a rural setting compared to controls, which may influence their lifestyle and eating habits. In addition, this study didn't investigate the intake of other food groups, such as fish, meat, and fats, which were previously linked with intestinal immunity, inflammation and gut microbiota homeostasis (Fu et al., 2021; Ingkapairoj et al., 2021; Wolters et al., 2018). Finally, the tool employed to collect the information has intrinsic limitations, as a national validated food frequency questionnaire is critically required to accurately assess the link between individual food intake and disease.

CONCLUSIONS

As the frequency of antibiotics use in psoriasis patients tend to be increased, and it is associated with gut dysbiosis and a more severe psoriatic status, this study suggests that consuming fermented and prebiotic foods,

such as fermented dairy products, kombucha, whole grains, fruits, and vegetables, may have an essential role in limiting or alleviating psoriasis symptoms, by modulating the gut microbiota. First, increasing the intake of fermented products, such as fermented dairy products, may help introduce beneficial bacteria to the gut microbiota in psoriasis patients who experience gut dysbiosis. Fermented products are known to contain probiotics, which are live microorganisms that can provide health benefits when consumed in adequate amounts. These probiotics can help to restore the balance of gut microbiota in psoriasis patients, potentially reducing inflammation and other symptoms associated with psoriasis. Second, the prebiotics, such as fructooligosaccharides, inulin, or galactooligosaccharides might promote the development of beneficial bacteria in the intestinal microbiota. Finally, the biologically active compounds included in prebiotic foods may also be involved in the improvement of psoriatic symptoms. However, more clinical trials are needed to fully understand the link between probiotic food, prebiotic food and, psoriasis.

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REFERENCES

1. Afifi, L., Danesh, M. J., Lee, K. M., Beroukhim, K., Farahnik, B., Ahn, R. S., Yan, D., Singh, R. K., Nakamura, M., Koo, J., & Liao, W. (2017). Dietary Behaviors in Psoriasis: Patient-Reported Outcomes from a U.S. National Survey. Dermatology and Therapy, 7(2), 227–242. https://doi.org/10.1007/S13555-017-0183-4
2. Antiga, E., Bonciolini, V., Volpi, W., Del Bianco, E., & Caproni, M. (2015). Oral curcumin (meriva) is effective as an adjuvant treatment and is able to reduce IL-22 serum levels in patients with psoriasis vulgaris. BioMed Research International, 2015, 1-7. https://doi.org/10.1155/2015/283634
3. Armstrong, A. W., Mehta, M. D., Schupp, C. W., Gondo, G. C., Bell, S. J., & Griffiths, C. E. M. (2021). Psoriasis Prevalence in Adults in the United States. JAMA Dermatology, 157(8), 940–946. https://doi.org/10.1001/JAMADERMATOL.2021.2007
4. Barrea, L., Balato, N., Di Somma, C., Macchia, P. E., Napolitano, M., Savanelli, M. C., Esposito, K., Colao, A., & Savastano, S. (2015). Nutrition and psoriasis: Is there any association between the severity of the disease and adherence to the Mediterranean diet? Journal of Translational Medicine, 13(1), 1–10. https://doi.org/10.1186/s12967-014-0372-1
5. Boboia, A., Feher, L. A., Cuc, S., & Moldovan, M. (2017). Comparative study between the sales of antiulcer drugs H2 antagonists and proton pump inhibitors. Farmacia, 65(4), 635–642.
6. Boboia, A., Florea, L. S., Turcu-Stiolica, A., Tăerel, A. E., Rais, C., Revnic, C., Florea, A., Vedeanu, N. S., Nastasă, C., & Oniga, O. (2020). Decision analysis of antibiotic use. Farmacia, 68(4), 757–765. https://doi.org/10.31925/farmacia.2020.4.24
7. Boboia, A., & Polinicencu, C. (2012). Application Of The Pareto Analysis Regarding The Research On The Value Of Preparations In Community Pharmacies From Cluj-Napoca, Romania. Farmacia, 60, 578–585.
8. Boboia, A., Turcu-Stiolica, A., Groza, M. R., Stoica, C. I., Florea, A., Revnic, C., Lotrean, L. M., Rais, C., Negrean, A. G., Grigor, A. S., Pele, R., & Nastasa, C. (2021). The role of the pharmacists and the pharmaceutical companies in the ecosystem of the public health campaigns - A case study in information campaigns on diabetes mellitus. Acta Poloniae Pharmaceutica - Drug Research, 77(6), 951–962. https://doi.org/10.32383/APPDR/130067
9. Buhaș, M. C., Gavrilaș, L. I., Candrea, R., Cătinean, A., Mocan, A., Miere, D., & Tătaru, A. (2022). Gut Microbiota in Psoriasis. Nutrients, 14(14), 1-21. https://doi.org/10.3390/NU14142970
10. Burshtein, J., Strunk, A., & Garg, A. (2020). Incidence of psoriasis among adults in the United States: A sex- and age-adjusted population analysis. Journal of the American Academy of Dermatology, 84, 1023–1029. https://doi.org/10.1016/J.JAAD.2020.11.039
11. Buscemi, S., Rosafio, G., Vasto, S., Massenti, F. M., Grosso, G., Galvano, F., Rini, N., Barile, A. M., Maniaci, V.,

Cosentino, L., & Verga, S. (2015). Validation of a food frequency questionnaire for use in Italian adults living in Sicily. International Journal of Food Sciences and Nutrition, 66(4), 426–438. https://doi.org/10.3109/09637486.2015.1025718
12. Castaldo, G., Rastrelli, L., Galdo, G., Molettieri, P., Rotondi Aufiero, F., & Cereda, E. (2020). Aggressive weight-loss program with a ketogenic induction phase for the treatment of chronic plaque psoriasis: A proof-of-concept, single-arm, open-label clinical trial. Nutrition (Burbank, Los Angeles County, Calif.), 74, 1-7. https://doi.org/10.1016/J.NUT.2020.110757
13. Chen, H., Lu, C., Liu, H., Wang, M., Zhao, H., Yan, Y., & Han, L. (2017). Quercetin ameliorates imiquimod-induced psoriasis-like skin inflammation in mice via the NF-κB pathway. International Immunopharmacology, 48, 110–117. https://doi.org/10.1016/J.INTIMP.2017.04.022
14. Chen, S., Li, H., Liu, Y., Zhu, Z., & Wei, Q. (2017). Quercitrin extracted from Tartary buckwheat alleviates imiquimod-induced psoriasis-like dermatitis in mice by inhibiting the Th17 cell response. Journal of Functional Foods, 38, 9–19. https://doi.org/10.1016/J.JFF.2017.08.034
15. Chen, X., Song, X., Zhao, X., Zhang, Y., Wang, Y., Jia, R., Zou, Y., Li, L., & Yin, Z. (2022). Insights into the Anti-inflammatory and Antiviral Mechanisms of Resveratrol. Mediators of Inflammation, 2022, 1–11. https://doi.org/10.1155/2022/7138756
16. Costa, M. A. C., Vilela, D. L. S., Fraiz, G. M., Lopes, I. L., Coelho, A. I. M., Castro, L. C. V., & Martin, J. G. P. (2021). Effect of kombucha intake on the gut microbiota and obesity-related comorbidities: A systematic review. Critical reviews in food science and nutrition, 1–16. https://doi.org/10.1080/10408398.2021.1995321
17. De La Fuente-Arrillaga, C., Vzquez Ruiz, Z., Bes-Rastrollo, M., Sampson, L., & Martinez-González, M. A. (2010). Reproducibility of an FFQ validated in Spain. Public Health Nutrition, 13(9), 1364–1372. https://doi.org/10.1017/S1368980009993065
18. Dei-Cas, I., Giliberto, F., Luce, L., Dopazo, H., & Penas-Steinhardt, A. (2020). Metagenomic analysis of gut microbiota in non-treated plaque psoriasis patients stratified by disease severity: development of a new Psoriasis-Microbiome Index. Scientific Reports, 10(1), 1–11. https://doi.org/10.1038/s41598-020-69537-3
19. Deng, Y., Fang, Z., Cui, S., Zhao, J., Zhang, H., Chen, W., & Lu, W. (2021). Evaluation of probiotics for inhibiting hyperproliferation and inflammation relevant to psoriasis in vitro. Journal of Functional Foods, 81, 1-8. https://doi.org/10.1016/J.JFF.2021.104433
20. Deschamps, V., de Lauzon-Guillain, B., Lafay, L., Borys, J. M., Charles, M. A., & Romon, M. (2007). Reproducibility and relative validity of a food-frequency questionnaire among French adults and adolescents. European Journal of Clinical Nutrition, 63(2), 282–291. https://doi.org/10.1038/SJ.EJCN.1602914
21. Fahlquist-Hagert, C., Sareila, O., Rosendahl, S., & Holmdahl, R. (2022). Variants of beta-glucan polysaccharides downregulate autoimmune inflammation. Communications Biology, 5(1), 1-12. https://doi.org/10.1038/S42003-022-03376-Y
22. Frankel, H. C., Han, J., Li, T., & Qureshi, A. A. (2012). The association between physical activity and the risk of incident psoriasis. Archives of Dermatology, 148(8), 918–924. https://doi.org/10.1001/ARCHDERMATOL.2012.943
23. Fu, Y., Wang, Y., Gao, H., Li, D., Jiang, R., Ge, L., Tong, C., & Xu, K. (2021). Associations among Dietary Omega-3 Polyunsaturated Fatty Acids, the Gut Microbiota, and Intestinal Immunity. Mediators of Inflammation, 2021, 1-11. https://doi.org/10.1155/2021/8879227
24. Gan, Z., Wei, W., Li, Y., Wu, J., Zhao, Y., Zhang, L., Wang, T., & Zhong, X. (2019). Curcumin and Resveratrol Regulate Intestinal Bacteria and Alleviate Intestinal Inflammation in Weaned Piglets. Molecules (Basel, Switzerland), 24(7), 1-14. https://doi.org/10.3390/MOLECULES24071220
25. Garbicz, J., Całyniuk, B., Górski, M., Buczkowska, M., Piecuch, M., Kulik, A., & Rozentryt, P. (2021). Nutritional Therapy in Persons Suffering from Psoriasis. Nutrients, 14, 1-19. https://doi.org/10.3390/NU14010119
26. Gavrilaș, L. I., Ionescu, C., Bălăcescu, O., Revnic, C., Ciobârcă, D., Filip, L., Boboia, A., & Miere, D. (2018). Foods and food groups associated with colorectal cancer: A case-control study. Farmacia, 66(5), 846–852. https://doi.org/10.31925/farmacia.2018.5.15
27. Guida, B., Napoleone, A., Trio, R., Nastasi, A., Balato, N., Laccetti, R., & Cataldi, M. (2014). Energy-restricted, n-3 polyunsaturated fatty acids-rich diet improves the clinical response to immuno-modulating drugs in obese patients with plaque-type psoriasis: a randomized control clinical trial. Clinical Nutrition, 33(3), 399–405. https://doi.org/10.1016/J.CLNU.2013.09.010

28. Guillet, C., Seeli, C., Nina, M., Maul, L. V., & Maul, J.-T. (2022). The impact of gender and sex in psoriasis: What to be aware of when treating women with psoriasis. International Journal of Women's Dermatology, 8(2), e010. https://doi.org/10.1097/JW9.0000000000000010
29. Hidalgo-Cantabrana, C., Gómez, J., Delgado, S., Requena-López, S., Queiro-Silva, R., Margolles, A., Coto, E., Sánchez, B., & Coto-Segura, P. (2019). Gut microbiota dysbiosis in a cohort of patients with psoriasis. The British Journal of Dermatology, 181(6), 1287–1295. https://doi.org/10.1111/BJD.17931
30. Ingkapairoj, K., Chularojanamontri, L., Chaiyabutr, C., Silpa-archa, N., Wongpraparut, C., & Bunyaratavej, S. (2021). Dietary habits and perceptions of psoriatic patients: Mediterranean versus Asian diets. The Journal of Dermatological Treatment, 33(4), 2290-2296. https://doi.org/10.1080/09546634.2021.1959500
31. Kanda, N., Hoashi, T., & Saeki, H. (2020). Nutrition and Psoriasis. International Journal of Molecular Sciences, 21(15), 1–19. https://doi.org/10.3390/IJMS21155405
32. Kjær, T. N., Thorsen, K., Jessen, N., Stenderup, K., & Pedersen, S. B. (2015). Resveratrol Ameliorates Imiquimod-Induced Psoriasis-Like Skin Inflammation in Mice. PLoS ONE, 10(5), 1-18. https://doi.org/10.1371/JOURNAL.PONE.0126599
33. Korovesi, A., Dalamaga, M., Kotopouli, M., & Papadavid, E. (2019). Adherence to the Mediterranean diet is independently associated with psoriasis risk, severity, and quality of life: a cross-sectional observational study. International Journal of Dermatology, 58(9), e164–e165. https://doi.org/10.1111/IJD.14523
34. Li, Y., Yao, J., Han, C., Yang, J., Chaudhry, M. T., Wang, S., Liu, H., & Yin, Y. (2016). Quercetin, Inflammation and Immunity. Nutrients, 8(3), 1-14. https://doi.org/10.3390/NU8030167
35. Liu, Y., Wang, J., & Wu, C. (2022). Modulation of Gut Microbiota and Immune System by Probiotics, Pre-biotics, and Post-biotics. Frontiers in Nutrition, 8, 1-14. https://doi.org/10.3389/FNUT.2021.634897
36. Llamas-Velasco, M., Ovejero-Merino, E., & Salgado-Boquete, L. (2021). Obesity — A Risk Factor for Psoriasis andCOVID-19. Actas Dermo-Sifiliograficas, 112(6), 489-494. https://doi.org/10.1016/J.ADENGL.2021.03.013
37. Lu, W., Deng, Y., Fang, Z., Zhai, Q., Cui, S., Zhao, J., Chen, W., & Zhang, H. (2021). Potential Role of Probiotics in Ameliorating Psoriasis by Modulating Gut Microbiota in Imiquimod-Induced Psoriasis-Like Mice. Nutrients, 13(6), 1-17. https://doi.org/10.3390/NU13062010
38. Meng, T., Xiao, D., Muhammed, A., Deng, J., Chen, L., & He, J. (2021). Anti-Inflammatory Action and Mechanisms of Resveratrol. Molecules (Basel, Switzerland), 26(1), 1-15. https://doi.org/10.3390/MOLECULES26010229
39. Moludi, J., Khedmatgozar, H., Saiedi, S., Razmi, H., Alizadeh, M., & Ebrahimi, B. (2021). Probiotic supplementation improves clinical outcomes and quality of life indicators in patients with plaque psoriasis: A randomized double-blind clinical trial. Clinical Nutrition ESPEN, 46, 33–39. https://doi.org/10.1016/J.CLNESP.2021.09.004
40. Murer, C., Sgier, D., Mettler, S. K., Guillet, C., Maul, J. T., Djamei, V., Navarini, A. A., & Anzengruber, F. (2020). Gender differences in psoriasis: a Swiss online psoriasis survey. Archives of Dermatological Research, 313(2), 89–94. https://doi.org/10.1007/S00403-020-02066-1
41. Naldi, L., Conti, A., Cazzaniga, S., Patrizi, A., Pazzaglia, M., Lanzoni, A., Veneziano, L., Pellacani, G., Miglietta, R., Padalino, C., Giannetti, A., Santoro, S., Satolli, F., Donelli, S., Savoia, F., Di Lernia, V., Virgili, A., Borghi, A., Alessandrini, F., & Di Crecchio, R. (2014). Diet and physical exercise in psoriasis: a randomized controlled trial. The British Journal of Dermatology, 170(3), 634–642. https://doi.org/10.1111/BJD.12735
42. Nicolescu, A. C., Bucur, Ş., Giurcăneanu, C., Gheucă-Solovăstru, L., Constantin, T., Furtunescu, F., Ancuţa, I., & Constantin, M. M. (2021). Prevalence and Characteristics of Psoriasis in Romania-First Study in Overall Population. Journal of Personalized Medicine, 11(6), 1-12. https://doi.org/10.3390/JPM11060523
43. Parisi, R., Iskandar, I. Y. K., Kontopantelis, E., Augustin, M., Griffiths, C. E. M., & Ashcroft, D. M. (2020). National, regional, and worldwide epidemiology of psoriasis: systematic analysis and modelling study. The BMJ, 369, 1-12. https://doi.org/10.1136/BMJ.M1590
44. Phan, C., Touvier, M., Kesse-Guyot, E., Adjibade, M., Hercberg, S., Wolkenstein, P., Chosidow, O., Ezzedine, K., & Sbidian, E. (2018). Association Between Mediterranean Anti-inflammatory Dietary Profile and Severity of Psoriasis: Results From the NutriNet-Santé Cohort. JAMA Dermatology, 154(9), 1017–1024. https://doi.org/10.1001/JAMADERMATOL.2018.2127
45. Ramírez, J., Azuaga-Piñango, A. B., Celis, R., & Cañete, J. D. (2021). Update on Cardiovascular Risk and Obesity in Psoriatic Arthritis. Frontiers in Medicine, 8, 1-8. https://doi.org/10.3389/FMED.2021.742713
46. Rendon, A., & Schäkel, K. (2019). Psoriasis Pathogenesis and Treatment. International Journal of Molecular Sciences, 20(6), 1-28. https://doi.org/10.3390/IJMS20061475

47. Richetta, A. G., Grassi, S., Moliterni, E., Chello, C., Calvieri, C., Carnevale, R., Peruzzi, M., Violi, F., & Calvieri, S. (2020). Increased intestinal barrier permeability in patients with moderate to severe plaque-type psoriasis. The Journal of Dermatology, 47(10), e366–e368. https://doi.org/10.1111/1346-8138.15361
48. Rodríguez-Cerdeira, C., Cordeiro-Rodríguez, M., Carnero-Gregorio, M., López-Barcenas, A., Martínez-Herrera, E., Fabbrocini, G., Sinani, A., Arenas-Guzmán, R., & González-Cespón, J. L. (2019). Biomarkers of Inflammation in Obesity-Psoriatic Patients. Mediators of Inflammation, 2019, 1-15. https://doi.org/10.1155/2019/7353420
49. Şanlier, N., Gökcen, B. B., & Sezgin, A. C. (2017). Health benefits of fermented foods. Critical Reviews in Food Science and Nutrition, 59(3), 506–527. https://doi.org/10.1080/10408398.2017.1383355
50. Schade, L., Mesa, D., Faria, A. R., Santamaria, J. R., Xavier, C. A., Ribeiro, D., Hajar, F. N., & Azevedo, V. F. (2022). The gut microbiota profile in psoriasis: a Brazilian case-control study. Letters in Applied Microbiology, 74(4), 498-504 https://doi.org/10.1111/LAM.13630
51. Shahbazi, R., Sharifzad, F., Bagheri, R., Alsadi, N., Yasavoli-Sharahi, H., & Matar, C. (2021). Anti-Inflammatory and Immunomodulatory Properties of Fermented Plant Foods. Nutrients, 13(5), 1-20. https://doi.org/10.3390/NU13051516
52. Sikora, M., Chrabąszcz, M., Maciejewski, C., Zaremba, M., Waśkiel, A., Olszewska, M., & Rudnicka, L. (2018). Intestinal barrier integrity in patients with plaque psoriasis. The Journal of Dermatology, 45(12), 1468–1470. https://doi.org/10.1111/1346-8138.14647
53. Sikora, M., Stec, A., Chrabaszcz, M., Knot, A., Waskiel-Burnat, A., Rakowska, A., Olszewska, M., & Rudnicka, L. (2020). Gut microbiome in psoriasis: An updated review. Pathogens, 9(6), 1–14. https://doi.org/10.3390/pathogens9060463
54. Snekvik, I., Smith, C. H., Nilsen, T. I. L., Langan, S. M., Modalsli, E. H., Romundstad, P. R., & Saunes, M. (2017). Obesity, Waist Circumference, Weight Change, and Risk of Incident Psoriasis: Prospective Data from the HUNT Study. The Journal of Investigative Dermatology, 137(12), 2484–2490. https://doi.org/10.1016/J.JID.2017.07.822
55. Stiemsma, L. T., Nakamura, R. E., Nguyen, J. G., & Michels, K. B. (2020). Does Consumption of Fermented Foods Modify the Human Gut Microbiota? The Journal of Nutrition, 150(7), 1680-1692. https://doi.org/10.1093/JN/NXAA077
56. Subtirelu, M. S., Turcu-Stiolica, A., Vreju, F. A., Ciurea, P. L., Dinescu, S. C., Barbulescu, A. L., Neamtu, J., & Danciulescu, R. C. (2019). Cultural Adaptation and Optimization of the Compliance Questionnaire-Rheumatology (CQR) Through Statistical Methods for Patients with Rheumatic Diseases. Broad Research in Artificial Intelligence and Neuroscience, 10(Special Issue 2), 33–45.
57. Takahashi, M., Takahashi, K., Abe, S., Yamada, K., Suzuki, M., Masahisa, M., Endo, M., Abe, K., Inoue, R., & Hoshi, H. (2020). Improvement of Psoriasis by Alteration of the Gut Environment by Oral Administration of Fucoidan from Cladosiphon Okamuranus. Marine Drugs, 18(3), 1-13. https://doi.org/10.3390/MD18030154
58. Todberg, T., Egeberg, A., Zachariae, C., Sørensen, N., Pedersen, O., & Skov, L. (2022). Patients with psoriasis have a dysbiotic taxonomic and functional gut microbiota. British Journal of Dermatology, 187(1), 89–98. https://doi.org/10.1111/BJD.21245
59. Turcu-ştiolică, A., Bogdan, M., Tăerel, A. E., Boboia, A., Subţirelu, M. S., Foia, L. G., & Pădureanu, V. (2018). Developing of a new tool for evaluation of therapeutic adherence in COPD. Farmacia, 66(5), 920–924. https://doi.org/10.31925/farmacia.2018.5.25
60. Wilson, P. B., Bohjanen, K. A., Ingraham, S. J., & Leon, A. S. (2012). Psoriasis and physical activity: a review. Journal of the European Academy of Dermatology and Venereology, 26(11), 1345–1353. https://doi.org/10.1111/J.1468-3083.2012.04494.X
61. Wolters, M., Ahrens, J., Romaní-Pérez, M., Watkins, C., Sanz, Y., Benítez-Páez, A., Stanton, C., & Günther, K. (2018). Dietary fat, the gut microbiota, and metabolic health - A systematic review conducted within the MyNewGut project. Clinical Nutrition (Edinburgh, Scotland), 38(6), 2504–2520. https://doi.org/10.1016/J.CLNU.2018.12.024
62. Zákostelská, Z., Málková, J., Klimešová, K., Rossmann, P., Hornová, M., Novosádová, I., Stehlíková, Z., Kostovčík, M., Hudcovic, T., Štepánková, R., Jůzlová, K., Hercogová, J., Tlaskalová-Hogenová, H., & Kverka, M. (2016). Intestinal Microbiota Promotes Psoriasis-Like Skin Inflammation by Enhancing Th17 Response. PLOS ONE, 11(7), e0159539. https://doi.org/10.1371/JOURNAL.PONE.0159539

63. Zeng, L., Yu, G., Wu, Y., Hao, W., & Zeng, L. (2021). The Effectiveness and Safety of Probiotic Supplements for Psoriasis: A Systematic Review and Meta-Analysis of Randomized Controlled Trials and Preclinical Trials. Journal of Immunology Research, 2021, 1-14. https://doi.org/10.1155/2021/7552546
64. Zhang, S., Chen, D. C., & Chen, L. M. (2019). Facing a new challenge: the adverse effects of antibiotics on gut microbiota and host immunity. Chinese Medical Journal, 132(10), 1135-1138. https://doi.org/10.1097/CM9.0000000000000245
65. Zhang, X., Shi, L., Sun, T., Guo, K., & Geng, S. (2021). Dysbiosis of gut microbiota and its correlation with dysregulation of cytokines in psoriasis patients. BMC Microbiology, 21(1), 1–10. https://doi.org/10.1186/s12866-021-02125-1
66. Zheng, Q., Sun, X. Y., Miao, X., Xu, R., Ma, T., Zhang, Y. N., Li, H. J., Li, B., & Li, X. (2018). Association between physical activity and risk of prevalent psoriasis: A MOOSE-compliant meta-analysis. Medicine, 97(27), e11394. https://doi.org/10.1097/MD.0000000000011394
67. Żyła, E., Dziendzikowska, K., Kamola, D., Wilczak, J., Sapierzyński, R., Harasym, J., & Gromadzka-Ostrowska, J. (2021). Anti-inflammatory activity of oat beta-glucans in a crohn's disease model: Time-and molar mass-dependent effects. International Journal of Molecular Sciences, 22(9), 1-17. https://doi.org/10.3390/ijms22094485