Original Article

Study of Serum Chitinase-3-like-1 Protein (CHI3L1) and C-reactive Protein (CRP) in Patients Suffering from Chronic Plaque Psoriasis

Ahmed Hassan Al-Saba, Khawla Abdulhamza Shemran, Mohammed K. Al-Hattab

College of Medicine, University of Babylon, Hilla, Iraq

Abstract

Background: Psoriasis is a chronic inflammatory disease marked by the formation of well-defined raised erythematous plaques on the skin surface with silvery white scales. Chitinase-3-like-1 protein (CHI3L1) is thought to be important in physiological and pathological processes including angiogenesis, mitogenesis, and remodeling. C-reactive protein (CRP) has been suggested as an inflammatory biomarker in psoriasis and other disorders. **Objectives:** The aim of the current study is to determine the serum levels of CHI3L1 and CRP in psoriasis patients and to compare with healthy controls. In addition, the present study aims to investigate which is more sensitive and specific for diagnosing psoriasis. **Materials and Methods:** This is a case–control study. Sixty patients were involved in this study, divided into two groups (severe group that contains 30 patients and moderate group that contains 30 patients). Thirty individuals apparently healthy as control subjects were involved in the current study and all of them without any skin disease or other autoimmune diseases. **Results:** The current study revealed a significant increase in the serum CHI3L1 and CRP among psoriatic patients when compared with healthy controls. **Conclusion:** CHI3L1 and CRP increase with increased severity of psoriasis disease. CHI3L1 was a more sensitive and specific biomarker than CRP, according to the area under the curve in the receiver-operating characteristic curve test. Therefore, it is a good marker for the diagnosis of psoriasis patients.

Keywords: Body mass index (BMI), chitinase-3-like-1protein (CHI3L1), C-reactive protein (CRP), psoriasis, Psoriasis Area and Severity Index (PASI) score, receiver-operating characteristic (ROC) curve

Introduction

Psoriasis is a chronic inflammatory disease marked by the formation of well-defined raised erythematous plaques on the skin surface with silvery white scales.[1] The prevalence of psoriasis ranged from 2% to 3% of the world population.[2] There are two ages of onset peaks: the greatest is between the age of 20 and 30 years, whereas the smallest peak is between the age of 50 and 60 years. These data suggest that there are two types of psoriasis: type I psoriasis, which appears before the age of 40 years and is associated with a positive family history of psoriasis, frequent human leukocyte antigen (HLA) association, and more severe diseases. Type II psoriasis, which appears after 40 years and has no HLA link, has a negative family history.[3] Psoriasis is systematically characterized by alterations in cytokine production, vascular expansion, leukocyte infiltration, and hyperproliferation and aberrant differentiation of keratinocytes in the skin.[4] The beginning and exacerbation of the illness are linked to the number of emotional stressful physiological psychological events as well as systemic infections and environmental factors. Psoriasis can be induced as a side effect of some drugs such as imatinib mesylate.[5]

A member of the evolutionarily conserved glycosyl hydrolase family 18, chitinase-3-like 1 protein (CHI3L1, also known as YKL-40), has a great affinity for chitin but

Access this article online

Quick Response Code:

Website: www.medjbabylon.org

DOI: 10.4103/MJBL.MJBL_236_22

Address for correspondence: Dr. Ahmed Hassan Al-Saba, College of Medicine, University of Babylon, Hilla, Iraq.
E-mail: ahmedalsaba1994@gmail.com

Submission: 07-Oct-2022 **Accepted:** 20-Oct-2022 **Published:** 09-Jan-2023

How to cite this article: Al-Saba AH, Shemran KA, Al-Hattab MK. Study of serum chitinase-3-like-1 protein (CHI3L1) and C-reactive protein (CRP) in patients suffering from chronic plaque psoriasis. Med J Babylon 2022;19:729-35.

is unable to directly degrade it enzymatically.[6] CHI3L1 has unclear biological functions. However, it is thought to be important in physiological and pathological processes including angiogenesis, mitogenesis, and remodeling.[7] Recently, few studies have looked into the functions of CHI3L1 in cutaneous psoriasis; nevertheless, the results so far have been conflicting.[8] In response to cytokines including interleukin (IL)-1, IL-6, and tumor necrosis factor (TNF), hepatocytes primarily produce the acute phase substance known as C-reactive protein (CRP).[9] Hepatocytes in the liver create CRP primarily, but smooth muscle cells, macrophages, endothelial cells, lymphocytes, and adipocytes can also make it.[10] CRP has been suggested as an inflammatory biomarker in psoriasis and other disorders.[11]

The aim of the current study is to evaluate the levels of CHI3L1 and CRP in psoriasis patients and to compare with the healthy controls. Also, the present study aims to investigate which is more sensitive and specific marker for diagnosing psoriasis patients. It also aims to evaluate the body mass index (BMI) in psoriasis patients.

Materials and Methods

Date and duration

The duration of the current study extended from October 2021 to March 2022. This research was carried out at the Merjan Medical Teaching Hospital in Hilla City, Iraq and at the Department of Biochemistry at College of Medicine at the University of Babylon.

Study design

A case–control study was used for the current study.

Patients and controls

Daniel's sample size formula equation was used to determine the sample size.[12] In this study, 60 patients were involved, divided into two groups [severe psoriasis patients group that contains 30 patients, which was classified according to gender into 21 (70%) psoriatic males and 9 (30%) psoriatic females, and moderate psoriasis patients groups that contain 30 patients, who were classified according to gender into 21 (70%) psoriatic males and 9 (30%) psoriatic females]. Thirty individuals apparently healthy as control subjects were involved in this study, who were classified into 21 (70%) healthy males and 9 (30%) healthy females based on gender. All of them were without any skin disease or other manifestation, and patients were age- and sex-matched.

Exclusion criteria

The exclusion criteria were pregnancy and lactating women, patients less than 18 years of age, any autoimmune diseases, any inflammatory diseases, cancer, and patients who took any systemic treatment in the last 1 month.

Statistical analysis

Statistical Package for Social Sciences (SPSS) version 20 was used for statistical analysis. Continuous data were presented as (mean±SD), whereas percentages and frequencies were supplied for categorical variables. The means of the three groups were compared using the one-way analysis of variance test. To determine the relationship between variables, the correlation test (Pearson's test) was used. The sensitivity and specificity of a biochemical parameter were determined using a receiver-operating characteristic (ROC) curve. *P*-values less than 0.05 were regarded as significant.

Body mass index (BMI)

Each person who participated in this study had their BMI calculated by using the specific following formula which required the presence of body weight in kg and body height in (m^2). People are typically classified as underweight, overweight, or obese using the BMI, a simple weight-for-height index. It is calculated by dividing the weight in kilograms by the square of the height in meters (kg/m^2).[13]

Psoriasis Area and Severity Index (PASI) score

In every patient, the Psoriasis Area and Severity Index (PASI) was calculated. PASI scores of all patients were calculated using specialized software (the PASI calculator), which was downloaded from the Apple application store. The PASI score is useful for assessing the severity of the disease. If the PASI score is below 10, the psoriasis is considered mild; between 10 and 20 it is considered moderate; and over 20 it is considered severe.[14] It was calculated using an online PASI calculator and depends on four parameters including erythema (redness), induration (thickness), desquamation (scaling), and area of involvement, as shown in the formula [Figure 1][15]:

$$\text{PASI} = 0.1(\text{Eh} + \text{Ih} + \text{Dh})\,\text{Ah} + 0.2(\text{Eu} + \text{Iu} + \text{Du})\,\text{Au} + 0.3\,(\text{Et} + \text{It} + \text{Dt})\,\text{At} + 0.4\,(\text{El} + \text{Il} + \text{Dl})\,\text{Al}. \quad \text{formula (1)},$$

where E is erythema, I induration, D desquamation, A area involved, h head, u upper limbs, t trunk, and l lower limbs.

Determination of serum CHI3L1

Diagnostic ELISA kits were used to determine CHI3L1 levels in the patient and control groups. Catalog No. of kit was E2063Hu, and the country was China.

Principle

The Sandwich-ELISA technique was used in this ELISA kit. The plate has been precoated with human CHI3L1 antibody. CHI3L1 present in the sample was added and binds to antibodies coated on the wells. After removing any unbound substances, a biotinylated human CHI3L1

antibody was added to wells and binds to CHI3L1 in the sample. After washing, streptavidin-horseradish peroxidase (HRP) was added to wells and binds to the biotinylated CHI3L1 antibody. After incubation, unbound streptavidin-HRP was washed away during a washing step. The substrate solution was added to wells and the color develops in proportion to the amount of human CHI3L1 bound. The color development was stopped and the intensity of the color was measured at 450 nm.[16]

Determination of serum CRP

Determination of serum CRP was done by the immunoturbidimetric method. Catalog. No. of the kit was 520801, and the country was China.

Principle

CRP and its corresponding antibody-sensitized latex particles met in a solution, agglutination reaction occurred, and certain turbidity was produced in the linear range of 0.2–320 mg/L. The turbidity was proportional to the content of antigen in the presence of a certain amount of antibodies. The change of turbidity was detected by scattering turbidimetry. The content of CRP in the sample was detected by comparing with the curve equation fitted by the same calibrator.[17]

Ethical consideration

The investigation was carried out in conformity with the moral guidelines found in the Declaration of Helsinki. Before taking a sample, it was done with patients' verbal and analytical consent. According to document number 1025 and the date 4/11/2021, a local Ethics Committee evaluated and approved the study protocol, subject information, and permission form.

Results

General characteristics of the study

Age in patients and controls

Ninety individuals participated in the current study and were divided into three groups: the severe psoriasis patients group whose age ranged from 18 to 68 years with mean ± SD of 42.4 ± 15.22; the moderate psoriasis patients group whose age ranged from 19 to 65 years with mean ± SD of 38.2 ± 13.38; and the healthy control group whose age ranged from 18 to 68 years with mean ± SD of 41.6 ± 15.67, as shown in Table 1.

Gender distribution in psoriasis patients and controls

Thirty severe psoriasis patients were involved in the current study and classified depending on the gender into 21 (70%) psoriatic males and 9 (30%) psoriatic females; 30 moderate psoriasis patients also classified depending on the gender into 21 (70%) psoriatic males and 9 (30%) psoriatic females; and 30 healthy controls also classified into 21 (70%) healthy males and 9 (30%) healthy females.

Body mass index (BMI) of participants

The results of the current study revealed a significantly higher *P*-value ≤ 0.001 for BMI among the severe psoriatic patients group when compared with the healthy control

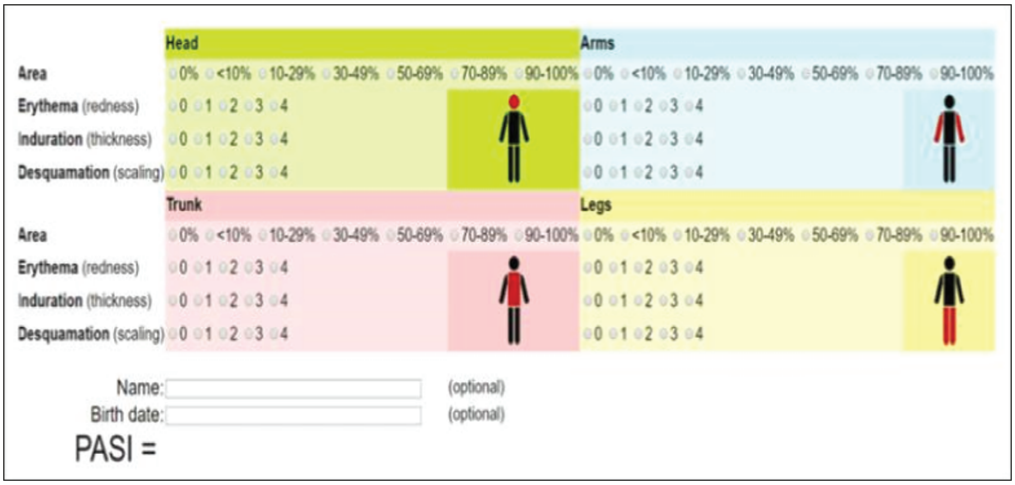

Figure 1: PASI score calculation

Table 1: Age distribution in patients and healthy control

Subject	Study groups	No.	Mean ± SD	*P*-value
Age (years)	Severe	30	42.4 ± 15.22	0.516
	Moderate	30	38.2 ± 13.38	
	Control	30	41.6 ± 15.67	

Table 2: The body mass index (kg/m²) of participants

Subject	Study group	No.	Mean ± SD	*P*- value
BMI (kg/m²)	Severe groups	30	30.1 ± 6.96	≤ 0.001
	Control group	30	23.1 ± 1.70	
	Moderate group	30	27.7 ± 6.08	0.001
	Control group	30	23.1 ± 1.70	

Table 3: Comparison of mean serum CHI3L1(ng/mL) levels in patients and healthy control groups

Parameter	Study groups	No.	Mean ± SD	*P*-value
CHI3L1 (ng/mL)	Severe group	30	68.57 ± 25.17	≤ 0.001
	Control group	30	43.99 ± 8.34	
	Moderate group	30	63.59 ± 22.60	≤ 0.001
	Control group	30	43.99 ± 8.34	

Table 4: Comparison of mean serum C-reactive protein (mg/L) level in psoriasis patients and control groups

Parameter	Study groups	No.	Mean ± SD	*P*-value
C-reactive protein (mg/L)	Severe group	30	13.33 ± 4.84	≤ 0.001
	Control group	30	9.54 ± 2.18	
	Moderate group	30	11.35 ± 2.83	0.04
	Control group	30	9.54 ± 2.18	

group. The results also revealed a significantly higher *P*-value = 0.001 among moderate psoriatic patients when compared with the healthy control group [Table 2].

Biochemical parameters

Serum human chitinase-3-like-1 protein in psoriatic patients and healthy control groups

The serum concentration of human CHI3L1 in the severe psoriasis patients was significantly greater (*P*-value ≤ 0.001) than that in the control group, according to the current study. Also the results revealed a significantly higher *P*-value ≤ 0.001 in the serum concentration of human CHI3L1 among moderate patients when compared with the control group [Table 3].

Serum C-reactive protein among psoriatic patients and healthy control groups

The current study findings showed that severe psoriatic patients had significantly higher serum concentrations of CRP than the control group (*P*-value ≤ 0.001). Additionally, the results showed that the blood levels of human CRP of moderate serum psoriatic patients were significantly greater (*P*-value = 0.04) than those of the control group [Table 4].

Correlation between CRP and BMI

The result of the current study shows a statistically significant positive correlation between CRP and BMI (*P*-value = 0.012, *R* = 0.265) [Figure 2].

Correlation between BMI and PASI score

BMI and PASI score in the current study had a significant positive correlation (*P* = 0.042, *R* = 0.264) [Figure 3].

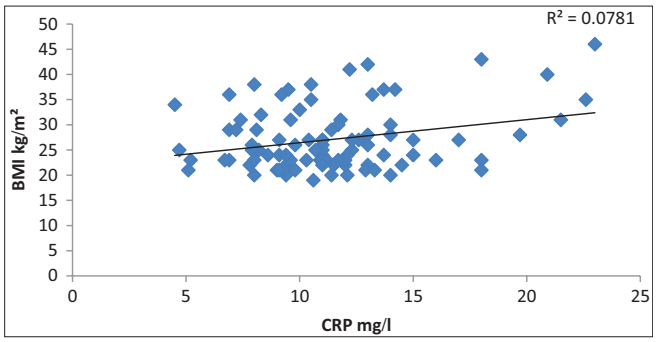

Figure 2: Correlation of CRP and BMI

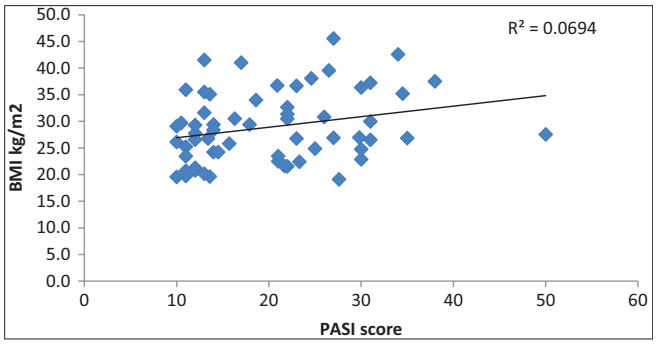

Figure 3: Correlation between BMI and PASI score

ROC curve of chitinase-3-like-1 protein (CHI3L1)

The ROC curve for CHI3L1 (ng/mL) for the diagnosis of psoriasis disease is shown in Figure 4: cut-off point was 49.81 (ng/mL), AUC= 0.83, *P*-value = 0.001, 95% confidence interval (CI) (0.747–0.912), the sensitivity and the specificity were 76% and 80%,

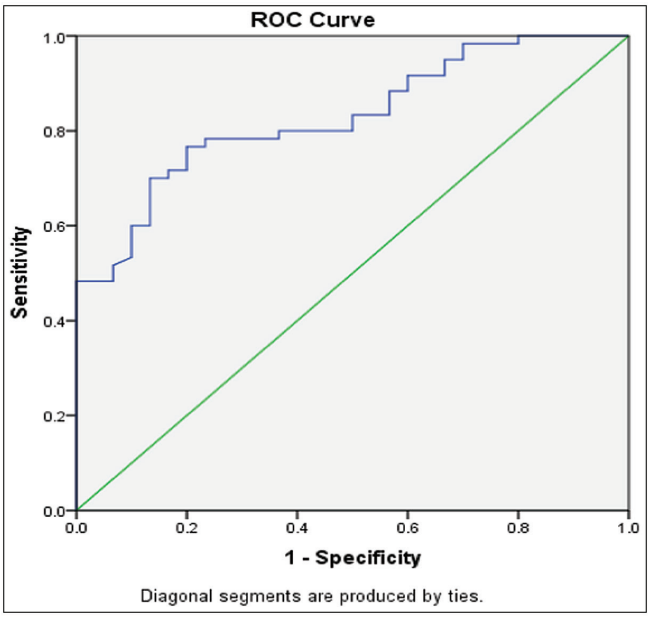

Figure 4: ROC curve of CHI3L1

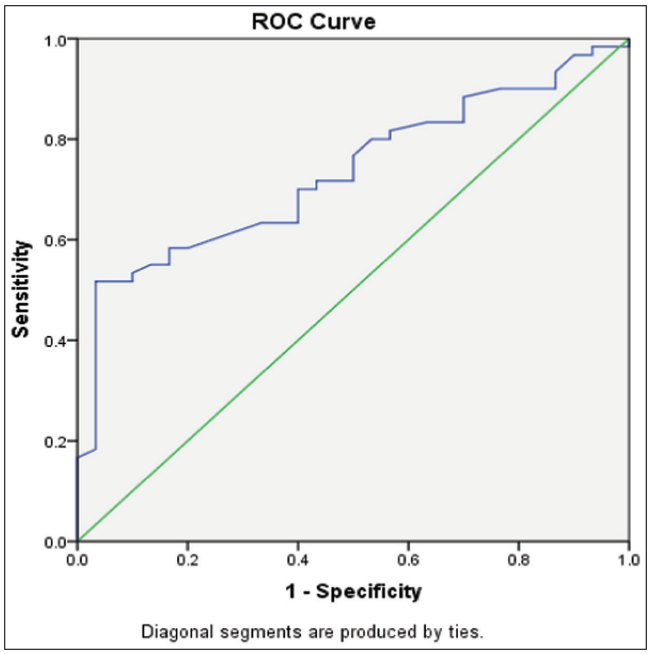

Figure 5: ROC curve of CRP

respectively, the positive predictive value (PPV) was 80%, and the negative predictive value (NPV) was 60%.

Roc curve of C-reactive protein

ROC curve for the sensitivity and specificity of CRP (ng/mL) for the diagnosis of psoriasis disease is shown in Figure 5: cut-off point was ≤ 10.35 (ng/mL), AUC= 0.73, $P \leq 0.001$, 95% CI (0.630–0.835), the sensitivity and specificity were 70 and 60%, respectively, PPV was 75%, and NPV was 53.8%.

Discussion

The results of the current study as shown in Table 1 showed no significant difference (*P*-value >0.05) between age and gender of severe and moderate psoriatic patients when compared with healthy control groups. The current findings were consistent with those of a previous psoriasis study conducted in Iraq.[1]

The adaption of a western lifestyle with reduced physical activity and a diet high in fat and carbohydrates, both of which favor the development of overweight and obesity in psoriasis patients, can be attributed for the significantly higher level of BMI, as shown in Table 2 in this study.[18]

Another explanation for the emergence of obesity in psoriasis patients is that Th17 cells, which secrete IL-17, play a significant role in the comorbidity's development of obesity in these people. In psoriatic diseases, immune dysregulation is driving complex reactions that result in the development and progression of obesity. This immune dysregulation is characterized by increased expression of IL-17 and the cell subsets that produce IL-17 and by decreased expression of regulatory T-cells (T-regs) and associated cytokines (such as IL-10).[19] Some studies revealed that IL-17 controls adipogenesis and glucose metabolism.[20]

In contrast, by secreting proinflammatory cytokines such as IL-6 and tumor necrosis factor-α (TNF-α), keratinocytes in psoriasis patients contribute to psoriasis inflammation.[21]

In terms of physiology, TNF promotes the production of adipocyte leptin, causes lipolysis, and prevents the creation of both lipogenesis and anabolic insulin-like growth factor 1.[22] TNF-α is therefore regarded as an anti-obesity cytokine that inhibits the growth of body mass. Therefore, the elevated TNF-α levels in obese individuals are thought to have a protective role. Contrarily, TNF-α secreted by keratinocytes in psoriasis patients may also contribute to obesity by inhibiting glucose transporter-4 and suppressing insulin receptor activity. As a result, insulin levels rise, stimulating the hunger center and increasing food intake, which increases body mass in psoriasis patients.[23]

According to certain research, the stress and decreased physical activity associated with psoriasis predispose individuals to the development of obesity.[24]

The findings of the present study matched those of a study by Zachariae and Skov,[18] who found that people with cutaneous psoriasis are more likely to become obese.

The precise biological roles of CHI3L1 are unknown. As a result, it is suggested that they play a role in physiological and pathological processes such as angiogenesis, mitogenesis, and remodeling.[25]

Furthermore, CHI3L1 was found to play a function in VEGF upregulation and increased angiogenesis. Therefore, both CHI3L1 and vascular endothelial growth factor (VEGF) may synergistically promote endothelial cell angiogenesis.[26] Additionally, it was demonstrated that CHI3L1 had a role in tissue remodeling, cell migration, and angiogenesis in the process of endothelial dysfunctions.[27]

Immunohistochemistry on bone marrow cells revealed that neutrophil precursors start producing CHI3L1 during the myelocyte-metamyelocyte stage, the stage of maturation at which other specific granule proteins are generated, which is the cause of the elevation of CHI3L1 in this study, as shown in Table 3. When the neutrophil is fully activated, CHI3L1 retained in the neutrophil granules is released.[28]

Other causes of elevated serum CHI3L1 in psoriasis include active neutrophils, which produce spongiform pustules by highly expressing CHI3L1 in the epidermis.[7]

More studies demonstrate that the blood level of CHI3L1 can serve as a reliable biomarker for psoriasis vulgaris and can reflect that the severe skin lesions are in psoriatic patients.[29]

The findings of the current study were in agreement with those of a previous study conducted by Imai *et al.*[29] and El-Gamal *et al.*,[7] who reported that the CHI3L1 important in the pathogenesis of psoriasis was manifested by its increase in the serum of psoriatic patients when compared with the healthy control group. In addition, Jensen *et al.*[30] and Ahmed *et al.*[31] revealed that psoriatic patients' serum CHI3L1 levels were higher than healthy controls. This study findings were in contrast to those of Ataseven and Kesli's[32] study, who found no statistically significant difference between the CHI3L1 serum concentrations of psoriatic patients and the control group. In response to a number of cytokines that are essential for the growth of psoriasis, the liver releases CRP.[33]

The result in Table 4 showed elevated mean serum levels of CRP in psoriasis patients, which may be attributed to some immunological mediators and proinflammatory cytokines such as TNF-α and IL-6, which in turn lead to generation of psoriatic lesions or atherosclerotic plaques which induce releasing of CRP.[34]

In addition to being a biomarker, CRP is an active inflammatory protein that plays a part in endothelial cell dysfunction and vascular remodeling; this could be another reason for rise in CRP.[35]

In 24 out of the 28 studies that compared the CRP levels in psoriatic patients with those of healthy controls, an increase in serum CRP was shown to be statistically significant, similar to our finding.[36]

The positive correlation result in the current study between CRP and BMI as shown in Figure 2 and between BMI and PASI score as shown in Figure 3 may be attributed to obesity, which have been related to higher production of proinflammatory cytokines (TNF-α, IL-6) that are responsible for certain aspects of the insulin resistance.[37-39] Additionally, proinflammatory cytokines including TNF-α and IL-6 cause CRP to be produced in psoriasis patients.[34]

In addition, TNF-α may possibly have a role in obesity by blocking glucose transporter-4 and counteracting insulin receptor function, resulting in an increase in insulin levels that induce the hunger center.[23] As TNF-α and IL-6 play a significant role in psoriasis, CRP and BMI as well as BMI and PASI score show positive correlations. Similar to the findings of Strober *et al.*,[40] our study found a numerically positive correlation between BMI and CRP levels in psoriatic individuals. Similar to our findings, a case–control study with 448 participants showed a relationship between obesity (BMI) and rising PASI.[41]

According to the area under the curve (AUC) in the ROC curve, our results for the Chitinase-3-like 1 protein show that it has a good diagnostic value in the diagnosis of psoriasis patients. According to the AUC in the ROC curve, our findings for CRP indicate that it has a fair diagnostic value in the diagnosis of psoriasis patients. Depending on the AUC, the value was higher in CHI3L1 (0.83) than in CRP (0.73); the CHI3L1 biomarker was more sensitive and specific than CRP in the diagnosis of psoriasis patients.

Conclusion

- The BMI was significantly increased in psoriasis patients when compared with the healthy control group and it increases with increase in severity of psoriasis, so that obesity is considered as a comorbid for psoriasis patients.
- The biochemical parameters included in the current study such as CHI3L1 and CRP are influenced by the severity and duration of psoriasis and it increased with an increase in severity of psoriasis, so it was higher in the severe than moderate group and in moderate than healthy control group.
- There was a positive correlation between CRP and BMI and between BMI and PASI score due to the important role of TNF-α and IL-6 in psoriasis disease, which effect on the mass of the body and the severity of psoriasis.
- CHI3L1 could be considered as a biomarker of inflammation in psoriasis and is more sensitive and specific than CRP according to the AUC in the ROC curve; therefore, it is a good biomarker for diagnosis of psoriasis patients.
- Chitinase-3-like protein 1 can be used as a new biomarker for the evaluation of disease severity and progression in psoriasis.

Acknowledgments

The staff of the Biochemistry Department of the University of Babylon's College of Medicine are to be thanked for their assistance and resources in completing the task for this study. The staff at the Dermatology

Department at Merjan Teaching Hospital in Hilla, Iraq, who helped with sample collection, are also acknowledged by the authors.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

References

1. Al-Mokhtar AM, Alta AH, Al-Hattab MK. Leptin and resistin induce oxidative stress in patients with chronic plaque. Res J Pharm Biol Chem Sci 2017;8:135-45.
2. Alhattab MK, Density OL, Before L. Chronic plaque psoriasis (a case–control study). Med J Babylon 2015;12:1173-90.
3. Hassoon HJ, Risan FA, Abdul-Muhaimen N. Estimation the concentration of IL-23, and IL-17A in the sera of patients with psoriasis in Baghdad city. Iraqi J Biotechnol 2014;13:75-85.
4. Litvinov IV, Bizet A, Binamer Y, Sasseville D, Philip A. Importance of CD109 and transforming growth factor-β signaling in psoriasis. In: Psoriasis Forum. Vol 16. Los Angeles, CA: SAGE Publications; 2010. p. 16-9.
5. Hattab MKAL. Possible adverse cutaneous effects in patients taking imatinib mesylate (Gleevec) in treatment of chronic myeloid leukemia (CML) and gastro intestinal stromal tumors (GISTs) at Hilla City. Med J Babylon 2013;10:537-46.
6. Kim EG, Kim MN, Hong JY, Lee JW, Kim SY, Kim KW, *et al*. Chitinase 3-like 1 contributes to food allergy via M2 macrophage polarization. Allergy Asthma Immunol Res 2020;12:1012-28.
7. El-Gamal EEA, Abo Al-Wafa HO, Abd-Alsamee HS, Bazied ME. Assessment of serum level of chitinase-3-like-protein 1 among psoriatic patients. Egypt J Hosp Med 2019;74:1844-8.
8. Salomon J, Matusiak Ł, Nowicka-Suszko D, Szepietowski JC. Chitinase-3-like protein 1 (YKL-40) is a new biomarker of inflammation in psoriasis. Mediators Inflamm 2017;2017:9538451.
9. Niknezhad N, Haghighatkhah HR, Zargari O, Ghalamkarpour F, Younespour S, Niknejad N, *et al*. High-sensitivity C-reactive protein as a biomarker in detecting subclinical atherosclerosis in psoriasis. Dermatol Ther 2020;33:e13628.
10. Sproston NR, Ashworth JJ. Role of C-reactive protein at sites of inflammation and infection. Front Immunol 2018;9:754.
11. Wacewicz M, Socha K, Soroczyńska J, Niczyporuk M, Aleksiejczuk P, Ostrowska J, *et al*. Concentration of selenium, zinc, copper, Cu/Zn ratio, total antioxidant status and C-reactive protein in the serum of patients with psoriasis treated by narrow-band ultraviolet B phototherapy: A case–control study. J Trace Elem Med Biol 2017;44:109-14.
12. Naing L, Winn T, Rusli BN. Practical issues in calculating the sample size for prevalence studies. Arch Orofac Sci 2006;1:9-14.
13. Elobeid HE-T, Alfarouk KO, Aljarbou AN, Elhassan GO, Muddathir AK, Ramadan ARMA, *et al*. correlation between the body mass index and psoriasis in Dermatology and Venereology Teaching Hospital in Khartoum. Am J Dermatol Venereol 2017;6:30-9.
14. Coimbra S, Oliveira H, Reis F, Belo L, Rocha S, Quintanilha AT. C-reactive protein and leucocyte activation in psoriasis vulgaris according to severity and therapy. J Eur Acad Dermatol Venereol 2010;24:789-96.
15. Sneha CB, Govind B, Mounika C, Srinivas JS, Garnepudi K, Narsimha Reddy LV. Therapies in the management of psoriasis at tertiary care. World J Pharm Res 2018.
16. Protein HC-like, Kit CE. Human Chitinase-3-like Protein 1, CHI3L1 ELISA Kit. Published online 2020:1-9.
17. Taika Road, Block C of Jianqiao Industrial Park, Dadukou District, C-reactive protein (CRP) kit (immunoturbidimetric method). 2021;86:0-1.
18. Zachariae C, Skov L. Obesity as a risk factor for psoriasis. J Eur Acad Dermatol Venereol 2020;34:915-6.
19. Zafiriou E, Daponte AI, Siokas V, Tsigalou C, Dardiotis E, Bogdanos DP. Depression and obesity in patients with psoriasis and psoriatic arthritis: Is Il-17-mediated immune dysregulation the connecting link? Front Immunol 2021;12:699848.
20. Gerkowicz A, Pietrzak A, Szepietowski JC, Radej S, Chodorowska G. Biochemical markers of psoriasis as a metabolic disease. Folia Histochem Cytobiol 2012;50:155-70.
21. Orsmond A, Bereza-Malcolm L, Lynch T, March L, Xue M. Skin barrier dysregulation in psoriasis. Int J Mol Sci 2021;22:1-27.
22. Jin D, Sun J, Huang J, He Y, Yu A, Yu X, *et al*. TNF-α reduces g0s2 expression and stimulates lipolysis through PPAR-γ inhibition in 3T3-L1 adipocytes. Cytokine 2014;69:196-205.
23. Chiricozzi A, Gisondi P, Girolomoni G, Chiricozzi A. The pharmacological management of patients with comorbid psoriasis and obesity. Expert Opin Pharmacother 2019;168:1-10.
24. Neimann AL, Shin DB, Wang X, Margolis DJ, Troxel AB, Gelfand JM. Prevalence of cardiovascular risk factors in patients with psoriasis. J Am Acad Dermatol 2006;55:829-35.
25. Łata E, Gisterek I, Matkowski R, Szelachowska J, Kornafel J. The importance of determining the prognostic marker YKL-40 in serum and tissues. Pol Merkur Lek Organ Pol Tow Lek 2010;28:505-8.
26. Francescone RA, Scully S, Faibish M, Taylor SL, Oh D, Moral L, *et al*. Role of YKL-40 in the angiogenesis, radioresistance, and progression of glioblastoma. J Biol Chem 2011;286:15332-43.
27. Furukawa T, Matsui K, Kitano M, Yokoyama Y, Sekiguchi M, Azuma N, *et al*. Relationship between YKL-40 and pulmonary arterial hypertension in systemic sclerosis. Mod Rheumatol 2019;29:476-83.
28. Volck B, Price PA, Johansen JS, Sørensen O, Benfield TL, Nielsen HJ, *et al*. YKL-40, a mammalian member of the chitinase family, is a matrix protein of specific granules in human neutrophils. Proc Assoc Am Physicians 1998;110:351-60.
29. Imai Y, Aochi S, Iwatsuki K, Sano H, Yamanishi K. YKL-40 is a serum biomarker reflecting the severity of cutaneous lesions in psoriatic arthritis. J Dermatol 2013;40:294-6.
30. Salomon J, Matusiak K, Nowicka-Suszko D, Szepietowski JC. Plasma YKL-40: A potential biomarker for psoriatic arthritis? J Eur Acad Dermatology Venereol 2013;27:815-9.
31. Ahmed SF, Attia EAS, Saad AA, Sharara M, Fawzy H, El Nahrery EMA. Serum YKL-40 in psoriasis with and without arthritis; correlation with disease activity and high-resolution power Doppler ultrasonographic joint findings. J Eur Acad Dermatology Venereol 2015;29:682-8.
32. Ataseven A, Kesli R. Novel inflammatory markers in psoriasis vulgaris: Vaspin, vascular adhesion protein-1 (VAP-1), and YKL-40. G Ital Dermatol Venereol 2016;151:244-50.
33. Namazi MR, Parhizkar AR, Jowkar F. Serum levels of hypersensitive-C-reactive protein in moderate and severe acne. Indian Dermatol Online J 2015;6:253-7.
34. Uysal S. The levels of serum pentraxin-3, CRP. Published online 2014:3453-8.
35. Dreiher J, Weitzman D, Davidovici B, Shapiro J, Cohen AD. Psoriasis and dyslipidaemia: A population-based study. Acta Dermatol Venereol 2008;88:561-5.
36. Beygi S, Lajevardi V, Abedini R. C-reactive protein in psoriasis: A review of the literature. J Eur Acad Dermatol Venereol 2014;28:700-11.
37. Paschoal RS, Cardili RN, Silva DA. Psoriasis patients: A cross-sectional study. Published online 2018:11-4.
38. Abbas ZA, El-Yassin HD. The impact of glycemic control on procalcitonin level in patients with type ii diabetes. Med J Babylon 2022;19:391-5.
39. Kareem JM, Al-Waely NK, Al-Hashimi AF. Diaphragmatic thickness in chronic obstructive pulmonary disease. Med J Babylon 2022;19:427-33.
40. Strober BE, Poulin Y, Teller C, Wang Y, Williams DA, Goldblum OM. Changes in C-reactive protein in patients with moderate-to-severe psoriasis switched to adalimumab therapy after suboptimal response to etanercept, methotrexate or phototherapy. J Eur Acad Dermatol Venereol 2014;28:1701-6.
41. Fleming P, Kraft J, Gulliver WP, Lynde C. The relationship of obesity with the severity of psoriasis : A systematic review. J Cutan Med Surg 2016;19:450-6.