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Role of Gamma-Glutamyl Transferase, High Sensitivity C Reactive Protein and Apolipoprotein B as A Marker of Disease Severity in Psoriasis

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Psoriasis can develop into systemic psoriasis, which primarily affects the liver, bile ducts, and cardiovascular system. Assessing the severity of psoriasis was crucial for determining treatment and cardiovascular disease risk. The aim of this study was to determine the role of Gamma-Glutamyl Transferase (GGT), High Sensitivity C-Reactive Protein (HS-CRP), and apolipoprotein B (APO B) in assessing the severity of psoriasis. Methods: This study was a cross-sectional, observational analytic study. A total of 33 psoriasis patients were tested for GGT, HS-CRP, APO B levels, and the Psoriasis Area and Severity Index (PASI) score. Results: The average GGT level was 70.75±56.47 u/L, the average HS-CRP level was 0.91±1.03 mg/L, the average APO B level was 110.09±26.47 mg/dL, and the average PASI score was 11.70±4.54. 12.1% of patients had mild psoriasis, 51.5% had moderate psoriasis, and 36.4% had severe psoriasis. There was a positive and strong correlation between GGT and PASI score, HS-CRP and PASI score, and APO B and PASI score. The multivariate correlation between GGT, HS-CRP, and APO B with PASI score had a value of R = 0.874, F = 31.145, p = <0.001. Conclusion: The multivariate correlation between GGT, HS-CRP, and APO B with PASI scores shows a positive and strong correlation, thus it useful for assessing the severity of psoriasis and evaluating the likelihood of cardiovascular disease.

Keywords: Psoriasis, GGT, hs-CRP, apo B, PASI score

INTRODUCTION

Psoriasis is a systemic inflammatory condition mainly of the skin that is chronic, residual, and multi system. Psoriasis is associated with various comorbid diseases, such as cardiovascular disease, hypertension, diabetes mellitus (DM), metabolic syndrome, and anxiety (Ion et al., 2022; Ilves et al., 2023). The incidence of psoriasis is worldwide and affects 2-3% of the world's population or about 125 million people, and can occur at any age (but generally between 20-30 years and 50-60 years), gender (predominance in men), various ethnicities and countries (Bae et al., 2021). The prevalence of psoriasis is higher in countries with colder climates. Psoriasis can cause economic impact and reduced quality of life, as well as affecting physical, emotional, and social conditions (Visser, 2021).

The main symptoms of psoriasis are skin inflammation and epidermal cell hyperplasia. Psoriasis lesions are well-demarcated plaques accompanied by thick whitish scales. Plaques are usually found on the elbows, knees, scalp, and lower back. Skin affected by psoriasis can be very dry and may crack or bleed Systemic involvement can be found in this disease (Pratiwi & Damayanti, 2018). The exact mechanism of how this occurs has not yet been elucidated, but it is thought to be related to the presence of pro-inflammatory factors circulating in the itchy or painful circulation (Ramezani et al., 2019). When psoriasis lesions occur on the nails, the nails will thicken, change color, and separate from the nail bed. As many as 30% of psoriasis patients may progress to psoriasis arthritis, which is characterized by inflammation, progressive destruction, and stiffness of the peripheral joints or spine (Heitmann et al., 2021). Diagnosis of psoriasis is done by physical examination, namely examination of the skin, nails, and scalp for signs of psoriasis. Psoriasis is related to genetics, so it is necessary to ask for a history of psoriasis in patients and families. In some cases of unclear psoriasis, a skin biopsy can be performed to confirm the diagnosis and help determine the type of psoriasis (Guo et al., 2023). A skin biopsy is done by taking a small sample of skin and examining it under a microscope. In some cases, a patch test is required to rule out allergic contact dermatitis. In patients suspected of arthritic psoriasis, a thorough joint examination, x-rays, and blood laboratory tests may be performed (Hoffmann et al., 2017; Fiore et al., 2018).

The pathogenesis of psoriasis is thought to involve complex mechanisms with multi-factorial processes. The molecular mechanisms that control the inflammatory and proliferative processes in psoriasis are still under further study (Wang et al., 2022). Psoriasis not only affects the skin but can also cause systemic disease (Visser, 2021). The main target organs in systemic psoriasis are the liver, biliary tract, and cardiovascular system. Psoriasis is associated with hepatobiliary disease, characterized by elevated Gamma-Glutamyl Transferase (GGT) levels, which is considered the most sensitive indicator for hepatobiliary disease (Belinchón-Romero et al., 2021; Zhang et al., 2022). Gamma-glutamyl transferase is an enzyme found in the liver and bile ducts, is the most sensitive indicator of hepatobiliary disease, and is a marker of oxidative stress and inflammation (Smirnova et al., 2016). Psoriasis lesions can have an increase in pro-inflammatory cytokines that can cause insulin resistance and trigger endothelial dysfunction, which can further lead to atherosclerosis Dobrică et al., 2022). Pro-inflammatory cytokines can alter the function of hepatocytes and arterial smooth muscle cells to induce lipoprotein composition, causing dyslipidemia, increased expression of cellular adhesion molecules, and increased lipid deposition on the arterial wall (Dizon et al., 2016; Oszukowska et al., 2017).

Psoriasis causes the expression of various pro-inflammatory cytokines and increases CRP levels. High-sensitivity c-reactive protein is a plasma protein produced by the liver and plays a role in the inflammatory process. Psoriasis expresses various pro-inflammatory cytokines such as interleukin (IL), tumor necrosis factor (TNF), and interferon-γ (IFN-γ). Tumor necrosis factor-α functions to increase the release of cytokines by lymphocytes and macrophage cells, increase the expression of adhesion molecules that attract neutrophils and macrophages to the lesion through vascular endothelial activation, induce keratinocyte cell proliferation and endothelial cell neovascularization that stimulates the inflammatory process (Beygi et al., 2014). This results in increased levels of pro-inflammatory CRP and leptin, and decreased levels of anti-inflammatory adiponectin. Research by Setyowatie *et al* (2016), reported that there are many factors that influence CRP levels so CRP cannot be used as a single indicator of inflammation in psoriasis vulgaris. Apolipoprotein B may act as a marker of dyslipidemia and cardiovascular disease in psoriasis patients, an important independent immune modulator that links lipid metabolism to local and systemic inflammatory responses. Psoriasis patients need early screening and therapy of hyperlipidemia to prevent atherosclerosis and its complications. Research by Ramezani *et al* (2019) reported abnormalities in serum lipid profiles, lipoproteins, and apolipoproteins in psoriatic patients and more risk of atherosclerosis and cardiovascular disorders. Elevated Lp (a) levels and modifications in biochemical markers of lipid peroxidation associated with psoriasis severity may be involved in the pathogenesis and progression of the disease and related complications. Elevated Lp (a) levels may also affect the expression of vascular adhesion protein 1 (VAP-1) or its activity in T cell adhesion and migration, thereby increasing risk factors for psoriasis and its complications. Psoriasis is associated with dyslipidemia, but the magnitude of the correlation between psoriasis and APO B remains unclear.

METHODS

This study is a cross-sectional, observational analytic study and has obtained ethical clearance from Dr.Moewardi Hospital Surakarta. The study was conducted at the Dermatology and Venereology Polyclinic of UNS Hospital, in Sukoharjo. The research period is from March to June 2023. The selection of research subjects is carried out consecutively (sequentially), The sample size was calculated using the sample size formula for multivariate analysis (Dahlan, 2019), which is the number of independent variables multiplied by 10. The minimum sample size required for this study was 30 subjects. The inclusion criteria are psoriasis patients at the Dermatology and Venereology Polyclinic of UNS Hospital aged 18 to 70 years and willing to sign an informed consent. Exclusion criteria are patients with acute infection characterized by fever with a temperature of more than 38^0C and a history of liver disease.

Psoriasis patients are explained about the objectives, benefits, and procedures of the study in detail to each research subject before the research began. Subjects who agreed and are willing to participate in the study are asked to sign an informed consent sheet and fill in patient data. Patients are assessed for PASI score and a 5 ml blood sample is taken for GGT, HS-CRP, and APO B examination. The examination of GGT, HS-CRP, and APO B uses the TMS 30i Clinical chemistry tool. The examination of GGT levels uses the kinetic photometric examination method. Examination of HS-CRP and APO B levels using the immunoturbidimetric examination method. Assessment of psoriasis severity using the Psoriasis Area and Severity Index (PASI), by assessing squamous, erythema, and induration in psoriasis lesions. The PASI score is assessed by a dermatology and venereology specialist at UNS Hospital. Psoriasis patients are classified into three, namely mild severity if the PASI score is < 7, moderate severity if the PASI score is 7-12, and severe severity if the PASI score is > 12.[21] The research analysis will assess the correlation between GGT levels and PASI scores, the correlation between HS-CRP and PASI scores, the correlation between APO B and PASI scores, and the correlation between GGT, HS-CRP and APO B with PASI scores, the Pearson product-moment or the Spearman rank correlation test is used.

ETHICS

This clinical trial was approved by the Medical Ethics Committee of Dr.Moewardi Hospital (169/ II/HREC/2022). All patients voluntarily signed the informed consent.

STATISTICAL ANALYSIS

Data was presented as means and standard deviations (SD). Data were analyzed using the SPSS 23 computer program for Windows. Normality was tested using the Shapiro-Willk test because the sample size was less than 50. Correlation tests used Pearson's product-moment correlation if the data were interval or ratio scaled or normally distributed, or the Spearman's rank correlation if the data were ordinal scaled or not normally distributed. Correlation refers to the relationship between GGT levels and PASI scores, the relationship between HS-CRP and PASI scores, the relationship between APO B and PASI scores, and the relationship between the combination of GGT, HS-CRP, and APO B with PASI scores. Correlation strength: Very weak (0–0.25), Weak (0.25–0.50), Moderate (0.50–0.75), Strong (0.75–0.99), or Very strong (1).

RESULTS AND DISCUSSION

This study involved 33 psoriasis patients, with the following basic characteristics of the research subject.

Table 1
Baseline Characteristic of the Subject

Variable	F(%)/ Mean+sd	Min.	Max.	Units
Sex				
Female	16 (48.5%)			-
Male	17 (51.5%)			-
Age	53.21 ±13.37	20.00	70.00	Year
SGOT	21.15 ±14.74	10.00	97.00	u/L
SGPT	21.24 ±17.58	7.00	104.00	u/L
GGT	70.75 ±56.47	13.30	192.20	u/L
HS-CRP	0 .97 ±1.03	0.04	4.51	mg/L
APO B	110.09 ±26.47	79.70	197.90	Mg/dL
PASI score	11.70 ±4.54	5.00	22.00	-
Mild	4 (12.1%)			
Moderate	17 (51.5%)			
Severe	12 (36.4%)			

Table 1 shows that based on the assessment of the PASI score, the degree of psoriasis was found to be mild 12.1%, moderate 51.5%, and severe 36.4%. Normality test using the Shapiro-Wilk test and the results obtained there are variables that are not normally distributed, then using the Spearman rank correlation test.

Correlation of GGT with PASI Score

Spearman rank correlation analysis between GGT and PASI scores showed the following results.

Descriptive blood pressure prior to and after fluid administration

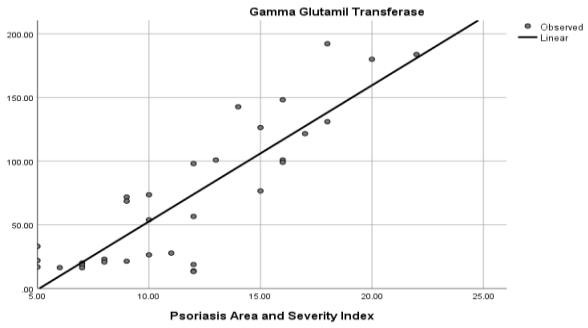

Figure 1. Scatter plot of GGT correlation with PASI score

Figure 1 shows a positive correlation between GGT and PASI score. The results of statistical analysis of the correlation between GGT and PASI scores showed a value of r=0.777, and the correlation is statistically significant.

Correlation of HS-CRP with PASI score

Spearman's rank correlation analysis between HS-CRP and PASI scores obtained the following results.

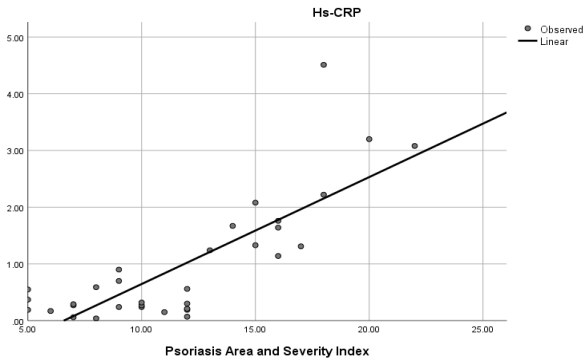

Figure 2. Scatter plot of HS-CRP correlation with PASI score.

Figure 2 shows a positive correlation between HS-CRP and PASI score. The results of statistical analysis of the correlation between HS-CRP and PASI score obtained a value of r=0.712, and the correlation is statistically significant.

Correlation of APO B with PASI Score

Spearman rank correlation analysis between APO B and PASI score showed the following results.

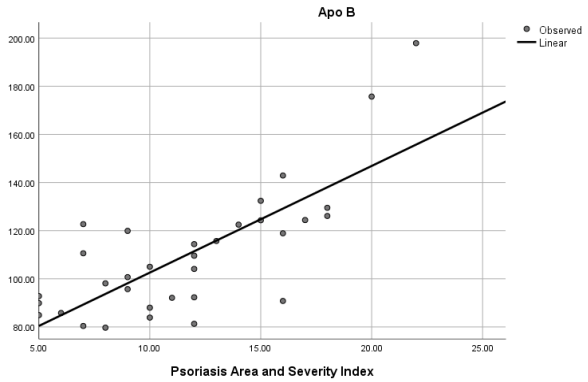

Figure 3. Scatter plot of APO B correlation with PASI score.

Figure 3 shows a positive correlation between APO B and PASI score. The results of statistical analysis of the correlation of APO B with the PASI score obtained a value of r = 0.684, and the correlation is statistically significant.

Correlation of GGT, HS-CRP, and APO B with PASI Score

Correlation analysis of GGT, HS-CRP, and APO B with PASI score using regression analysis test, with the following results.

Table 2. Regression Analysis of the correlation between GGT, HS-CRP, and APO B with the PASI Score

Variable	PASI scores		
	B	t/f	p-value
Constanta	3.560		
GGT	0.049*	2.714	0.011*
HS-CRP	0.350*	0.391	0.699
APO B	0.039*	1.602	0.120
R	0.874*	31.145	<0.001*
R^2 Ajd	0.739		

Note: Multiple Regression Test; B: Beta ;t-test; f-test; *) significant at p < 0.05

Table 2 shows the regression equation of PASI score = 3.560 +0.049 GGT +0.350 HS-CRP +0.039 APO B. The value of the GGT regression coefficient (B = 0.049, t = 2.714, p = 0.011) states that if the GGT value increases by 1 number, there is a possibility that the PASI score increases by 0.049, which means that there is a positive and significant correlation between GGT levels and PASI scores. The regression coefficient value of HS-CRP (B = 0.350, t = 0.391, p = 0.699) states that if the HS-CRP value increases by 1 number, there is a possibility that the PASI score will increase by 0.350, which means that there is a positive correlation between HS-CRP levels and PASI scores but not statistically significant. The regression coefficient value of APO B (B = 0.039, t = 1.602, p = 0.120) states that if the APO B value increases by 1 number, there is a possibility that the PASI score will increase by 0.039, which means that there is a positive correlation between APO B levels and PASI scores but not statistically significant. Based on the description above, it can be seen that the variable that has a dominant correlation with the PASI score is the GGT variable.

The correlation of GGT, HS-CRP, and APO B with PASI score simultaneously obtained the value (R=0.874, F=31.145, p = <0.001, and the correlation is significant. The value of R2 =0.739 which means that the variation in GGT, HS-CRP, and APO B data can explain the variation in PASI scores by 73.9% and the remaining 26.1% is influenced by other variables outside the model.

There was a positive and strong correlation between GGT and PASI score and the correlation was significant. Gamma-glutamyl transferase is a variable that has a dominant correlation with the PASI score. This result is in accordance with the research of Smirnova *et al.*, 2016 that GGT is an enzyme involved in glutathione metabolism and is considered a marker of oxidative stress. Increased GGT levels in psoriasis patients illustrate an increase in systemic oxidative stress. The hepatobiliary system is one of the main target organs in the development of systemic psoriasis. Non-alcoholic fatty liver disease and chronic cholecystitis are predictors of psoriasis disease progression (Fiore et al., 2018). Recent studies have shown a strong association between elevated GGT enzyme activity in plasma and various diseases such as cardiovascular disease, metabolic syndrome such as DM and obesity, neurological and neurodegenerative diseases, and many other diseases. Since the measurement of GGT enzyme activity is cheap and easy to perform, it has the potential to be used to aid in the diagnosis, prognosis, and further evaluation of various diseases. This should be studied further so that the measurement of this enzyme activity in blood serum can be a precise and accurate biomarker for various diseases (Oszukowska et al., 2017). Recent studies have shown a strong correlation between elevated GGT enzyme activity in the blood and various diseases. The GGT enzyme test is cheap and easy to perform, so GGT has the potential to be used in the diagnosis, prognosis, and further evaluation of various diseases (Smirnova et al., 2016; Fiore et al., 2018). Gamma Glutamyl Transferase and indirect bilirubin may play a role in the pathogenesis of psoriasis and the balance of both may describe oxidative stress-mediated systemic inflammation and associated metabolic abnormalities, so in psoriasis patients who have mild liver dysfunction, monitoring with GGT testing is recommended (Goto et al., 2021). Psoriasis patients have a higher risk of developing nonalcoholic fatty liver disease (NAFLD), due to a chronic inflammatory process associated with increased levels of pro-inflammatory adipokines and decreased levels of adiponectin. Psoriasis patients with NAFLD are significantly more at risk of metabolic syndrome, DM, dyslipidemia, body mass index of 30 kg/m2, homeostatic model of insulin resistance assessment (HOMA IR) greater than or equal to 2.15, and higher severity of psoriasis. Previous studies reported an association between metabolic syndrome and NAFLD,

which may be related to insulin resistance as a pathogenic pathway in psoriasis (Oszukowska et al., 2017).

There was a positive and strong correlation between HS-CRP and PASI score and the correlation is significant. These results are in accordance with the research of Wang *et al*., 2023 who found a positive correlation between HS-CRP inflammatory markers and PASI scores, where the production of pro-inflammatory cytokines in psoriasis, especially IL-6 can induce the liver to produce CRP so that HS-CRP levels will increase. The results of the study by Sirin *et al.,* 2020, that HS-CRP, the ratio of monocytes to HDL cholesterol, and the ratio of lymphocytes to monocytes are closely related to the PASI score, and can be considered as objective indicators in determining disease severity. Pro-inflammatory cytokines in psoriasis and those found in psoriatic lesions can cause insulin resistance and trigger endothelial cell dysfunction leading to atherosclerosis and eventually resulting in stroke or myocardial infarction (Visser, 2021). Pro-inflammatory cytokines can also affect lipid metabolism, by altering adipocyte and hepatocyte gene expression, resulting in an increase in pro-atherogenic lipids and a decrease in anti-atherogenic lipids, as well as disrupting reverse cholesterol transport. Systemic psoriasis can induce secondary hyperlipidemia, putting you at risk of cardiovascular disease. In psoriasis, the level of oxidative stress is increased, which plays a role in inflammation and tissue damage. Oxidative stress occurs when there is an imbalance between the production of free radicals and the ability to neutralize them. ROS-induced oxidative stress can regulate the increased activity of transcription factors and many protein kinases cascades that play a role in the regulation of the crosstalk between autophagy, apoptosis, and regeneration. It is thus important to avoid the destructive effects of the resulting ROS-mediated oxidation stress (Guo et al., 2023). The relationship between psoriasis and oxidative stress is influenced by several polymorphisms that appear in genes encoding markers or enzymes related to redox balance. Although the involvement of oxidative stress in psoriasis remains uncertain, future research is needed to explore the utility of assessing serum, plasma, urine, and/or circulating skin biomarkers as markers of oxidative stress and studying polymorphisms in genes that regulate redox balance, as well as how these findings can be translated into psoriasis management, as well as in understanding the pathogenesis and evolution of psoriasis (Dobrică et al., 2022).

CONCLUSIONS

Based on the results of the statistical test with *the Paired Samples Test* the P value produced was 0.000 < 0.05, meaning the null hypothesis (H_0) was rejected in favor of the alternative hypothesis (Ha). This suggests that there is a statistically significant effect of preoperative fluid administration on blood pressure stability before and after the intervention in C-section patients under spinal anesthesia at RSUD Sekarwangi. A correlation coefficient of 0.480 was found, indicating a positive correlation. This means that the administration of preoperative fluids contributed to improved blood pressure stability in C-section patients who experienced hypotension following spinal anesthesia. The correlation coefficient falls within the interval of 0.40–0.599, which indicates a moderate strength of association between the independent and dependent variables.

There was a positive and strong correlation between APO B and PASI score and the correlation was significant. Serum APO B levels and the APO B/APO A1 ratio were significantly increased in psoriasis with arthritis compared to psoriasis without arthritis (Alrubaye et al., 2020). This result is in accordance with the study of Wang *et al*., 2023 that psoriasis is associated with increased levels of APO B in serum compared to healthy controls. There was a positive and very strong correlation between GGT, HS-CRP, and APO B with PASI score, and the correlation was significant. This result is in accordance with the study of Wang *et al*., 2023 which states that the inflammatory marker HS-CRP not only correlates positively with disease severity (PASI score) at baseline but also correlates positively with APO B/APOA1. Patients with psoriasis have a higher risk of cardiovascular disease, due to systemic inflammation, endothelial dysfunction, and other cardiovascular risk factors associated with psoriasis. Oxidative stress and chronic inflammation in psoriasis can lead to endothelial dysfunction, atherosclerotic plaque formation, and increased risk of thrombosis, and pro-inflammatory cytokines can affect lipid metabolism and insulin resistance (Goto et al., 2021).

Many women suffer from mild psoriasis while many men have systemic psoriasis, so it is necessary to consider gender in the management of psoriasis and in the prevention and management of comorbidities (Hägg et al., 2017). Research by Wang *et al*., 2022 found that gender is also an important factor affecting lipid profile. Male patients had significantly lower levels of triglycerides, especially anti-atherogenic lipid profiles such as HDL and APO A1 than female patients. The APO B/APO A1 ratio was significantly higher in male patients than in female patients, which is consistent with the epidemiology of heart and vascular disease where age-adjusted cardiovascular disease (CVD) mortality and morbidity rates are highest in men than in women.

The exact etiology of psoriasis is still unknown, but it is thought to involve a complex mechanism with multi factorial processes such as genetic (if one or both parents have psoriasis, then there is a higher risk of developing psoriasis), metabolic, and immunological along with trigger factors such as trauma to the skin, bacterial or viral infection, obesity, hormones, alcohol, smoking, and stress. Obesity is a risk factor that influences the development of psoriasis and may correlate with psoriasis activity. Psoriasis patients have a higher prevalence and incidence of obesity, and those with more severe skin lesions have a higher likelihood of obesity than those with mild psoriasis. Epidemiological studies show that smoking increases the risk of psoriasis almost twofold. Smoking is not only a risk factor for

psoriasis but also increases the severity of psoriasis as well as decreases the therapeutic response, making therapy less effective (Pratiwi & Damayanti, 2018). In observational studies it has been reported that the risk of systolic hypertension is twice as high in psoriasis patients than in the general population, the more severe the development of psoriasis the higher the risk of hypertension. Some anti hypertensive drugs may also play a role in inducing psoriasis, including β-blockers and sartans. So long-term hypertensive status is associated with an increased risk of psoriasis (Ramezani et al., 2019).

The effects of Methotrexate (MTX) on lipid profiles and CVD are controversial. One meta-analysis showed that MTX use decreased the risk of cardiovascular events by 20%. However, another study found that there was no effect of MTX on HDL, LDL, triglyceride, total cholesterol, IL-1β, IL-6, and HS-CRP levels. MTX therapy can reduce the levels of pro-atherogenic lipids such as LDL and APO B as well as anti-atherogenic, especially in male patients. Androgen hormones can also enhance the anti-inflammatory effects of MTX, which may be the main reason why the anti-inflammatory effects and lipid profile down regulation of MTX are more pronounced in male patients than in female patients (Wang et al., 2022; Zhang et al., 2022). Psoriasis therapy aims to eliminate skin lesions, reduce itching, reduce the frequency of psoriasis recurrence and its complications, and improve the patient's quality of life. Psoriasis therapy uses topical corticosteroids, calcipotriol, or a combination thereof. Topical corticosteroids function as anti-inflammatory, anti-proliferative, and local vasoconstriction by down regulating genes encoding pro-inflammatory cytokines (Guo et al., 2023). Initial psoriasis is treated with oral administration of methotrexate (MTX) at a dose of 7.5 - 10 mg once a week. Then the dose will be increased by 2.5 mg every 2 to 4 weeks to a dose of 15 mg weekly. The dose of MTX given depends on the patient's clinical response, drug side effects, and the results of hematology and clinical chemistry laboratory examinations of each psoriasis patient. If the results of the clinical chemistry examination show a 2-3-fold increase in liver enzymes, the MTX dose should be reduced by 2.5 mg weekly and given once 2-4 weeks later. Methotrexate treatment should be discontinued if there is a more than 3-fold increase in liver enzymes (Wang et al., 2022).

Systemic psoriasis therapy using methotrexate and cyclosporine can be hepatotoxic, either due to direct liver damage or immunosuppression, or both immune-mediated and direct liver injury, characterized by elevated markers of liver function (Fiore et al., 2018). This is due to deregulation of the cellular antioxidant system which then results in oxidative damage to hepatocytes triggered by stress (Pratiwi & Damayanti, 2018; Fiore et al., 2018). Patients taking methotrexate did not show an increased risk of hepatic steatosis, in accordance with previous research studies. This finding is important because methotrexate is often used to treat psoriasis but is implicated in the development of liver fibrosis, especially when used long-term in patients with other risk factors for fatty liver disease, such as excessive alcohol use, obesity, and diabetes. The understanding of psoriasis as a systemic disease has changed the management of psoriasis patients, with an emphasis on the prevention and therapy of comorbidities, especially cardiovascular disease (Belinchón-Romero et al., 2021).

PASI scores may vary depending on psoriasis therapy, and there is high heterogeneity among study subjects. Further research is needed to examine the multivariate correlation between GGT, HS-CRP, and APO B with PASI severity scores conducted in multiple centers to describe a broader population, with more complete data such as type of therapy and diet.

CONCLUSION

There was a positive and strong correlation between GGT and PASI scores, between HS-CRP and PASI scores, between APO B and PASI scores, and between the combination of GGT, HS-CRP, and APO B and PASI scores. The combination of GGT, HS-CRP, and APO B produces the strongest correlation, making it a potential biomarker for assessing the severity of systemic psoriasis. Patients with psoriasis and a PASI score greater than 7 should undergo combined testing of GGT, HS-CRP, and APO B to assess systemic disease activity and the risk of comorbidities.

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