Journal of Health Study and Medicine
2021, No. 4
pp. 5–26
DOI 10.36145/JHSM2021.19

Stratification and Management of Cardiovascular Risk among Patients with Psoriasis

Adam Wełniak[1]
https://orcid.org/0000-0001-6473-3068

Karol Gryczka[1]

Kornelia Kędziora-Kornatowska[1]
https://orcid.org/0000-0003-4777-5252

[1] Nicolaus Copernicus University in Torun, Ludwik Rydygier Collegium Medicum in Bydgoszcz

Address for correspondence

Adam Wełniak
Nicolaus Copernicus University in Torun
Ludwik Rydygier Collegium Medicum in Bydgoszcz
13–15 Jagiellońska St., 85-067 Bydgoszcz, Poland
welniakadam96@gmail.com

Abstract

Older patients belong to the group with increased CVD risk, and one of the pillars of modern medicine is the stratification of risk and its reduction. Hence, physicians must approach the patient holistically and consider the multitude of factors that increase that risk. Recent reports suggest that, in addition to the classic cardiovascular risk factors, there is a group of lesser-known factors that also increases the incidence of CVD. One of them is psoriasis. This disease, known primarily for its cutaneous manifestation, actually impacts the whole body due to systemic inflammation. The challenge for physicians is to incorporate these new risk factors into the standard management of patients with psoriasis and to adjust treatment. Our work aims to analyse not only the association of psoriasis with increased CVD risk, but also what therapeutic options are available. This work also seeks to outline the actual risk in patients with psoriasis, which is higher than in the general population, as well as to highlight the problem that there are no tools that can unambiguously determine it.

Key words: *psoriasis, cardiovascular risk, risk assessment*

Introduction

Psoriasis (Ps) is an autoimmune disease associated with chronic inflammation [1]. The pathogenesis is very complex and still under investigation, but it seems that it is the activation of Th17 lymphocytes mediated by IL-23 [2, 3] which is crucial. Genetic factors are significant in the development of the disease; however, their role is probably greater in early-onset psoriasis rather than late-onset [3]. Psoriasis affects women and men equally, but more frequently white (especially Caucasian and Scandinavian) individuals [2]. According to the WHO Global report on psoriasis, about 100 million people worldwide are affected by the disease; however, scientists claim that the data may be underestimated [4]. Generally, the main manifestations of this condition are red, flaky plaques or patches on skin due to impaired keratosis and the inflammatory process [2].

Although inflammation is not only limited to skin, it has a systemic character. From a cardiovascular point of view, it is significant that it is localized in the vessel wall and for this reason it promotes atherosclerosis [3, 5, 6, 7].

We have analysed studies concerning different approaches to managing cardiovascular risk (CVR) in patients over 65 years old affected by different types of psoriasis. The aim of this review was to verify the current state of knowledge on the association between psoriasis and CVD, identify the different methods of CVR stratification of those patients and to compare the effectiveness and safety of the different therapeutic methods recently used.

Cardiovascular diseases (CVD) are the first cause of death in many countries. Between 1990 and 2015, most European states saw an increase in the number of new CVD cases, with a 100% increase in some countries. In 2015, there were just under 11.3 million new cases of CVD in Europe [8]. Detection and prevention is the basic and appropriate approach. Taking into account individual cardiovascular risk in the treatment process of psoriasis may have a beneficial influence not only for the patient, but potentially also for the health care system, thanks to the prevention of cardiovascular complications.

Correlation between psoriasis metabolic syndrome and cardiovascular risk

The incidence of metabolic syndrome (MS) in psoriasis patients is higher compared to the rest of the population [9]. Individual components of metabolic syndrome, such as increased waist circumference, elevated triglyceride levels, reduced HDL-C content, impaired fasting plasma glucose and arterial hypertension also occur more frequently in those patients in comparison to the global population. According to H. Radner et al., 18.5% of psoriasis patients had increased Total Cholesterol, 16. 9% increased LDL and 33.7% increased TG; 74.2% of men and of 16.9% women had low HDL, and 68.8% of men and 86.5% of women had increased waist circumference [10]. Statistically, per 1000 patients with psoriasis hypertension (range 68.2–79.8) is most common, followed by hyperlipidaemia (range 40.3–52.0), obesity (range 24.4–32.9) and diabetes (range 10.6–14.7) [10]. These findings are in accordance with other studies [12, 13, 14, 15]. However, there are inconsistencies when it comes to the impact of psoriasis on hypertension, hypercholesterolemia and hyperglycaemia. In one large cross-sectional study, psoriasis was positively associated with a higher Body Mass Index (BMI), waist circumference and hsCRP, with the corresponding increased incidence of overweight and metabolic syndrome. A positive link with diabetes, myocardial infarction and angina has also been proven, yet, in this study, there were no clear association between psoriasis and blood pressure, blood lipids or blood glucose levels [15]. This may be due to the fact that the investigator did not have any information on the use of lipid lowering drugs and could not rule out the possibility that this had an effect on the results. N. Curcó et al. tried to investigate the prevalence of metabolic syndrome and other cardiovascular risk factors in a group of patients with psoriasis and its association with the severity of skin lesions, patient characteristics and lifestyle [16]. CVR was assessed using systematic coronary risk assessment (SCORE) cards; CVR was considered high when values were ≥5%. Patients with severe psoriasis have been proved to have a higher risk of cardiovascular events than those with mild psoriasis. It is associated with the fact that the occurrence of diabetes

mellitus, baseline glycemia, insulin levels, and score risk was higher in patients with severe psoriasis. Insulin levels were associated with BMI and waist circumference, but not with Body Surface Area (BSA) and Psoriasis Area and Severity Index (PASI). In addition, when metabolic syndrome criteria were analysed independently, it was found that patients with severe psoriasis had lower levels of HDL-C than those with mild psoriasis. It is worth noting that the increased incidence of metabolic syndrome was observed especially in postmenopausal women (40%; 18/45). Metabolic syndrome accelerates the process of atherosclerosis, as it has been shown that patients with psoriasis show an increase in IMT (carotid artery intima-media thickness). Patients in the study group showed increased PWV (Pulse wave velocity), as well as increased IMT of the left part of the common carotid artery [12]. The increased risk of metabolic diseases applies not only to Ps and to Psoriatic arthritis (PsA) [17]. The same study showed that major adverse cardiovascular events (MACE) significantly increased in people with psoriasis. It is worth noting that adequate therapy has shown a reduction in risk. Patients on biological agents were less likely to have a PASI >10; however, patients on topical agents were 3.2 times more likely to have a PASI >10 [11]. No treatment led to an increase in CVD risk associated with increased BMI, blood pressure >140/90 or Waist to height ratio (WtHR) >0.5. This study showed that BMI and other CVD risk factors were not significantly increased in patients who were on biological agents. This suggests that the improvement in PASI may also correspond to an improvement in BMI and therefore other CVD risk factors. Psoriasis significantly increases not only the risk of psoriatic arthritis, but also of other diseases, such as non-specific inflammatory bowel diseases, uveitis, and psychological and psychiatric disorders [18]. Among psychiatric disorders, mainly depression, the incidence in psoriasis patients is about 20% [10]. It is believed that the onset of depression may increase the risk of developing cardiovascular disease. Of these, 47.2% had a moderate risk and 8.8% had a high risk of developing coronary artery disease within 10 years. Forty-five patients (28.3%) had a higher than expected risk score for same-sex individuals and ages. In addition to the significant prevalence of depression and regular alcohol consumption, there was also a link to smoking.

Psoriasis affects hormonal balance, although the mechanisms of the relationship between psoriasis and arterial hypertension are not conclusively established. As is well known, people with severe psoriasis have higher serum endothelin (ET-1) values compared to the general population [19]. Increased plasma renin activity, increased angiotensin converting enzyme activity and elevated ET-1 in psoriasis patients may contribute to poor blood pressure control. In addition, there is speculation that increased Angiotensin II levels may disturb the balance between the proliferation and differentiation of keratinocytes and have a proinflammatory effect [20].

Risk assessment

The Framingham Score (FRS) is the most commonly used theoretical regimen that shows a causal link with cardiovascular disease (CVD) and justifies adequate CVR stratification for future CVD. A Framingham score is calculated based on age, LDL and HDL cholesterol, blood pressure, diabetes and smoking in men and women. The sum of the points of each CVR factor for 10 years is estimated. In assessment of the risk of psoriasis patients, a certain study has proved the FRS was significantly higher in psoriasis patients than in the control group (8.36±5.75 vs. 6.61±4. 13; P<0.001) [9]. FRS was higher in men and in patients over 50 years of age. Depending on the severity of psoriasis, FRS increased from mild to moderate-severe (6.82±4.48 to 8.8±6.71; P=0.003). A close link between psoriasis and factors associated with a higher likelihood of cardiovascular disease has been shown [12]. Of the 159 patients, 38.4% had a moderate risk and 8.8% had a high risk of developing coronary artery disease within 10 years [10]. Such associations occur in patients with moderate to severe psoriasis and this risk is much greater than that reported in the general population. The risk of heart attack in psoriasis patients compared to the general HR population was 1.59 (95% CI: 1.26–2.02) in the early period and 1.60 (95% CI: 1.28–2.00) in the late period [21]. As the researchers point out, current guidelines recognize the increased risk of CVD among psoriatic patients and the need for early identification and better stratification [13]. However, predictive cardiovascular risk algorithms such as the Framingham risk scale

do not take into account systemic inflammatory activity as caused by psoriasis leading to an underestimation of actual risk. This might explain why some studies do not find a correlation between Ps and CVR. One study with patients over the age of 75 with acute coronary syndrome (ACS) and Ps did not show psoriasis being associated with a higher cardiovascular risk, but in this study the majority of psoriasis cases had a low PASI score. It is also worth mentioning that only three cases were treated systematically [22]. Similarly, about a quarter of psoriasis patients in the control group received certain systemic medications during their lifetime, while most of them received local treatment during the study. Therefore, anti-inflammatory treatment of psoriasis is unlikely to affect the cardiovascular system results because the inflammatory response is not significantly intensified during such a stage of the disease. Structural parameters such as the use of cardiac and vascular imaging and laboratory biomarkers can be used to improve the sensitivity of traditional risk stratification algorithms in psoriasis patients. Therefore, it is worth analysing another factor, namely Quality Intima Media Thickness (QIMT). It is another important parameter, responsible for identifying subclinical atherosclerotic disease in patients with or without risk factors. Elaine Abrahão-Machado and colleagues verified the thickening of the inner layer arteries, internal QIMT [23]. In group 1 of patients receiving TNF-α inhibitors (TNF-α-i), 56% of patients had thickening of the intima media layer of the carotid artery and 28% had developed cervical plaques. In group 2 taking MTX, 72% of patients had altered QIMT results and 20% had plaques on the carotid artery. There was no statistically significant difference between CVR (as measured by Framingham and QIMT) compared to the drug used in the group (MTX and TNF-α-i), so it is not possible to determine from the study which medicine is more effective. While it is noteworthy in this study that there is a moderate to strong positive association of QIMT values correlated with Framingham score values ($p<0,001$), it also indicates the possible use of QIMT as a screening test for cardiovascular risk assessment in Ps patients. In a similar study there were two groups of 25 patients each: one taking MTX for more than 6 months, the other taking either infliximab or adalimumab in the same time period [24]. Framingham-based CVR score risk results showed a reduction of risk: more than 60% presented low risk, with

a probability of less than 10% of developing a cardiovascular event in 10 years, with 56% in the MTX group and 72% in the biological group. The authors assume that drugs that remove inflammatory factors associated with the pathological process of psoriasis may reduce the risk of CV. Therefore, the assumed treatment of psoriasis should not only affect the reduction of skin plaques, but also the reduction of inflammation [24]. The last possible screening tool to discuss is Carotid Intima-Media Thickness (CIMT). In the study to determine the effect of psoriasis on CIMT, the mean age was 54 in all those diagnosed with psoriasis [25]. The mean CIMT measurement for the study sample was 0.7 (0.12) mm and increased CIMT was found in 6 patients (15.0%), of whom 2 had myocardial infarction. Moderately linear correlations were observed between CIMT and the 10-year risk of a cardiovascular incident predicted on the Framingham scale: (=0.55; P=0.002).

Treatment

Statins

Statins seem to be the best pharmacological option for controlling cardiovascular risk among psoriatic patients. In fact, it is especially their pleiotropic anti-inflammatory and immunomodulating effects which might play a key role in relieving inflammation [26]. Many studies have inspected the effectiveness of statin therapy as a part of their research (Table 1). Ports et al. evaluated results from three clinical trials (CARDS, TNT, IDEAL) relating to cardiovascular outcomes of statins administration in patients with psoriasis compared with non-psoriatic patients [27]. A statistically significant difference was noticed in HDL-C increase in the group with psoriasis – interestingly, the increase in this parameter was inversely proportional to the dose. On the other hand, reduction of unfavourable parameters for cardiovascular risk – for example, TC:HDL-C, LDL/HDL, ApoB:ApoA1 – was directly proportional to statin doses and the decline was greater in the psoriasis-free group. Psoriatic patients should be assessed for cardiovascular risk and, on this basis, a decision should be made whether they qualify for statin therapy. Currently available tools for

assessment of cardiovascular risk have a tendency to underestimate it in patients with chronic inflammatory diseases, such as psoriasis [28]. According to Masson et al., only patients with moderate/average CV risk should take statins. Eighteen-month therapy intense rosuvastatin treatment resulted in a statistically significant reduction of LDL-C level and some reduction in height of atherosclerotic plaques in carotid arteries (carotid plaques, CP) of patients with rheumatoid arthritis (RA), ankylosis spondylitis (AS) or PsA. The plaque height reduction effect was most expressed among the youngest group. It should be emphasized that patients were taking simultaneously at least one of the following drugs on a regular basis for their underlying disease: bDMARDs, sDMARDs (biological/synthetic disease modifying antirheumatic drugs), NSAIDs, a-HT (antihypertensive) medications, prednisolone. In the group taking bDMARDs, the reduction of CP height was much smaller compared to those taking sDMARDs, or those not taking DMARDs at all [29]. On top of that, this therapy significantly improved arterial stiffness parameters and lowered BP. Strong correlation between aPWV improvement and SBP reduction has been observed and it was independent from a-HT therapy patterns of individual patients [30]. Another study assessed the safety and efficacy of atorvastatin as a complementary treatment of mild-to-moderate chronic plaque psoriasis. Besides that, patients participating in that study were allowed to use beclomethasone valerate 0.1% ointment topically. After six months, PASI reduction was higher in the atorvastatin group compared to a placebo, but the difference was not statistically significant [31]. Researchers indicated atorvastatin has the strongest anti-inflammatory component among all statins, especially starting with a 40 mg/day dose. Interestingly, the hsCRP level in the atorvastatin group rose more than in the placebo group, although it was not a statistically significant increase. According to the scientists, the strategy of using atorvastatin routinely in psoriatic patients needs to be evaluated further [31].

TNF-α inhibitors and DMARDs

Eder et al. investigated how TNF-α-i therapy could affect subclinical atherosclerosis in patients with Ps and PsA [32]. Interestingly, TNF-α-i treatment

caused statistically significant inhibition of the forming of atherosclerotic plaques among men, while in women there was no association between using TNF-α-i and atherosclerosis progression. This anti-atherogenic effect was observed independently of the use of other systemic drugs. Despite some hypotheses, scientists failed to understand the reasons for the gender difference in response to TNF-α-i in plaque progression. After one year of follow-up in the group taking TNF-α-i, inflammation within the aortic wall significantly improved compared to the no treatment group. Surprisingly, in this study, DMARDs treatment in comparison with non-systemic treatment turned out to be less effective in stopping progression of atherosclerosis. According to the researchers, this may be due to the fact that patients treated only topically have generally less advanced disease and therefore a potentially lower baseline cardiovascular risk (including a tendency to build up atherosclerotic plaques). Sparks et al. analysed retrospectively a group of 985 patients with psoriasis taking DMARDs. All patients had a past medical history (PMH) of a CV event [33]. At baseline, most patients were taking csDMARDs (conventional synthetic DMARDs), such as methotrexate, hydroxychloroquine, sulfasalazine. Investigators state that dermatologists should advise their psoriasis patients not to quit DMARDs therapy after the initial CV event, which according to the authors is quite a common phenomenon. They point out that it is important to have in mind that psoriasis is an independent CV risk factor, and discontinuation of systemic therapy with DMARDs after an initial CV event was associated with higher risk of a subsequent CV event. The study involved patients with Ps, RA and PsA, but interestingly the discontinuation rate of prior treatment with DMARDs was the highest in the group with psoriasis. Taking into account another classic DMARD – methotrexate – its immunomodulatory component probably plays the main role in psoriasis relief. Warren et al. investigated the pros and cons of subcutaneous administration of methotrexate versus traditional per os treatment [34]. As advantages of s.c. administration they indicated: less time needed to achieve improvement; more stable long-term response (measured as improvement in PASI and sPGA [static physician global assessment]) and lower doses needed to gain the same effect. Moreover, patients are less likely to resign from subcutaneous MTX than from oral form.

Managing metabolic syndrome

Breaking down the link between psoriasis and the metabolic syndrome spectrum seems to be a critical strategy in reducing cardiovascular risk among these patients.

Researchers generally agree that treating metabolic syndrome significantly reduces cardiovascular risk and for this reason all patients with psoriasis should be actively screened and properly treated [36, 37]. Therapeutic strategies have to take into account complex pathogenesis of MS.

Dietary intervention should be one of the first steps in the psoriasis treatment process. Psoriatic patients have essential nutrient deficiency, which results in intensification of ROS (reactive oxygen species) production and therefore increased oxidative stress [37]. Many clinical trials have shown that diets rich in ω-3 PUFA are associated with relieving psoriasis symptoms. Reducing weight improves PASI in overweight and obese patients. Furthermore, patients with BMI >40 have a generally impaired response to any systemic treatment of psoriasis [37]. According to Peralta et al., ustekinumab (monoclonal antibody anti-IL-12 and IL-23) is a good option for inverse psoriasis. It is resistant to standard therapy and is also present in the group of patients with high BMI [37]. A good target of therapeutic intervention seems to be an adiponectin. Increasing its serum level might be key in preventing insulin-resistance [36]. Singh et al. observed effects of using pioglitazone and metformin in patients with mild to moderate psoriasis [3]. After 12 weeks, significant improvement of PASI, ESI and PGA was noticed in both groups compared to a placebo. In both the metformin and pioglitazone groups, significant improvement in fasting plasma glucose, total cholesterol and triglycerides was observed. In the metformin group, after 12 weeks a substantial reduction of weight, waist circumference and BMI was seen when compared to a placebo. On top of that, in the pioglitazone group there was a significant decrease in SBP and DBP. Pioglitazone and metformin in this study were equally effective in managing metabolic syndrome but due to the better weight reduction effect of metformin, it could be preferred [35].

Ascorbic acid

Reactive oxygen species (ROS) take part in the pathogenesis of inflammatory diseases such as psoriasis. Ascorbic acid (VIT C) is known for its antioxidant properties, thanks to which it is commonly used in cosmetics. The idea was put forward that VIT C could be used to treat psoriasis through its anti-inflammatory effects. However, the penetration of this drug into the affected skin had to be verified. N. Leveque et al. demonstrated that ascorbic acid concentrations in psoriatic lesional skin were statistically lower compared to those in healthy subjects [38]. Attempts have been made to use DDH-1, a derivative of VIT C with higher penetration into the skin. Findings are very promising: DDH-1 dose-dependently reduced the elevated mRNA expression of IL-1b and TNF-α in the skin lesions and 0.5% DDH-1 significantly inhibited their expression. DDH-1 administration also dose-dependently inhibited inflammatory cell infiltration into the skin lesions [39]. An interesting and promising target for future anti-psoriatic therapies might be LXR-α (Liver X Receptor-alpha) encoded by the NR1H3 gene. In the study performed using cultured keratinocytes derived from skin biopsies of psoriatic lesions, it turned out that the agonizing aforementioned receptor, or promoting its expression, could inhibit the proliferation of keratinocytes (observed decreased number of cells in S-phase of the cell cycle) [40]. Ascorbic acid and atorvastatin were used as LXR-α activators. In the group of cells treated with atorvastatin, an increase of 55% in LXR-α gene expression was observed compared to 24% in those treated with ascorbic acid.

Discussion

Patients suffering from psoriasis should be assessed for the risk of cardiovascular disease and their concomitant diseases should be actively treated. A study in Denmark used imaging and population studies to verify whether a longer duration of psoriasis could lead to increased vascular inflammation, which could in turn lead to serious cardiovascular complications due to longer exposure to chronic systemic inflammation observed in psoriasis [41].

This study is crucial, as it has shown that psoriasis duration is associated with increased vascular inflammation, a relationship which persists even when adjusting for traditional CV risk factors. On the basis of field studies, it has been shown that the risk of future CV events increases by 1% each year of the disease; that means psoriasis has the same effect as smoking, for example. Moreover, patients who had psoriasis for more than 10 years were more susceptible to hypertension, suggesting that certain factors in both the skin and cardiovascular system may be affected during the development of the disease [14]. It has been proven that mortality was significantly higher in the psoriasis group compared to the general population. In psoriasis patients, having two or more vascular risk factors was associated with higher mortality compared to having only one or no risk factors [13]. An increased incidence of MACE in inflammatory diseases, such as psoriasis is reported [15]. Researchers suggest the need to improve screening and management of traditional CV risk factors in patients with inflammatory diseases. Despite the well-established link between psoriasis and CVD risk factors, psoriasis patients are not necessarily aware of this relationship, which can affect their lifestyle and reduce risk management. The percentage of patients who correctly identified psoriasis as a CVD risk factor was 50.8% [11]. Patients should be advised of the risk by their clinicians.

Conclusion

The influence of psoriasis on cardiovascular risk is still an unexplored clinical aspect of this disease. The problem with the current risk stratification methods is the underestimation of the impact of this skin disease on the cardiovascular system. Undoubtedly, the group that could benefit from prophylactic pharmacology and screening methods are patients with advanced psoriasis, as well as patients with other concomitant factors of CVD. Better methods of cardiovascular risk stratification in patients with psoriasis should be sought.

It is also advisable to look for new therapeutic methods that will prevent complications of chronic inflammation accompanying psoriasis.

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Table 1. Summarizing the results of pharmacological studies in psoriasis

Article	Mean age of participants	Number of participants	Comorbidities of study population	Intervention in this study (dose min.-max.)	Tools for evaluating CV risk factors	Duration of study	Type of study
Rollefstad et al.	60.8 +/ – 8.5 yo	**86** (RA-55, AS-21, PsA-10)	HT, DM, CVDs, carotid artery plaques	Rosuvastatin (5–40 mg o.d.) patients >70 yo started with 5mg o.d.	LDL-C and measure of height of carotid artery plaques with USG (B-mode)	18 months	Retrospective analysis of RORA-AS study (NCT01389388)
Chua et al.	41.29 +/ – 11.38 yo	**28** (mild-to-moderate chronic plaque psoriasis [PASI<10]; 14 – atorvastatin group; 14 –placebo group) **Only 14 finished the study** (6 from atorvastatin group and 8 from placebo group)	No info	Atorvastatin (40 mg o.d.)	Lipid profile (TC, TG, LDL, HDL), hsCRP	6 months	Randomized, double-blinded clinical trial (NCT01389388)
Ikdahl et al.	No info	**89** (RA-55, AS-23, PsA-11)	HT, CVDs, DM, atherosclerotic plaques in carotid artery	Rosuvastatin (5–40 mg o.d.; average 30 mg o.d.)	Parameters of arterial stiffness (AIx, aPWV); SBP, DBP	18 months	Retrospective analysis of RORA-AS study
Lerman et al.	PS 50,4 +/- 12,6 yo Hiperlipidemic cohort 61,2+/- 3,5 yo	**105** – PS (plaque psoriasis; 50 underwent 1-year follow-up) 100 – hiperlipidemia without psoriasis and any other inflammatory diseases (eligible for statins therapy according to NCEP ATP III guidelines) 25 – healthy control group	hiperlipidemias	none	Assessing coronary plaque burden (TB and NCB) and HRP using CCTA; TC, HDL, LDL, hsCRP	No info	Observational study

Article	Mean age of participants	Number of participants	Comorbidities of study population	Intervention in this study (dose min.-max.)	Tools for evaluating CV risk factors	Duration of study	Type of study
Ports et al.	CARDS: 60.3+/-7,7 yo Pooled TNT/IDEAL: 61,6+/-8,7 yo	**52** – CARDS **49** – Pooled TNT/IDEAL	DM, MS, CVDs,	CARDS – 10 mg atorvastatin TNT – 8-week 10 mg atorvastatin next randomization 10 or 80 mg atorvastatin IDEAL – randomization to 20 mg simvastatin or 80 mg atorvastatin	TC, LDL, HDL, TGs, ApoB, ApoA1	Clinical trials conducted in years 1999–2001	Retrospective analysis of: CARDS (NCT00327418), TNT (NCT00327418), IDEAL (NCT00159835)
Eder et al.	Stage 1. 54.5 +/-11.5 yo Stage 2. 51.9 +/-10.5 yo	Stage 1. **319** patients with PS alone or PS + PsA Stage 2. **34** patients with PsA alone (only men)	DM, HT, dyslipidemias	TNFi – exact drugs and doses not specified Stage 1. 5 PS and 106 PS+PsA patients were receiving therapy	Stage 1. ultrasound assessment of carotid arteries plaques Stage 2. vascular inflammation assessed by FDG-PET/CT	No info	Prospective cohort and prospected nested cohort study

Legend: DM – diabetes mellitus, yo – years old, PS – psoriasis, MS – metabolic syndrome, HT – hypertension, CVD – cardiovascular disease, o.d. – once daily, SBP/DBP – systolic/diastolic blood pressure, aPWV – aortic pulse wave velocity, TNFi – TNF inhibitor, hsCRP – high sensitivity C-reactive protein, AIx – augmentation Index

Source: [27, 28, 29, 30, 41, 42].

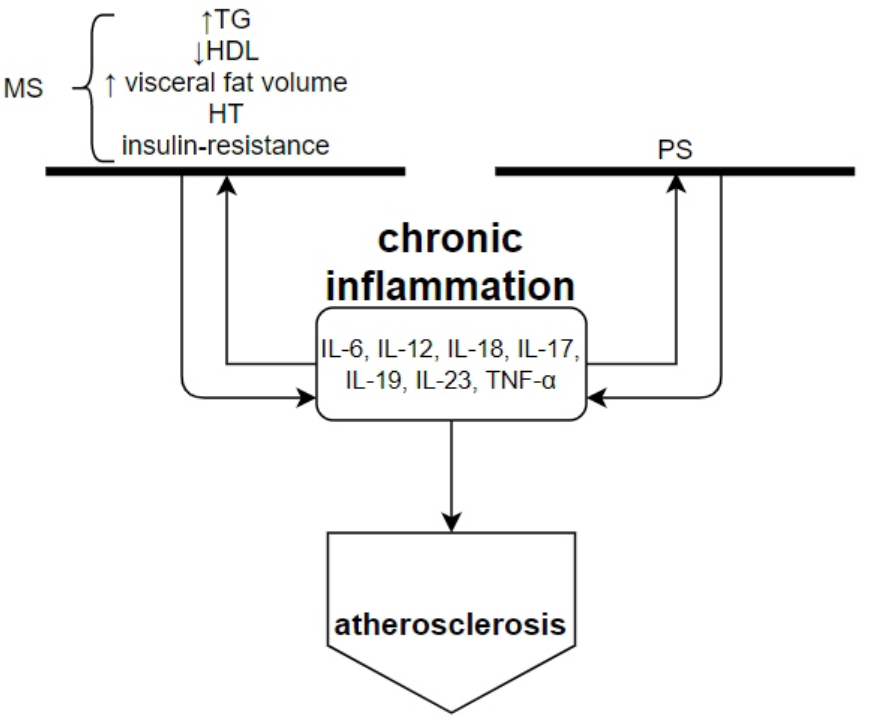

Figure 1. Linkage between psoriasis, metabolic syndrome and atherosclerosis