Review article / Artykuł przeglądowy

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The impact of liver disease and diet on skin condition

Wpływ chorób wątroby oraz diety na stan skóry

ABSTRACT

The liver is one of the most important organs in the human body. It performs many functions, such as carbohydrate, lipid and protein metabolism, detoxification and regulation of the immune system. It plays an important role in maintaining glucose homeostasis, synthesizing essential proteins and eliminating toxins. Liver dysfunction can manifest as a variety of skin lesions, such as pruritus, stellate telangiectasias and liver spots.

This study aimed to discuss the basic aspects of liver disorders and their impact on skin conditions.

Understanding the role of the liver and the consequences of liver dysfunction is essential for maintaining both body and skin health. Lifestyle modification and proper diet are effective preventive measures for its well-functioning.

Keywords: liver, liver disease, liver function, skin, diet

STRESZCZENIE

Wątroba to jeden z najważniejszych narządów w organizmie człowieka. Pełni wiele funkcji, takich jak metabolizm węglowodanów, lipidów i białek, detoksykacja oraz regulacja układu immunologicznego. Jest odpowiedzialna za utrzymanie stabilnego poziomu glukozy, syntezę niezbędnych białek oraz usuwanie toksyn z organizmu. Zaburzenia czynności wątroby mogą objawiać się różnorodnymi zmianami skórnymi, takimi jak świąd, teleangiektazje gwiaździste i plamy wątrobowe.

Celem pracy było przedstawienie podstawowych aspektów schorzeń wątroby oraz ich wpływu na stan skóry.

Zrozumienie roli wątroby i konsekwencji zaburzeń jej funkcjonowania ma istotne znaczenie dla zachowania zdrowia całego organizmu, w tym również skóry. Wprowadzenie zdrowych nawyków oraz odpowiednio zbilansowanej diety wspiera jej prawidłowe funkcjonowanie i działa profilaktycznie.

Słowa kluczowe: wątroba, choroby wątroby, czynność wątroby, skóra, dieta

INTRODUCTION

The liver, a vital organ with multifaceted functions, is crucial for survival, performing a wider range of tasks than any other body part. Often described as the body's central laboratory, it orchestrates numerous physiological processes, including the transformation of lipids, carbohydrates, and proteins. Its roles encompass detoxification, metabolism, filtration, and storage, while also playing a crucial part in immunity and thermoregulation, as blood leaving the liver is notably warmer. Understanding liver function is paramount to maintaining overall health and balance [1].

In carbohydrate metabolism, the liver acts as a dynamic glucose regulator, storing glycogen, producing glucose through gluconeogenesis, and releasing it via glycogenolysis according to the body's energy demands. It also converts carbohydrates and proteins into fats, synthesizes lipoproteins such as LDL (*Low Density Lipoprotein*) and HDL (*High Density Lipoprotein*), phospholipids, and cholesterol. Lipid breakdown generates fatty acids, which undergo β-oxidation to produce acetyl-CoA, acetoacetic acid, and ketone bodies. The liver is pivotal in protein metabolism, generating 85% of plasma proteins like

Table 1 Examples of the effects of liver condition on the skin

Liver condition	*Skin symptoms*	*Cause*
Jaundice	Yellowing of the skin and whites of the eyes	Increased bilirubin levels in the blood
Itchy skin	Persistent itching of the skin, often without visible changes	Accumulation of bile acids in the skin
Palmar erythema	Redness of the palms, especially the ball of the thumb and little finger	Hormonal changes and dilation of blood vessels
Spider veins	Small, red blood vessels that resemble spiders	Circulatory problems and hormonal changes
Pigmentation changes	Skin discoloration, liver spots	Metabolism disorders and toxin accumulation
Dry and scaly skin	Rough, cracked skin, especially on the hands and	Metabolism disorders and vitamin deficiencies
Rashes and hives	Red, itchy patches and blisters on the skin	Allergic reactions and immune disorders
Oedema	Swelling of the legs, ankles and abdomen	Fluid retention in the body caused by liver failure

Source: [2-4]

albumin, prothrombin, fibrinogen, and coagulation factors. It also produces amino acids and related compounds, modifying them for the Krebs cycle through transamination. Oxidative deamination yields keto acids and ammonia, which are converted to urea in hepatocytes. Additionally, the liver stores glycogen, vitamins A, D, B12, and iron (Fe^{3+}), and is the primary site for detoxifying endogenous compounds and xenobiotics through conjugation and degradation [2].

Immunologically, the liver's phagocytic activity is crucial, involving antigen degradation and presentation. It hosts various immune processes, acting as a significant reservoir of active phagocytes that engulf particles via endocytosis. These cells eliminate cellular debris, cancer cells, denatured proteins, immune complexes, and foreign particles. Activated phagocytes can release pro-inflammatory and destructive factors, including lysosomal hydrolases and collagenases, and endotoxins. In severe infections, the liver acts as a homeostatic buffer, though it may suffer pathological changes. Sinusoidal endothelial cells also contribute to clearance, absorbing macromolecules and regulating the matrix through collagen and laminin production [1, 2].

Liver dysfunction can manifest in diverse skin changes due to several mechanisms. Impaired bilirubin metabolism leads to jaundice. Disrupted blood flow causes portal hypertension, resulting in spider veins and palmar erythema. Hormonal imbalances, particularly increased estrogen, also contribute to these vascular changes. Bile acid accumulation causes itching. Ineffective detoxification leads to toxin buildup in the skin, causing pigmentation changes and rashes. Protein synthesis disruption results in dry, flaky skin and edema. Immune system dysfunction can trigger rashes and hives. These skin symptoms, often subtle and appearing on various body parts, not just the face, can include itchy rashes, spider veins, and liver spots. The liver's role in iron metabolism and hemoglobin breakdown into bilirubin is also significant; damaged hepatocytes cause bilirubin accumulation in the skin. Chronic liver inflammation can induce immunological changes, leading to antibody production and skin spot formation. Skin changes in liver cirrhosis are complex and necessitate immediate medical attention as they can indicate serious underlying health issues (Table 1) [2-4].

Liver diseases are a global health problem that is constantly growing. Society is increasingly exposed to risk factors such as alcohol abuse, unhealthy lifestyle, obesity, and the number of people affected by liver diseases is constantly growing. The liver is the largest and most important organ in the human body. It plays an irreplaceable role in metabolic processes and the production of proteins for the proper functioning of the body. The study's main aim was to understand the essence of liver diseases, their side effects, learn the role of diet in the treatment of these diseases and propose lifestyle and diet changes to alleviate the symptoms or avoid the disease.

CUTANEOUS MANIFESTATIONS OF LIVER DISEASE

Skin lesions are often a prominent symptom of liver disease. Jaundice, a yellowish discoloration of the skin and eyes, is a common example. While jaundice has multiple causes, liver problems are a significant contributor. Other skin discolorations, such as generalized discoloration, may also point to liver conditions like porphyria cutanea tarda, hemochromatosis, or vitamin deficiencies. Jaundice is a key symptom suggesting various liver diseases. Although diagnosis requires a thorough evaluation, certain clinical features of jaundice can guide the physician towards an accurate diagnosis. Jaundice, the yellowing of the skin and eyes, arises from excessive bilirubin accumulation in the body. Bilirubin, a yellow pigment, is a byproduct of red blood cell breakdown, which is typically eliminated by the liver. However, in liver diseases or conditions affecting bilirubin production or excretion, accumulation occurs, leading to jaundice. In cases of passive hepatic congestion, jaundice may primarily affect the upper body, sparing the swollen legs. This is known as "local jaundice" (*icterus localisatus*) [4].

Another notable skin symptom associated with jaundice is yellow dermographism, where pressure on the skin

produces a yellowish streak. This phenomenon may be an early indicator of impending jaundice. It's also important to note that individuals with jaundice often exhibit increased skin blood vessel permeability. Liver abscesses usually do not cause jaundice unless they spread to other organs or cause blood poisoning. Fatty liver disease and amyloidosis, on the other hand, are often associated with jaundice. The intensity of the disease in cases of gallstones or parasitic infections depends on the degree and duration of bile duct obstruction. Even rare diseases such as liver cysts can cause jaundice [5, 6].

Jaundice often accompanies various infections, including viral hepatitis, infectious mononucleosis, and leptospirosis. The latter, in addition to jaundice, can manifest itself with characteristic skin rashes and muscle pain. It is worth remembering that jaundice can be one of the symptoms of many different diseases and requires a thorough medical diagnosis [6].

Itching is often a bothersome symptom that can accompany many diseases, including liver diseases. It is particularly problematic in cases of bile flow disorders (cholestasis). The exact mechanism of itching in cholestasis is not fully understood. Initially, it was believed to be caused by the deposition of harmful substances, such as bile acids, in the skin. However, studies have shown that the relationship between the concentration of these substances in the skin and the intensity of itching is not clear. It is likely that other factors, not yet comprehensively elucidated, are also involved in the development of itching [7].

Itching associated with liver disease, particularly in cholestasis, can be exceedingly distressing. While the exact causes of this occurrence remain unclear, efficient treatments exist that may alleviate the symptoms [7].

Spider veins, or small, red skin moles resembling a spider's web, often appear on the face, neck, arms and torso. Although they may be harmless, their presence may indicate more serious health problems, especially related to the liver. The exact mechanism of the development of spider veins is not fully understood, but it is believed that they are related to hormonal disorders, in particular increased levels of estrogen. This is why they often appear in pregnant women and people taking hormone replacement therapy. Spider veins can be not only an aesthetic issue, but also a sign of more serious health problems, especially those related to the liver. Therefore, it is worth consulting a doctor in case of noticing such skin changes [7, 8].

Burst blood vessels necessitate proficient intervention. Although it may be alluring to assume they would resolve themselves, they actually necessitate specialized treatment. Cosmetologists and dermatologists have a variety of methods for removing spider veins, such as lasers, electrocoagulation, or intense pulsed light (IPL). The choice of the appropriate method depends on the skin type, the extent of the problem, and individual predispositions. In addition to professional treatments, daily care of skin with blood vessels is extremely important. Cosmetics designed for this skin type contain ingredients that reduce irritation and strengthen blood vessels [4, 6].

Observing skin changes can provide valuable information about your health. In the case of liver diseases, especially cirrhosis, characteristic symptoms appear on the skin, such as palmar erythema and dilated abdominal veins. They are important diagnostic clues that can help a doctor diagnose liver diseases, especially cirrhosis. In case of noticing such symptoms, it is imperative to seek medical consultation. Early diagnosis and treatment can improve prognosis and quality of life [5, 7].

The liver is an amazing organ - it has no nerve endings, which means that even serious damage can initially occur without pain. Only when the disease progresses and the liver begins to enlarge may a feeling of fullness or dull pain in the upper right quadrant of the abdomen appear. This pain does not result from the liver itself, but from the stretching of the surrounding tissues. Early detection of liver diseases allows for appropriate treatment and prevention of serious complications. Therefore, it is important to seek medical advice in case of noticing any disturbing symptoms [8].

Liver diseases often develop insidiously, without obvious symptoms. Consequently, regular check-ups are essential, particularly for individuals with risk factors such as alcohol abuse, obesity, or viral hepatitis.

THE INFLUENCE OF DIET ON LIVER FUNCTION

The liver is essential for food processing and the regulation of numerous metabolic processes in the body. The diet is a crucial determinant of liver function and is essential for sustaining health and optimal performance. The primary aim of the diet is to detoxify the body of metabolites and toxins. Eating healthy foods, plenty of vegetables and fruits, and adequate amounts of whole grains can support liver health. Nutrients, vitamins (E and C), can protect liver cells from oxidative damage. However, a diet rich in trans and saturated fats, as well as excess salt, may burden the liver and lead to its damage. Alcohol consumption also has a negative impact because it leads to inflammation and steatosis. A conscious lifestyle approach can support liver health and function at various stages of life [2, 9-21].

According to a study published in the Journal of Research in Medical Sciences, a low-carbohydrate diet (less than 50% of the daily calorie intake from carbohydrates) in patients with NAFLD (Nonalcoholic Fatty Liver Disease), despite not reducing the concentration of liver enzymes in the serum, diminishes the fat content in the liver [22].

Ketogenic diet

The ketogenic diet (DK) is a low-carbohydrate, high-protein and high-fat nutrition model. The assumption of this diet is to introduce the body into a state of ketosis, i.e. redirecting

the metabolism to use ketone bodies instead of glucose as the main source of energy [23]. Dr. Bakshi's team demonstrated that the DK, even with its high fat content, does not induce hepatic steatosis and maintains hepatic insulin function. The effects of DK include increasing beneficial ceramides and improving fat and glucose metabolism. These results suggest that DK may be an effective dietary intervention in the treatment of NAFLD through its anti-steatogenic and insulin-sensitizing effects in the liver [24].

Intermittent fasting

Intermittent fasting (IF) is an eating strategy that involves restricting food intake for a specific period. Numerous studies show that IF may have a beneficial effect on health, including liver function. A study published by Ya-Nan Ma's team highlighted that IF can activate hepatic autophagy. Autophagy is the process by which cells remove and process damaged or unnecessary components, which is important for maintaining cellular homeostasis and providing adequate energy. Activating this process in the liver is crucial to protect liver cells against external and internal damage. Intermittent fasting affects hepatic autophagy through a number of signaling pathways and molecular mechanisms, including regulation of adenosine monophosphate-activated protein kinase, which is a key factor controlling this process [25].

Mediterranean diet

The Mediterranean Diet (MD) is considered as one of the best-studied diets in the world and has been proven to be effective in the treatment of many diseases. This diet is based on large amounts of plant foods, high consumption of fish and seafood, and low intake of meat. Olive oil consumption should be the main source of added fat, and saturated fatty acids contained in fatty meat, eggs and dairy products should be limited. Every meal ought to include fruit and vegetables [26, 27]. Researchers led by Marno C Ryan examined the effects of the MD on fatty liver disease and insulin sensitivity in people with NAFLD [28]. Twelve participants with confirmed disease were invited to participate in the twelve-week study. All participants were subjected to both the MD diet and a control, low-fat, high-carbohydrate diet. At the beginning of the experiment, the participants had abdominal obesity with elevated fasting glucose, insulin, triglycerides and ALT (Glutamic Pyruvic Transferase) levels. Weight loss did not differ between the two diets. Liver steatosis was effectively reduced following the MD, even without weight loss. This study confirmed that the MD is effective in the treatment of NAFLD [28-30].

Vegan diet

Vegan diets are low in saturated fats and refined sugars, ensuring a high intake of naturally occurring antioxidant compounds [31]. A vegan diet contains only plants (vegetables, grains, fruits and nuts), foods made from plants and excludes products of animal origin (meat, milk, eggs) [30, 32]. Nowadays, people decide on such a dietary model for various reasons, ranging from religion and ethics, concern for the environment and the desire to improve their own health. Such a diet must be well-balanced because the lack of nutrients such as calcium (Ca), iron (Fe), and vitamin B12 ($C_{63}H_{88}CoN_{14}O_{14}P$) may lead to deterioration of health [33]. A vegan diet has proven to be effective in improving a number of cardiovascular risk factors, such as insulin resistance and hypertension [34, 35]. Scientists Rami Najjar and Rafaela Feresin investigated the effect of a vegan diet excluding all animal products on liver chemistry in a group of patients with NAFLD. The study included 40 patients who had suspected NAFLD with persistent increases in liver enzymes. The study excluded alcohol abuse, and the patients were advised to follow a vegan diet for six months. The participants were constantly under the care of a doctor and a dietitian [36]. After six months, most patients had improved liver enzymes, and their weight had decreased. This study demonstrated that patients following a strict vegan diet had improvements in liver enzymes [36].

Diet is pivotal in maintaining liver health, which directly impacts skin condition (Table 2). The liver, the primary detoxification organ, processes nutrients and eliminates toxins that can adversely affect the complexion. Liver dysfunction often manifests through skin changes, including jaundice, pruritus (itching), spider angiomas (spider veins), or hyperpigmentation (discoloration). A diet high in saturated fats and simple sugars can lead to hepatic steatosis (fatty liver), presenting as dry, rough skin and acne breakouts. Furthermore, excessive sugar intake contributes to glycation, a process that damages collagen and elastin, accelerating skin aging. Conversely, deficiencies in vitamins and minerals, particularly B vitamins, vitamins A, C, and E, as well as zinc (Zn) and selenium (Se), impair skin regeneration and weaken its protective barrier, resulting in dryness, flaking, and increased inflammation [24-25].

Processed foods, laden with preservatives, artificial colors, and flavors, overburden the liver, potentially leading to toxin accumulation within the body. These toxins can manifest on the skin as acne, urticaria (hives), or pigmentation irregularities. Inadequate hydration hampers liver and kidney function, further contributing to toxin buildup and skin deterioration. Dehydrated skin becomes dry, lackluster, and more susceptible to wrinkles. To promote liver and skin health, a balanced diet rich in vegetables, fruits, whole grains, lean protein, and healthy fats is crucial. Limiting saturated fats and simple sugars by avoiding fatty meats, fried foods, sweets, and sugary beverages is essential. Increasing antioxidant intake through fruits and vegetables rich in vitamins A, C, and E protects the skin from free radical damage. Sufficient hydration, consuming at least two liters of water daily, and minimizing alcohol and processed food consumption, which strain the liver, are also vital. Incorporating liver-supporting foods, such as milk thistle, artichoke, turmeric, and green tea,

Table 2 Effects of different diets on liver health and potential effects on skin

Diet	*Mechanism of action on the liver*	*Potential effect on the skin*	*Notes*
Ketogenic diet (KD)	– Redirecting metabolism to the use of ketone bodies. – Increasing beneficial ceramides. – Improving fat and glucose metabolism. – Potential anti-steatosis and insulin sensitivity effects.	– Potential improvement in skin condition by regulating glucose and fat metabolism. – May affect ceramide levels, which are important for the skin barrier.	– Requires monitoring, especially in existing conditions. – High fat content may not be suitable for everyone.
Intermittent fasting (IF)	– Activation of hepatic autophagy, which is the process of removing damaged cellular components. – Protection of liver cells from damage. – Regulation of adenosine monophosphate-activated protein kinase (AMPK).	– Potential improvement in skin condition through detoxification and cellular regeneration. – May affect inflammatory processes.	– Must be adjusted to individual needs and health status. – Not recommended for people with certain medical conditions.
Mediterranean Diet (MD)	– Reduces fatty liver disease. – Improves insulin sensitivity. – Rich in antioxidants from fruits, vegetables and olive oil.	– Potentially improves skin condition by reducing inflammation and providing antioxidants. – Beneficial effect on overall skin health.	– Considered one of the healthiest diets. – Rich in nutrients.
Vegan Diet	– Low in saturated fats and refined sugars. – High in natural antioxidants. – Improves liver parameters (enzymes). – Improves insulin sensitivity and lowers blood pressure.	– Potentially improves skin condition by providing antioxidants and reducing inflammation. – May improve skin condition in cases of insulin resistance.	– Requires balancing to avoid nutrient deficiencies (e.g. B12, iron (Fe), calcium (Ca)). – Monitoring health parameters is recommended.

Source: [25-37]

can be beneficial [25-37]. For individuals with significant liver concerns, consulting a physician and a registered dietitian is imperative. A personalized dietary plan can substantially enhance liver function and improve skin appearance [38].

In summary, diet plays a key role in the functioning of the liver, and ingredients such as proteins, carbohydrates and fats have a significant impact on the health of this organ. The above-mentioned studies indicate that various dietary styles (ketogenic diet, Mediterranean diet, or intermittent fasting) have a significant impact on liver health and prevent many diseases. Therefore, it is worth approaching nutrition consciously to support the most important organs in the body and improve overall health.

SKIN CARE FOR LIVER DISEASES

Liver disease can significantly impact skin health, making proper care crucial. As the body's largest organ, the skin often reflects internal health, and liver problems can lead to dryness, pruritus (itching), and even jaundice (yellowing). Key aspects of skin care for individuals with liver disease include consistent moisturization, as dry skin is a common symptom. Emollients and hypoallergenic lotions should be used to maintain adequate hydration, and hot baths, which can exacerbate dryness, should be avoided. Gentle cleansing is also essential; therefore, fragrance-free, mild cleansers that minimize skin irritation are recommended. Harsh detergents and soaps should be avoided, and the skin should be gently patted dry after washing, rather than rubbed [38].

Sun protection is vital, as individuals with liver disease may have increased sensitivity to UV radiation. Using sunscreen with an SPF of 30 or higher and limiting prolonged sun exposure, particularly during peak hours, is essential. Pruritus, a frequent and bothersome symptom, can be alleviated by applying cool compresses and avoiding scratching. Antihistamines or topical anti-itch preparations can be used after consultation with a physician. A healthy diet rich in fruits, vegetables, and whole grains supports liver function and promotes healthy skin, and adequate hydration through ample water intake is also crucial [39-41].

Avoiding toxins, such as alcohol and tobacco, which burden the liver and negatively affect skin health, is paramount. Contact with skin-irritating chemicals should also be avoided. In cases of severe skin changes or persistent symptoms, a dermatologist consultation is necessary. A physician can recommend appropriate treatment and care tailored to individual health needs. Skin care for patients with liver disease should be comprehensive and personalized. Regular medical check-ups and health monitoring are essential for maintaining optimal skin health and overall well-being.

CONCLUSIONS

Liver diseases often develop insidiously, remaining asymptomatic for extended periods, which hinders early detection when treatment is most effective. Skin changes, such as jaundice, palmar erythema, or spider angiomas, can be among the first indicators. Early detection is crucial for successful treatment, making it essential to be vigilant about any concerning symptoms and to undergo regular check-ups, particularly for those with risk factors like alcohol abuse, obesity, or viral hepatitis.

A strong correlation exists between liver health and skin conditions, with liver dysfunction frequently manifesting as various dermatological issues. Understanding this connection empowers individuals to take proactive steps to support both liver and skin health. Maintaining a liver-friendly diet, engaging in regular exercise, managing stress, and avoiding toxins are key strategies for promoting liver health, which in turn contributes to clearer, healthier skin. If persistent skin problems arise, it is advisable to consider the possibility of underlying liver issues and consult a healthcare professional for appropriate testing and guidance.

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REFERENCES / LITERATURA

1. Hajdarevic B, Vehabovic I, Catic T, Masic I. The Role of Diet Therapy in the Treatment of Liver Disease. *Mater Sociomed.* 2020;32(3):200-206. https://doi.org/10.5455/msm.2020.32.196-199
2. Plauth M, Merli M, Kondrup J, et al. ESPEN Consensus Group. ESPEN guidelines for nutrition in liver disease and transplantation. *Clin Nutr.* 1997;16(2):43-55. https://doi.org/10.1016/s0261-5614(97)80022-2
3. Jamioł-Milc D, Gudan A, Kaźmierczak-Siedlecka K, et al. Nutritional Support for Liver Diseases. *Nutrients.* 2023;15(16):3640. https://doi.org/10.3390/nu15163640
4. Koulentaki M, Ioannidou D, Stefanidou M, et al. Dermatological manifestations in primary biliary cirrhosis patients: a case control study. *Am J Gastroenterol.* 2006;101(3):541-546.
5. Pinzani M, Rosselli M, Zuckermann M. Liver cirrhosis. *Best Pract Res Clin Gastroenterol.* 2011;25(2):281-290.
6. Salerno F, Gerbes A, Ginès P, et al. Diagnosis, prevention and treatment of hepatorenal syndrome in cirrhosis. *Gut.* 2007;56(9):1310-1318.
7. Zhou WC, Zhang QB, Qiao L. Pathogenesis of liver cirrhosis. *World J Gastroenterol.* 2014;20(23):7312.
8. Hartleb M, Hartleb M. Diagnostyka i leczenie encefalopatii wątrobowej u chorych z marskością wątroby, rekomendacje EASL i AASLD. *Gastroenterol Prakt.* 2016;2(31):32-42.
9. Shergill R, Syed W, Rizvi SA, Singh I. Nutritional Support in Chronic Liver Disease and Cirrhotics. *World J Hepatol.* 2018;10:685-694. https://doi.org/10.4254/wjh.v10.i10.685
10. D'Amico G, Garcia-Tsao G, Pagliaro L. Natural History and Prognostic Indicators of Survival in Cirrhosis: A Systematic Review of 118 Studies. *J Hepatol.* 2006;44:217-231. https://doi.org/10.1016/j.jhep.2005.10.013
11. Traub J, Reiss L, Aliwa B, Stadlbauer V. Malnutrition in Patients with Liver Cirrhosis. *Nutrients.* 2021;13:540. https://doi.org/10.3390/nu13020540
12. Prieto-Frías C, Conchillo M, Payeras M, et al. Factors Related to Increased Resting Energy Expenditure in Men with Liver Cirrhosis. *Eur J Gastroenterol Hepatol.* 2016;28:139-145. https://doi.org/10.1097/MEG.0000000000000516
13. Peng S, Plank LD, McCall JL, et al. Body Composition, Muscle Function, and Energy Expenditure in Patients with Liver Cirrhosis: A Comprehensive Study. *Am J Clin Nutr.* 2007;85:1257-1266. https://doi.org/10.1093/ajcn/85.5.1257
14. Guglielmi FW, Panella C, Buda A, et al. Nutritional State and Energy Balance in Cirrhotic Patients with or without Hypermetabolism. Multicentre Prospective Study by the "Nutritional Problems in Gastroenterology" Section of the Italian Society of Gastroenterology (SIGE). *Dig Liver Dis.* 2005;37:681-688. https://doi.org/10.1016/j.dld.2005.03.010
15. Pouwels S, Sakran N, Graham Y, et al. Non-Alcoholic Fatty Liver Disease (NAFLD): A Review of Pathophysiology, Clinical Management and Effects of Weight Loss. *BMC Endocr Disord.* 2022;22:63. https://doi.org/10.1186/s12902-022-00980-1
16. Schattenberg JM, Anstee QM, Caussy C, et al. Differences between Current Clinical Guidelines for Screening, Diagnosis and Management of Nonalcoholic Fatty Liver Disease and Real-World Practice: A Targeted Literature Review. *Expert Rev Gastroenterol Hepatol.* 2021;15:1253-1266. https://doi.org/10.1080/17474124.2021.1974295
17. Riazi K, Azhari H, Charette JH, et al. The Prevalence and Incidence of NAFLD Worldwide: A Systematic Review and Meta-Analysis. *Lancet Gastroenterol Hepatol.* 2022;7:851-861. https://doi.org/10.1016/S2468-1253(22)00165-0
18. Younossi ZM, Stepanova M, Younossi Y, et al. Epidemiology of chronic liver diseases in the USA in the past three decades. *Gut.* 2020;69(3):564-568. https://doi.org/10.1136/gutjnl-2019-318813
19. Sakurai Y, Kubota N, Yamauchi T, Kadowaki T. Role of Insulin Resistance in MAFLD. *Int J Mol Sci.* 2021;22:4156. https://doi.org/10.3390/ijms22084156
20. DiStefano JK, Gerhard GS. NAFLD in Normal Weight Individuals. *Diabetol Metab Syndr.* 2022;14:45. https://doi.org/10.1186/s13098-022-00814-z
21. Yu B, Wang J. The Efficacy of Parenteral Nutrition (PN) and Enteral Nutrition (EN) Supports in Cirrhosis: A Systematic Review and Network Meta-Analysis. *Medicine* (*Baltimore*). 2022;101:e28618. https://doi.org/10.1097/MD.0000000000028618
22. Mahmud N. Selection for Liver Transplantation: Indications and Evaluation. *Curr Hepatol Rep.* 2020;19:203-212. https://doi.org/10.1007/s11901-020-00527-9
23. Directive 2010/45/EU of the European Parliament and of the Council of 7 July 2010 on Standards of Quality and Safety of Human Organs Intended for Transplantation. *Off J Eur Union.* 2010;207.
24. Bakshi N, Singh K. Diet and Nutrition Therapy in Pre-Liver Transplant Patients. *Hepatoma Res.* 2016;2:207-215. https://doi.org/10.20517/2394-5079.2016.02
25. Ma YN, Jiang X, Tang W, Song P. Influence of intermittent fasting on autophagy in the liver. *Biosci Trends.* 2023;17(5):335-355. https://doi.org/10.5582/bst.2023.01207
26. Uebanso T, Taketani Y, Fukaya M, et al. Hypocaloric high-protein diet improves fatty liver and hypertriglyceridemia in sucrose-fed obese rats via two pathways. *J Physiol Endocrinol Metab.* 2009;297:E76-84.
27. Wood NJ. Liver: Nonobese individuals in the developing world are at risk of nonalcoholic fatty liver and liver disease. *Nat Rev Gastroenterol Hepatol.* 2010;7(7):357. https://doi.org/10.1038/nrgastro.2010.95
28. Ryan MC, Itsiopoulos C, Thodis T, et al. The Mediterranean diet improves hepatic steatosis and insulin sensitivity in individuals with non-alcoholic fatty liver disease. *J Hepatol.* 2013;59(1):138-143. https://doi.org/10.1016/j.jhep.2013.02.012
29. Aller R, De Luis DA, Izaola O, et al. Effect of a probiotic on liver aminotransferases in nonalcoholic fatty liver disease patients: a double blind randomized clinical trial. *Eur Rev Med Pharmacol Sci.* 2011;1090-1095.
30. Tuso PJ, Ismail MH, Ha BP, Bartolotto C. Nutritional Update for Physicians: Plant-Based Diets. *Perm J.* 2013;17:61-66.
31. Moore MP, Cunningham RP, Dashek RJ, et al. A Fad Too Far? Dietary Strategies for the Prevention and Treatment of NAFLD. *Obesity* (Silver Spring). 2020;28:1843-1852. https://doi.org/10.1002/oby.22964
32. Worm N. Beyond Body Weight-Loss: Dietary Strategies Targeting Intrahepatic Fat in NAFLD. *Nutrients.* 2020;12:1316. https://doi.org/10.3390/nu12051316
33. Li R, Li M, Fly AD, et al. Vegetarian diets and risk of nonalcoholic fatty liver disease: An observational study of National Health and Nutrition Examination Survey 2005-2018 using propensity score methods. *J Hum Nutr Diet.* 2024;37(3):643-654. https://doi.org/10.1111/jhn.13290
34. Turner-McGrievy GM, Davidson CR, Wingard EE, et al. Comparative effectiveness of plant-based diets for weight loss: a randomized controlled trial of five different diets. *Nutrition.* 2015;350-358.
35. American Diabetes Association. Diagnosis and classification of diabetes mellitus. *Diabetes Care.* 2013;36(Suppl 1):S67-S74.
36. Najjar RS, Feresin RG. Plant-Based diets in the reduction of body fat: physiological effects and biochemical insights. *Nutrients.* 2019;11(11):2712.
37. Murag S, Ahmed A, Kim D. Recent epidemiology of nonalcoholic fatty liver disease. *Gut Liver.* 2021;15(2):206-216. https://doi.org/10.5009/gnl20127
38. Liu Y, Zhao Y, Gao X, et al. Recognizing skin conditions in patients with cirrhosis: a narrative review. *Ann Med.* 2022;54(1):3017-3029. https://doi.org/10.1080/07853890.2022.2138961
39. Koulaouzidis A, Bhat S, Moschos J. Skin manifestations of liver diseases. *Ann Hepatol.* 2007;6(3):181-184.
40. Terkeltaub R, Esdaile JM, Bruneau C, et al. Vasculitis as a presenting manifestation of primary biliary cirrhosis: a case report. *Clin Exp Rheumatol.* 1984;2(1):67-73.
41. Hazin R, Abu-Rajab Tamimi TI, Abuzetun JY, Zein NN. Recognizing and treating cutaneous signs of liver disease. *Cleve Clin J Med.* 2009;76(10):599-606. https://doi.org/10.3949/ccjm.76A.08113

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