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The Diet as Medicine: The Power of Lifestyle Habits to Control Autoimmune Diseases

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Abstract

Autoimmune diseases are a family of conditions that result from a malfunction in the immune system. The immune system mistakenly targets healthy tissue in the body, causing severe inflammation and pain in the part that it targets. While research of the diseases has come a long way, there are still a lot of questions unanswered about their origins and treatments. There are no known cures for any of the over 80 identified diseases, and treatment involves reducing the conditions activity to as low as possible. Still, autoimmune patients often live with constant levels of discomfort and impaired quality of life. The aim of this research is to determine the efficacy of dietary factors and lifestyle habits to positively impact the state of an autoimmune patient's condition. This research seeks to observe the ability of lifestyle factors to aid, or potentially replace, current medical interventions and improve the quality of life of autoimmune patients. Subsequently, it was found that an individual's dietary and lifestyle habits played a large role in the state of their diagnosed condition and had a preventative effect on the development of autoimmune diseases. Specifically, increased intake of omega-3 fatty acids and dietary fiber had a large positive effect on numerous conditions. Furthermore, shifting focus away from processed foods to whole, nutrient-dense foods improved disease severity, gut microbiota, and reduced risk. Overall, modifying behavior to emphasize healthy lifestyle habits has both a healing and protective effect on many autoimmune diseases.

Keywords: autoimmune disease, quality of life, lifestyle habits, omega-3 fatty acids, gut microbiota

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Background

For centuries of human development, natural immunity has been observed and utilized within countless civilizations across the entire world. From inoculating contagious pustules to avoid later sickness to ingesting trace amounts of different poisons to survive future assassination attempts, immunity has been utilized by peasants and kings alike. What exists today as vaccinations, these immunotherapy techniques are believed to have originated in China between 1567 and 1572 as variolation. It was then spread across the world by civilizations like the Ottoman Empire (Ahsan, 2022). Feats of scientific brilliance highlighting the body's incredible, innate ability to adapt and resist toxic pathogens. Unfortunately, the body's own ability to fight harmful substances in the body can become just as much an issue as an fortune.

Paul Ehrlich termed this issue as "*horror autotoxicus*", a condition upon which the body mistakenly develops antibodies to target its own healthy tissue. His work, meaning the horror of self-toxicity, published in 1901, is one of the earliest published works to speculate about this issue (Ahsan, 2022). While not being widely accepted until the 1950s, this phenomenon has largely baffled professionals that attempt to discern its origins or solutions. Recognized as *autoimmune diseases,* this family of conditions is very large and affects a considerable percentage of people worldwide. Among the most common conditions are type 1 diabetes, multiple sclerosis, rheumatoid arthritis, lupus, Crohn's disease, psoriasis, and scleroderma. The National Stem Cell Foundation estimates that 4% of the world population is affected by at least 1 of over 80 different autoimmune diseases. Within the US, this percentage is between 5% - 8% and rising (2022; Autoimmune Disease, 2024).

Undetermined Information

The scientific understanding of autoimmune diseases has come miles from where it began in the early twentieth century. What was once a spontaneous blunder by the body has since been attributed trusted origins with high degrees of efficacy. When existing in one identical twin, autoimmune diseases have a prevalence of 12% - 67% to appear in the other. There is also an observed impact of environmental factors that trigger large immune responses and act, in part, to shock the system (Ahsan, 2022; Wang et al., 2015). As evident with the data twins, indicates a clear significance of genetic predisposition in the development of the condition. Unfortunately, apart from a few, usually monogenic diseases, research has been unable to reliably use genomics to predict the eventual development of a specific autoimmune disease. This is only one piece of these conditions scientists cannot fully explain.

The piece this paper will address has to do with the treatment of autoimmune diseases. As it stands, there is not a single autoimmune disease that is curable through modern medicine. This, of course, poses a grand issue for those that live with these conditions. While there are reliable treatment methods for most autoimmune diseases, these typically involve medication that reduces inflammation and renders the condition in a state of remission. While in a state of remission, the condition is not actively damaging healthy tissue or creating great deals of inflammation. However, the patient is still susceptible to flair ups and relapses in their condition. Furthermore, the cost of these treatments can weigh a significant burden on the patient. During 2015, treatment for rheumatoid arthritis totaled an annual average of $28,750 per patient. For patients with ulcerative colitis, this annual average was $20,480 per patient (Schroder et al., 2019). The burden of time, money, and residual effects associated with constant treatment has

led many individuals living with autoimmune disease to seek out more sustainable alternatives that can improve their quality of life.

This search for improved alternatives has resulted in the development of communities centered around the value of proper eating to improve most conditions in the body. Many books and documentaries have been published suggesting a miraculous effect reaped through proper monitoring of one's diet and exercise. While diet is an important piece to modern treatment for autoimmune disorders, the verdict is still out on whether diet alone can manage these conditions. With such polarizing claims that would suggest autoimmune diseases are possibly curable through diet, this paper aims to compile and analyze any reliable data to suggest that diet serves as a standalone treatment-method to replace medication and mitigate the effects of autoimmune disorders.

Purpose of Research

Although it is already known that diet is a large component in the severity of autoimmune disease, the reliability of diet as a stand-alone treatment is unknown, therefore I propose to compile the known data and testimonies to measure the efficacy of diet to replace modern medicine in managing autoimmune disease. The questions I will use to guide this research are as follows:

1. What role has been found of dietary factors to exacerbate autoimmune symptoms or accelerate development of the disease?
2. With what autoimmune diseases does diet have the largest observed affect over?
3. What diets are currently used to remedy autoimmune diseases?
4. What role does physical activity have in the severity of autoimmune diseases?

Summary

Autoimmune disease is a challenging condition that burdens many people across the entire world. Despite having been studied for nearly 80 years, there is still no feasible cure to these conditions. While the current treatments are often effective in mitigating the effects of the conditions, they still pose a large burden on the patient financially and often physically. It is due to the unideal circumstance of current treatment that I aim to develop a comprehensive answer as to the efficacy of diet as a sole treatment method to autoimmune diseases.

Main Research

What role has been found of dietary factors to exacerbate autoimmune symptoms or accelerate development of the disease?

Inflammation

One symptom that is consistent across nearly every autoimmune disease is inflammation in the body. The body's immune attack on healthy tissue causes pain, redness, and swelling internally and/or externally depending on the condition. In many autoimmune diseases, inflammation is even present in small quantities during remission, when the disease is not fully active. As this is a consistent symptom that generates the majority of a patient's discomfort, it is important to observe the effect that diet can have in mitigating this issue. Hess et al. (2021) states "Dietary factors such as fiber, antioxidants, and omega-3 fatty acids have been associated with decreased concentrations of markers of inflammation, whereas other factors such as saturated fat and sodium have been associated with increased levels of inflammation." The author further analyzes data regarding dairy consumption, often thought to be inflammatory. However, they concluded that there was insufficient data to deduce a significant connection between dairy consumption and inflammation (Hess et al., 2021). While this claim is based on data from studies

conducted on adults without defined autoimmune conditions, contradictory findings will be illustrated later in studies focused on certain autoimmune populations. Nonetheless, the point remains that diet cannot be ignored as a factor in body inflammation.

As previously eluded to, properly feeding the body can have incredibly healing effects. In a study conducted by Kopf et al. (2018) on overweight and obese adults, they found that increasing the individuals' consumption of whole grains, fruits, and vegetables significantly reduced inflammation across 3 of 5 tested markers [tumor necrosis factor-α (TNF-α), interleukin-6 (IL-6), lipopolysaccharide binding protein (LBP)] in the body. They allowed the participants to select their own foods to increase consumption, and the majority of participants reported increased mood and a plan to adhere to the regiment after testing had concluded (Kopf et al., 2018). Once again, this test does not directly observe an autoimmune population, but the findings are crucial to bodily health that could reduce the risk for autoimmune diseases. The markers tested deliver an important insight into the status of the patient's body. The altered levels of LBP were present in both the whole grain group and the fruit and vegetables group. It is indicative of improved intestinal barrier function. Similarly, the decreased levels of TNF-α and IL-6 show a decrease in subclinical inflammation. Furthermore, and most pertinently, all three of these inflammatory markers are also used to measure the severity of autoimmune diseases.

Two nutrients that have shown positive clinical effect on autoimmune diseases are Omega-3 fatty acids and Vitamin D. These nutrients have been recorded to have an increased positive effect when supplemented together on patients. Omega-3 fatty acids alone reduced the risk for autoimmune disease by 15%, but that reduction increased to 22% when supplemented in conjunction with Vitamin D (Poggioli et al., 2023). It is important to note that the same inflammatory markers that were presented earlier were used in part to determine disease severity

and risk in this research. This serves as another reminder of the interconnectedness of the body's systems and importance for simplicity in treating these issues. The human body is incredibly complex and intricate. Not to mention, it can be incredibly confusing for any person not intimately studied in its processes. Perhaps the largest challenge for any person aiming to exercise healthy diet habits to improve their health status is where to start. That being said, the reoccurring theme present in nearly every study aiming to reduce bodily inflammation through diet is the implementation of a proper diet. The factors analyzed so far, whole grains, fruits, vegetables, Vitamin D, and Omega-3 fatty acids are present in the proper, balanced model of a human diet. The issue is, they are often not present in the highly processed, convenient Westernized diet that has consumed most of the American population, and that might be the largest contributing factor to the increases in autoimmune disease in America.

Leaky Gut

Along with the clear nutritional shortcomings of the Westernized diet, it is theorized by researchers that the addition of flavors, dyes, stabilizers, and sweeteners may have its own negative effect on the body's immune function. "It is hypothesized (and has been demonstrated in vitro) that commonly used industrial food additives abrogate the human epithelial barrier function; thus, increasing intestinal permeability through the leaky tight junction, resulting in the passage of toxins, food antigens, and bacteria, which may carry immunogenic antigens. Further, depriving the intestinal gut microbiota of dietary fibers, mainly present in fruit, vegetables, legumes, and whole grains, which are not consumed in adequate amounts in Western dietary patterns, could trigger the induction of enzymes capable of degrading the intestinal mucin layer, contributing to the "leaky gut" condition described above" (Mazzucca et al., 2021). Indicative of dominoes, an impairment anywhere along the system of the body can cause further impairments

throughout the chain. Similar to how a tightness in the right hip can carry up the fascial line and limit mobility in the left shoulder, the body's internal systems can be even more sensitive. Autoimmune diseases, often triggered by a large shock or confusion to the immune system, could possibly be initiated by presence of immunogenic antigens that have managed to seep through the damaged intestinal walls. A few diseases potentially caused by leaky gut, some that will be highlighted later for their relationship with diet, including type 1 diabetes, multiple sclerosis, inflammatory bowel disease, systemic lupus erythematosus etc. (Paray et al., 2020). Lucky gut is not the only condition thought to lead to these conditions, but it has been linked as a potential risk factor for them.

With what autoimmune diseases does diet have the largest observed affect over?

Inflammatory Bowel Disease

Inflammatory bowel disease is often in the conversation when diet is used to control medical conditions. A group of two autoimmune diseases, Crohn's Disease and Ulcerative Colitis, inflammatory bowel disease results from the immune system attacking healthy tissue in the intestinal walls. It results in sores, called ulcers, lining the intestines and causing pain, weight loss, gastric reflex, gastrointestinal issues etc. Pediatric inflammatory bowel disease is treated almost entirely through enteral nutrition, administering nutritional solutions through feeding tubes. However, in older and more developed patients, other medications can be used to control the disease. Still, nutrition remains an integral piece in treatment for inflammatory bowel disease, as was discussed in the section prior. As for diet's role in the disease, increased consumption of omega 3 fatty acids has been observed to decrease risk for Ulcerative Colitis (Ananthakrishnan et al., 2014). Omega 3 fatty acids hail primarily from marine protein sources such as salmon and tuna, but they can be found in ample amounts in nuts and seeds as well as oils like olive oil.

Ananthakrishnan et al. also found that trans-unsaturated fatty acid intake was correlated with increased incidence of Ulcerative Colitis (2014). Though trans-unsaturated fatty acids have been banned for use in the United States due to their negative health effects, they can still be foods in trace amounts in fried and highly processed foods. Due to the chemical change fatty acids undergo when exposed to high temperatures, overconsumption of fried foods can lead to increased consumption of trans-unsaturated fatty acids. Olive oil, however, is more resistant to heat than other oils and can hold its chemical composition more reliably. Though frying in olive oil will likely still yield some trans fats, searing in the oil will be a safer option. There is more research to suggest that the presence of metabolite-sensing G protein-coupled receptors (GPCRs) can play a role in the systems regulation of inflammation in patients with IBD. These receptors bind to short-chain fatty acids (SCFAs), synthesized in the body from dietary fiber. IBD patients often show decreased levels of SCFAs and experience improve inflammation levels when administered SCFA treatment (Melhem et al., 2019). This research furthers the previously asserted claim that dietary fiber can provide effective treatment for autoimmune diseases. Overall, inflammatory bowel disease patients benefit from diets high in fiber from fruit and fatty acids from healthy oils and fish.

Multiple Sclerosis

Multiple Sclerosis is a serious condition that affects the central nervous system of the body. The immune system mistakenly targets the myelin sheath that protects the nerves within the body, causing damage to the nerves beneath. This damage weakens and slows signals sent throughout the body. It is a lifelong disease and severity of the inflammation can mean increasingly impairment movement or bodily control. Steroid treatment is primarily used to slow the development of the disease, but there is increasing efficacy that diet could play an important

role in improving the condition of Multiple Sclerosis patients. “Patients who consumed fish three or more times weekly or those taking high doses of omega-3 FAs have lower levels of disability and are almost living with normal mobility ($\rho < 0.001$). In addition, the health-related quality of life (HRQOL) was better and showed a stronger association for those using omega-3 supplements of 1–20 ml/d or consuming fish more frequently. In contrast, the relapsing rate was not improved by consumption of fish or taking the supplements, but there was little improvement among patients who consumed both fish and flaxseed oils ($\rho < 0.005$). Similar to relapsing rate, both fish and flaxseed oils increased the stability of the disease” (AlAmmar et al., 2021). These findings are not surprising, given omega-3 fatty acids’ relationship with other conditions, but also the extreme importance of lipids in building and preserving the nervous system. Other sources indicate the importance of vitamins D and B12 in patients with Multiple Sclerosis. Furthermore, there is an increasing amount of evidence to suggest that diets high in fruits and vegetables, low in saturated fats, and that intakes of whole grains and fish have a positive effect on patients (Bagur et al., 2017).

Rheumatoid Arthritis

Rheumatoid Arthritis is an autoimmune disease resulting from the immune system targeting and destroying bone and cartilage in the body. This causes increasing pain, and stiffness with joint movement. It is a condition that can cause extreme and constant discomfort in people that it affects. Due to its constant, debilitating effect on patients, diet offers the potential to improve one’s condition on a constant, daily basis. Diet, as previously discussed, can be much more affordable than constant medical care and allows the patient to have a direct effect on their health. One of the most evident examples of this is the literature supporting the Mediterranean Diet as having a positive effect on Rheumatoid Arthritis. The diets rich composition of omega-3

fatty acids and dietary fiber along with reducing the intake of processed foods has effectively shown to reduce inflammation in Rheumatoid Arthritis patients, as well as, have a protective effect on the cartilage of the joints (Gioia et al., 2020; Khanna et al., 2017; Picchianti Diamanti et al., 2020). The Mediterranean Diet is given its name due to its prominence in countries surrounding the Mediterranean Sea. It is the diet of this region because the geography and lifestyle of these countries supports the foods composing the pyramid. Since Western countries have a much different dietary landscape, this way of eating can feel unattainable or expensive. However, it provides a much more cost-effective method of eating than buying fast food three times every day. “RA patients presented a lower intake of fish, potatoes, mushrooms and organ meats; mushrooms, citrus fruits and dairy products consumption showed a protective effect on RA, while potatoes and other fruits’ consumption was associated with an increased risk” (Gioia et al., 2020). Gioia et al. also raised concerns with excessive consumption of red meat, eggs and dairy products. They called attention to the recorded positive relationship these foods showed on cardiovascular inflammation, but they had lacking research on Rheumatoid Arthritis. While Gioia et al. did not report increased risk associated with protein intake, they did source a significantly increased risk with excessive sodium intake (Gioia et al., 2020). Preparation methods of red meat and eggs are often high in saturated fats and sodium. Preparation methods, referring to basting in butter/grease or the addition of seasonings high in sodium, could be manipulated to reduce the inflammatory effect of these foods. Coupled with the research above, it may still be wise to limit intake of these foods with Rheumatoid Arthritis patients, but with proper preparation methods, they may be able to be consumed in moderation without to great a negative effect.

Systemic Lupus Erythematosus

Systemic Lupus Erythematosus is an autoimmune disease that results in widespread inflammation and tissue damage in the organs of the body. It can affect brain, skin, lungs, kidneys, etc. and can range from having a mild affect in the body to death in serious cases. Subsequently, there is little convincing required to suggest that any intervention methods that can reduce the severity of the disease is very important. Fortunately, there is expanding evidence to show the positive effect of diet on disease severity. “Omega-3 reduces cardiovascular risk, while omega-6 PUFA may exacerbate SLE activity. Flaxseed oil can lower serum creatinine and fish oil reduce [triglycerides] and increase HDL-C. Moderate protein intake improves renal function. Fibers regulate hyperlipidemia, lower blood pressure and [C reactive protein]. Vitamins are also important, vitamin D deficiency is associated with more severe disease activity, vitamin C prevents cardiovascular complications, reduces inflammation and antibodies level, retinoic acid also reduces antibodies level and vitamins from B complex improves clinical symptoms, reduce [triglycerides] and LDL-C. Flavonoids reduce proteinuria, antibodies production and INF-γ production. Regarding minerals, it's best to restrict zinc and sodium consumption, and also excess of iron. Curcumin (turmeric) is beneficial to lupus nephritis” (Constantin et al., 2019). Of course, this research compiles information about dietary effect on each respective area that can be affected by Systemic Lupus Erythematosus, so dietary modification could be made depending on what organs are affected within a patient. In a study observing the effects of Mediterranean-style eating on patients with Systemic Lupus Erythematosus, greater consumption of olive oil, vegetables, fruit, legumes, fish, and nuts was associated with a significantly lower amount of tissue damage. On the other hand, greater consumption of red meat, sugary foods, and pastries was associated with significantly higher amount of tissue damage resulting from Systemic Lupus Erythematosus (Pocovi-Gerardino et al., 2020). Systemic Lupus Erythematosus is a condition

that can be very serious if neglected and not properly addressed. Conversely, it can also be mitigated very effectively if the proper dietary strategies are applied. The climate of American food consumption creates a very challenging environment for these patients to receive proper education and dietary treatment. However, combating the typical American diet can have a very large impact on a Systemic Lupus Erythematosus patient's daily experience.

What diets are currently used to remedy autoimmune diseases?

Mediterranean Diet

Along with medication, diet is often manipulated, or regulated, to treat autoimmune patient's condition. Due to its volatile relationship with the gastrointestinal tract, Inflammatory Bowel Disease receives close attention in terms of diet. In a study conducted by Papada et al., Crohn's Disease patients utilized the Mediterranean Diet to treat their condition (2020). Mediterranean-style diets are often encouraged with certain conditions due to their increased emphasis on foods higher in omega-3 fatty acids and lower in saturated fats and added sugars. The Mediterranean Diet also encourages meals centered around whole grains and produce. As evident of the findings above, this diet sets a sturdy foundation for an effective autoimmune disease diet. While there may need to be special changes made to cater to specific conditions, this sturdy base could provide impactful benefits to an individual's condition, or risk. Furthermore, this is what was found in the aforementioned study. Patients that more closely adhered to the Mediterranean Diet saw a significant decrease in their disease activity (Papada et al., 2020). Apart from Inflammatory Bowel Disease, the Mediterranean Diet has shown improvement in many autoimmune diseases including Hashimoto's Thyroiditis, Rheumatoid Arthritis, and Systemic Lupus Erythematosus (Picchianti Diamanti et al., 2020; Ruggeri et al., 2023; Pocovi-Gerardino et al., 2020).

Autoimmune Protocol Diet

Another diet that has garnered prominence to treat autoimmune diseases is the appropriately named Autoimmune Protocol Diet. This diet targets traditionally inflammatory foods, has the patient gradually reduce consumption of them to zero, then reintroduces them to the diet one-by-one to monitor which ones worsen disease condition. Whichever foods negatively affect the disease are left out of the diet. The foods are grains (especially gluten-containing grains), legumes, nightshade vegetables, dairy products, processed foods, refined sugars, eggs, nuts and seeds, coffee, and alcohol. While this is a very restrictive diet and may be difficult for patients to continue for a prolonged period of time, it has shown to have positive effects on multiple autoimmune diseases. In a study observing the effect of Autoimmune Protocol Diet on females with Hashimoto's Thyroiditis, the researchers observed significant decreases in inflammation and increases in patient quality of life (Abbot et al., 2019). In use with Inflammatory Bowel Disease patients, "clinical remission was achieved by week 6 by 11/15 (73%) of study participants, and all 11 maintained clinical remission during the maintenance phase of the study" (Konijeti et al., 2017). While both of these studies were conducted with relatively small sample sizes, they provide important insight into the potential power of this diet. However, the diet is very restrictive, which can make it burdening for patients to adhere to it. There is also a danger of dietary insufficiencies due to the elimination of entire food groups that offer key nutrients to the body. Nonetheless, patients that successfully adhere to the diet report increased quality of life and health status.

What role does physical activity have in the severity of autoimmune diseases?

Physical Activity & Autoimmune Disease

On the topic of lifestyle habits, a major component to a person's everyday activities is how active they are. Activity level also plays a large role in an individual's health. As America has shifted to a nation valuing convenience and speed, much of the population has utilized convenient products and services to lead a much more sedentary lifestyle. Online services, like DoorDash, have made it possible for any food in town to arrive directly at your doorstep. Internet sites, like Amazon, have replicated this convenience with nearly every product in existence. Working remote from home has become a more common commodity in the workforce. If a person wanted to, they could spend their entire adult life having never walked out their front door. Where other cultures around the world walk miles a day just out of necessity to complete their daily tasks, it would take an intentional, often tedious, effort for most Americans to complete the same number of steps. Paired with the decreasing quality of food in the American diet, the environmental challenges for the American people to lead healthy lifestyles has led to an exponential increase in the rate of obesity and subsequent diseases that follow. The same is true for autoimmune diseases. "Physical activity leads to a significant elevation in T-regulatory cells, decreased immunoglobulin secretion and produces a shift in the Th1/Th2 balance to a decreased Th1 cell production. Moreover, physical activity has been proven to promote the release of IL-6 from muscles. IL-6 released from muscles functions as a myokine and has been shown to induce an anti-inflammatory response through IL-10 secretion and IL-1β inhibition" (Sharif et al., 2018). Physical activity, like a healthy diet, is an incredibly important factor for the huma body to remain in good health. However, most Americans must go out of their way to achieve an adequate level of activity, and health is not always prioritized in people's busy schedule. A common trend that has taken over media is the importance of physical gyms for getting active. Many influencers recognized as *fit and healthy* showcase their active lifestyles through gym

workouts or outdoor running. Due to busy life schedules and/or anxiety generated from lack of experience in gyms, these trends have made active lifestyles feel even less attainable. However, autoimmune disease patients can improve their activity from home. In a meta-analysis reviewing 16 studies that focused on at-home physical activity strength and conditioning workouts, Sieczkowska et al. found that home-based physical activity was effective in improving the quality of life, functional capacity, disease activity, and pain in patients with autoimmune rheumatic diseases (Sieczkowska et al., 2020). With the increasing convenience for Americans to stay in their homes, it might be incredibly effective to encourage an option that allows patients to improve their condition right from home. As they become more active and comfortable with conventional workouts, it can be a more smooth and natural transition to encourage them to move their workout to a gym or park where higher levels of activity are even more applicable. "Physically active [Rheumatoid Arthritis] patients were found to have a milder disease course, better cardiovascular disease (CVD) profile, and improved joint mobility. Physical activity decreases fatigue, enhances mood, cognitive abilities and mobility in patients with [Multiple Sclerosis]. In [Systemic Lupus Erythematosus] patients, enhanced quality of life and better CVD profile were documented in more physically active patients. Physically active patients with type 1 diabetes mellitus have a decreased risk of autonomic neuropathy and CVD. Both fibromyalgia and systemic sclerosis patients report decreased disease severity, pain, as well as better quality of life with more physical activity. Further, [Systemic Sclerosis] patients improve their grip strength, finger stretching and mouth opening with increased level of exercise" (Sharif et al., 2018). Across numerous conditions, physical activity not only improved the disease's severity, but the individual's ability to function with the condition.

Physical Activity & Obesity

One area where research appears to be slightly lacking is the effect that lifestyle modification can have on overweight autoimmune patients. Nonetheless, through analyzing obesity as a risk factor for autoimmune disease, research shows similar mechanisms at work that can factor physical activity into the equation. “From an immunological standpoint, the cellular and molecular mechanisms linked to this association include the overstimulation of T lymphocytes by nutrient- and energy-sensing pathways. The immunometabolic state of an individual is central to the modulation of immunological self-tolerance that suppresses self-reactivity to avoid autoimmunity. Adipose tissue is an immunologically active organ that influences systemic immune responses through the production of adipocytokines, and, in turn, immune cells affect adipocyte homeostasis and metabolism through the production of pro- and anti-inflammatory cytokines” (Matarese, 2023). The T lymphocytes mentioned here to be a link between obesity and the development of autoimmune disease are the same cells noted above by Sharif et al. that physical activity has a significant regulatory affect over (2018). Furthermore, Matarese links the disruptive nature excess adipose tissue has on metabolic function to increased risk for autoimmune disease (2023). As noted by Díaz, “The relationship between muscle and adipose tissue occurs through the secretion of myokines and adipokines. Depending on the amount of secreted cytokines in the serum, these molecules seem to have a beneficial or an adverse effect” (2018). The adverse effect referenced here occurs when there is an excess in adipocyte production as is present with obesity. Excess adipose tissue on the body results in large amounts of oxidative stress and pro-inflammatory cell production in the body. This even further strengthens its stance as a risk factor for autoimmune disease. However, physical activity can lead to improved metabolic function, decreased volume of adipose tissue, and increased muscle mass/myokine production. All three of these factors, along with the numerous other benefits of

physical activity, show to be a direct combatant to the effects of obesity on autoimmune disease risk and development. Therefore, it stands to reason that regardless of if it only combats the negative effects of obesity, or if it combats autoimmune disease directly, physical activity plays an incredibly important role in the risk and development of autoimmune diseases.

Conclusion

Lifestyle factors can contribute a very large role to the development and severity of certain autoimmune disorders. Across the board, consumption of highly processed food, smoking, and alcohol consumption damage the body's immune response and increase risk for autoimmune diseases. Along with these, sedentary habits and obesity increase the body's risk even more. With specialized diets for specific autoimmune diseases, studies suggest it is possible to control and improve a patient's quality of life. While not enough research is available to measure the strength of lifestyle habits against genetic factors, studies have determined with a high degree of efficacy, that an informed and defensive diet can reduce one's risk for developing autoimmune disorder, improve one's quality of life after diagnosis, and reduce the risk of flare ups in the condition. When paired with an adequate activity level, autoimmune disease patients can maximize their individual ability to increase their quality of life. For those without underlying conditions, these same steps should be taken to prioritize one's health. Many autoimmune patients were unaware of any genetic or environmental risk they possessed until the disease first arose. The research that is highlighted within this paper does not only apply to autoimmune patients, but the entirety of the world's population. Especially in America, where the incidence of autoimmune disease is steadily increasing, this paper highlights numerous factors within the average person's lifestyle that contribute to the development of autoimmune disease. The diet and lifestyle choices highlighted within this research should not be relegated to

reactive choices for autoimmune patients. Rather, they should also be proactive choices to improve the health and quality of life for even conventionally healthy people.

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