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Fasting Relationship with an Immune System and Heart Disease

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ABSTRACT

One of the most frequent contributors to co-morbidities or death among individuals living with HIV (PLWH) in antiretroviral therapy (ART) is cardiovascular disease (CVD). Vascular cardiovascular disease, arterial disease, stroke, illness, or cardiac cardiac were among the CVDs that over 50% of PLWH are expected to have a greater likelihood of acquiring. The pathological process on such organism varies by shared vulnerabilities, HIV Viral infection itself, or complications of immunosuppressive medication.

With this goal, potential non-pharmacological treatments, including dietary practices like intermittent fasting (IF), are now being investigated globally. The academic community is becoming increasingly interested within IF, a common procedure, because of its prospective advantages for improving blood pressure (BP), chronic inflammation, platelet-derived expansion factor AB, blood lipids as well as lipoproteins and blood vessel intima-media dimension, as well as additional cardiovascular health indicators. Because intermittent fasting has inherent features that improve the main heart disease risk variables as well as modulate inflammation responses linked to arterial disorder, lipid per oxidation, as well as ageing, this review can concentrate with investigating the possible advantages of irregular not eating as an alternatives to medication inexpensive approach to reducing the prevalence of heart conditions within HIV individuals on ART. Through the battle towards the rising incidence of cardiovascular diseases through PLWH, short-term fasting regimes require must be further evaluated in research studies as a significant, innovative, as well as affordable coadjutant of ART.

Keywords- Intermittent fasting, cardiovascular, immune system.

I. INTRODUCTION

According to the Cardiovascular Association's 2019, Coronary Disease as well as Stroke Statistical upgrade, 48% of people over aged age of 20, suffer from a cardiovascular disease (CVD) of a certain kind[1]. Around 7 million Americans have had a strokes at a minimum once, and 16.3 million Americans suffer from ischemic coronary artery disease. Furthermore, about 82.6 million Americans suffer from one or several types of cardiovascular disease, such as pulmonary and abdomen cardiac a blood vessel, a condition known as peripheral aortic atherosclerosis, as well as coronary heart diseases (CHD). According to present statistics, 1 in 4 fatalities in the United States are thought to be related to CVD, occurring each 36 seconds among Americans[2]. Additionally, the main prevalent pathologic basis for this sickness is coronary artery disease and it is described as a persistent low grade inflammation syndrome. It is currently demonstrated that the incidence of CVD was 50% greater for those who have HIV compared to those without the virus. Beyond the well recognized causes for cardiovascular disease (CVD), like smoking, alterations in lipid profiles, or insulin obstruction, Aids with infection as well as certain negative consequences of antiretroviral treatment (ART), particularly inhibitors of protease, are additional variables that affect this group[3]. Accordingly, among the leading sources of mortality for PLWH according to therapy through viro-logical as well as immunological management is heart disease. Billions of individuals worldwide engage among periodic practice of intermittent fasting (IF),that consists for intervals on rigorous calorie restriction (CR) interspersed among flexible food regimens. Both methods have grown more popular in contemporary research sector or media. Numerous intermittent fasting programmers have been

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documented in the literature, the two more well-known of which are Time Restrictive Feeding (TRF), whereby the duration of fasting is typically 14–20 hours per day, with Alternative Fasting, which is customarily 2 days fast as well as 5 days fed. It is noteworthy that intermittent fasting does not entail restricting the entire quantity of calories consumed every day, and seems typical with a standard dietary constraint programmed. Consequently, it may be used to treat disorders when calorie intake decrease is not necessary[4-5].

Improvements in diabetic tolerance or sugar of glucose, decreased body weight, postponed ageing, reduced systemic inflammation, advantageous effects on cognition, or cardiovascular health are just a few of the many possible advantages of intermittent fasting (IF) that are being stated. Prospective avenues of further investigation are being explored in order to uncover further metabolism advantages. To the greatest extent of our understanding, Intermittent fasting has been proven to be beneficial with cardiac illness, though that is a dearth in research on its effects in PLWH cases[6]. Because intermittent fasting has inherent features that improve the initial probability variables for heart disease as well as modulate the systematic inflammation a nation, Researchers sought to investigate its interest function as an alternatives to drugs as well as cost-effective method for reducing the incidence of coronary artery disease between HIV individuals on antiretroviral therapy (ART).

II. TYPES OF INTERMITTENT FASTING

Several distinct regimens are grouped together under the label "intermittent fasting": ADF, the 5:2 diet, or TRE (Figure 1). ADF usually consists of two days: one for feasting and the other for fasting. People are allowed to consume everything they want on the feasting day, without any limitations on the kinds or amounts of meals they may eat. Individuals had the option of eating zero-calorie ADF, or just water, during the fast days. As an alternative, people might practise reduced ADF that was defined by consuming around 25% of overall energy requirements (500–800 kcal) a single each day[7-8]. The early in the workday meals under altered ADF might be consumed at one sitting and stretched out over the course of the day without affecting the outcome of weight reduction. Conversely, the 5:2 diet is an adaptation of the ADF that calls for five days of feasting as well as two days of fasting per week. On days of feasting, people are allowed to consume as much as they like, just as in ADF. Approximately 25–80% of the daily energy requirements (500–800 kcal) are usually met on fast days in the 5:2 diet. Fasting days may fall on recurring or nonconsecutive days of the week[9]. By contrast, TRE needs people to stop eating for a brief amount of period each day, which sets it apart from the ADF or the 5:2 diet. somewhat more precise, TRE is restricting the amount in time that one may consume to a certain amount of hours per day (typically 4 to 10 hours), or then starving for the other hours of the day or consuming only zero-calorie drinks (such as water, black tea, black coffee, or calorie-free liquids). People are not obligated to track their meals consumption as well as count calories throughout their meal period.

Figure: 1 varieties of sporadic fasting. This diagram illustrates when food should be consumed for the 5:2 diet, alternate-day fasting, or time-restricted eating (TRE; an 8-hour TRE is shown here) on every single day of the week. An apple symbol is used to represent different meal consumption times.

III. PATHOPHYSIOLOGY

Despite in the context of successful ART, PLWH's increased risk of CVD may be accounted by their much higher levels of chronic inflammation or immunological response when contrasted with HIV-uninfected counterparts (Figure 1). Additional factors that have been determined to be participating include immune-senescence, persistent viral reproduction, ART-induced toxic effects, enhanced blood clotting, changed lipids metabolic processes, and macrophage/T-cell invasion of arteries[10]. Because senescent cells encourage the release of pro-inflammatory cytokines (referred to as "senescent-associated secretory phenotype, as well as

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SASP"), initial immunological ageing may be a primary cause of accelerating CVD. Accordingly, it was discovered which removing cells lymphocytes were dying from animals that aged too quickly stopped the ageing process in certain tissues[11]. Moreover, HIV is linked to lower concentrations of antioxidant like a substance called glut tocopherols, superoxide dismutase, ascorbic acid ,selenium, or tocopherols, or higher concentrations of hydroperoxides as well as malondialdehyde. Furthermore, lipid peroxidation as well as oxidation of LDL, which are implicated in that pathogenesis in CVD, makes hydrogen peroxide or aromatic compounds very hazardous substances to organisms as well as to serving as passively indicators of oxidative stress. Dysfunction insufficiency endothelial cells are linked to several conventional hazards for atherosclerotic as previously mentioned[12-13]. Oxidised low density lipoprotein (LDL) causes endothelium damage, which ought to be seen as a shared endpoint of many cardiovascular slurs. Yet, information about the metabolic adverse consequences of ART gets revised on a regular basis. In addition to the well-known metabolic adverse reactions of certain inhibitors of protease, the utilise of first-line medications like tenofovir alafenamide (TAF) as well as integration thread transmit inhibitors (raltegravir, dolutegravir in, elevategravir, as well as bictegravir) is giving rise to fresh worries about gaining weight as well as the ensuing metabolism disturbances[14]. The biggest hazard is associated with a combination of TAF followed by subsequent generations ISTIs (bictegravir as well as dolutegravir). (Scheme 1).

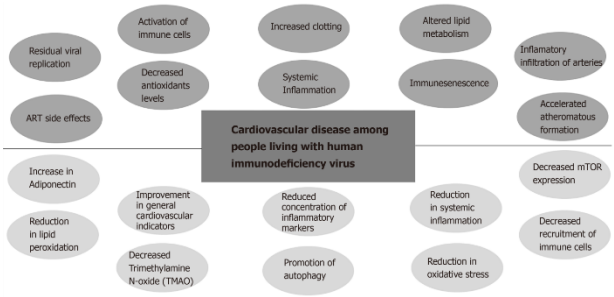

Figure 2: An overview of the interaction between the HIV/AIDS virus as well as pharmacological medication that affects cardiovascular hazards as well as the possible advantages of intermittent fasting for HIV-positive individuals.

With PLWH, the intestinal mucosa is probably where inflammatory as well as immunological activation begin immediately following infection. Numerous studies have shown that Aids with HIV or simian infection virus (SIV) illness cause breaches in the strong connections between the cell layers of the gastrointestinal tissue, allowing chemical messengers or microbiological contaminants to pass through[15-16]. These anomalies are both functionally and anatomically aberrant. It is well recognised that microbial byproducts of the "gut-microbiome," like lipopolysaccharides (LPS), may activate the intrinsic immunological systems by binding to patterns recognising receptors in the body such as TLR-4 (primarily), and causing an inflammatory response to develop both locally as well as systemically. Additionally, it has been demonstrated that initial death in HIV individuals is predicted by a rise of sCD14, a water-soluble marker of monocyte stimulation upon adsorption to LPS[17]. This discovery establishes the first connection between translocation of bacteria with HIV-related death rates, specifically in relation to CVD. With the use of certain cytokines description, it is possible to quantify with objectivity the elevated chronic inflammation as well as immune-activation in PLWH. Fibrinogen is as well as C-reactive protein (CRP) continue to be potent and distinct indicators for fatalities among Human mmunodefiency Virus persons receiving efficient antiretroviral therapy (ART) as well as exhibiting a good immune responsiveness (CD4 count of cells > 500). Furthermore, despite successful ART, levels of inflammatory cytokines (IL-6), CRP, tumour necrosis factor (TNF), interferon gamma (IFN-gamma), and D-dimer continue to be raised. It has been demonstrated that people without Aids who exhibit elevated CRP had the significantly higher comparative hazard in MI, as well as that both high CRP or HIV were individually linked to an increased incidence of myocardial infarction (MI)[18-19]. In this same cohort, there was a substantial correlation found between D-dimer as well as IL-6 for all-cause mortality. Additionally, chemokines such as interleukin 8 (IL-8), C-C motif ligand 2 (CCL2), interferon (IF gamma-induced amino acids ten (IP10), as well as Controlled upon the stimulation Average T Cell Expressed and Presumably Secreted (RANTES) continue to be raised within PLWH, indicating an ongoing attraction in resistant system cells into a plaques. All of the aforementioned suggests a well-established process for the expedited creation of atheromatous province in PLWH, an instance that begins localised levels for HIV-associated gastrointestinal mucosa function or is linked to systemically inflammation or local attraction of inflamed lymphocytes to the atheromatous plaques.

IV. INDIRECT MECHANISMS

By doing the enhancement of digestion of cell debris, reduction of lipids peroxidation, lower levels of Trimethylamine, or N-oxide (TMAO), as well as reduce in antioxidant anxiety, IF can subsequently lower the CVD danger in PLWH[20]. This will then slow the accelerated development of an atheroma plaques (Figure 3). It is crucial to understand that, despite knowing that IF exhibited many of its anti-inflammatory qualities in animal research, HIV individuals have inflammatory various levels it is significantly higher than those of AIDS negative oversight. precisely a consequence, all alterations could be associated with a substantial reduction in the probability of CVD as well as clinical

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trials events[21]. Human gastrointestinal bacteria produces trimethylamine are such N-oxide, an amine oxide, from excessive trimethylamine (TMA), which is an intermediary within the digestion of choline. It has been related to accelerate atherosclerotic as well as higher levels of inflammation in subcutaneous tissue[22]. Within an individual IF research, an average concentration for 14.3 ng of TMAO throughout fasting had been identified, compared to a starting point indicate of 27.1 ng within regulate participants (P = 0.019). This suggests that IF could have an impact on reducing discomfort in the atheromatous bacteria by both lowering TMAO various levels and the recruiting of triggered monocytes.

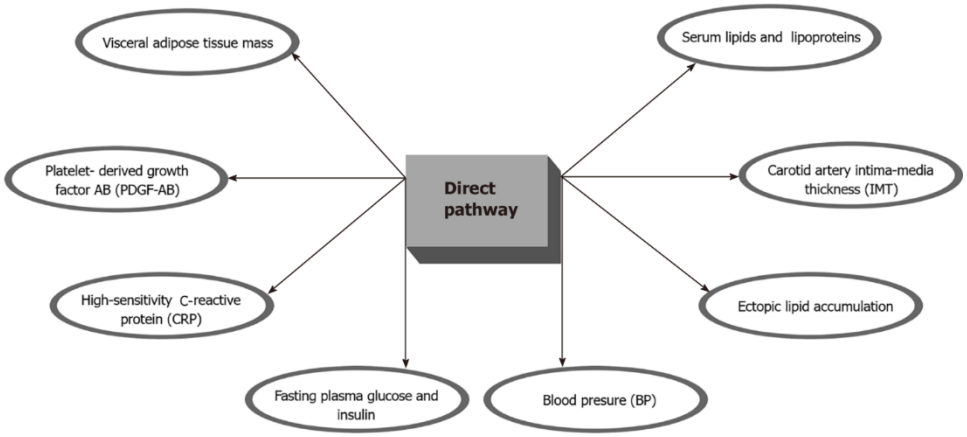

Figure 3: An overview of the indirect intermittent fasting pathway's possible advantages for HIV-positive individuals.

Such old system was most likely designed to employ phagocytosis to remove intracellular detritus, radical oxygen species (ROS), hazardous substances, or deterioration for DNA. It is therefore likely designed to utilize alternate energy resources whenever nutrition was scarce. As previously mentioned, oxidative stress or reduced antioxidant levels together with lipid peroxidation play a significant role in the development of atherosclerosis (Figure 3)[23-24]. Potential endothelial enhanced cellular adapting to ischemia as well as inflammatory processes (primarily towards ROS generation), decreased DNA damage, decreased inflammation, reduced immune system hiring, reduced the production of mammalian target of rapamycin (mTOR), as well as encouraging autophagy are some of the potential processes through which IF prevents the growth of atheromas[25]. Lower levels of TNF-alpha, IL-6, Interleukin 1 beta (IL1-b), as well as reduction of the so-called "inflammasome" were seen throughout mice who received IF in strokes research designs, whereby induces inflammatory in the brain. Regarding the hippocampal regions of mice who received systemically LPS, IF also led to a reduction of messengers ribonucleic acid (mRNAs) expressing the LPS receptors TLR4 or inducible nitric oxide synthase (iNOS). Moreover, IF prevented the rise during LPS-induced IL-1α, IL-1b, IFN-γ, RANTES, TNF-α, or IL-6 throughout an experiment. These two findings may have relevance for reducing gastrointestinal discomfort in PLWH by inhibiting TLR expression in primordial immunity lymphocytes stimulated by LPS. Reduction in gut inflammation will lead to a reduction of monocytes stimulation, immigration, or CD14 production, all of which are directly related to the faster creation of atheromatous atherosclerosis (Figure 3). The "gut-heart axis" might be disrupted by IF, which would also greatly reduce the function of endothelial cells[26]. Thus, by lowering the regional level of pro-inflammatory indicators like IL-6, homocysteine, and CRP as well as concurrently, by raising adiponectin levels, IF might also prevent the growth of atheroma bacteria in HIV patients. It would prevent the immune system from migrating to the subendothelial space. Research has demonstrated that giving men isocaloric time-restricted feeding (TORF) for eight weeks decreased many markers of inflammation, including TNF alpha, IL-6, and IL-1b, and raised the anti-inflammatory cytokine leptin[27-28]. This lowering in the probability of CVD might being therapeutically important since that the research is conducted on normal people volunteers while HIV individuals on antiretroviral therapy (ART) had a lot greater rates of inflammation. The aforementioned physiological processes in PLWH subjected by Intermitten Fasting should occur adhering the absence of any hypothetical biological obstacles. There are few key actors that require to be clarified in additionally depth in order to comprehend the biology of long-term inflammation. The multiprotein substrate called that NLRP3 inflammatory was triggered through hemorrhage or other forms of cellular stress, as well as infections like HIV[29]. When it is activated, pathogenic mediators like interleukin-1β (IL-1β) and IL-18 are secreted in a caspase-1-dependent manner, resulting in an inflammatory type of cell demise known as "Pyroptosis". One factor that is increasing the possibility of CVD is the proliferation of inflammasomes, which is known to cause inflammation[30]. HIV may immediately stimulate the

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inflammatory system by activating TLR8 within response to infectious RNA contact, although other TLRs-mediated mechanisms (including TLR4 across response to LPS in the gastrointestinal tissue, as previously mentioned) may also do so. Research has shown that the ketone bodies of acetate, which or β-hydroxybutyrate (BHB), which are both raised during fasting, suppress the NLRP3 inflammasome. In individual monocytes, which it has been demonstrated that BHB or acetoacetate inhibit the generation of interleukin (IL)-1β and IL-18 controlled through the NLRP3 the inflammasome. This process is crucial for subconsciously HIV-infected macrophages because it prevents registration as well as subsequent recruiting during translocation to the cardiovascular plaques[31-32]. IF might reduce harm to tissues or the inflammatory reaction in a research paradigm using mice that had an artificially produced infarction (as well as generates localized irritation) by inhibiting the activities of the NLRP1 or NLRP3 inflammasomes. It has been well established that a stressed Endoplasmic Reticulum (ER) produces ROS,that subsequently triggers the NLRP3 inflammasome or IL-1b release. Recent research conducted on rats revealed that β-hydroxybutyrate may have therapeutic effects by decreasing the stimulation of inflammasomes generated by strain in the ER[33]. The research, which found that Rheumatoid Arthritis (RA) participants saw substantial decreases in discomfort or inflammatory following a fasting interval or subsequent vegan diet, was informative. During another different research, IF-exposed overweight female bronchial individuals had better medical responses or significantly lower TNF-alpha as well as reactive oxygen species markers (8-isoprostane, protein carbonyls, or 4-hydroxynonenal conjugates)[34]. It demonstrated that extended fasting reduced the generation of cytokines by airways epithelium cells or inhibited a stimulation of T Helper 2 (Th2) cells or the NLRP3 inflammatory of steroid-naive asthmatics . These two researches demonstrate how IF's "survival-mode" may be used to combat chronic inflammatory conditions, which can in effect contribute to faster aging or cardiovascular disease. Actually, one of the best examples of a prolonged caused by inflammation illness is HIV[35-36]. Researchers believe that since the starting point of inflammatory is so prevalent in RA, allergies, or HIV, any modification is going to have a major therapeutic impact. It's probable which that reduced concentrations of inflammatory shown in both of these trials could worsen PLWH patients, but here is little basis to believe that this won't happen. Reduced levels of cardiovascular cell attachment molecular 1 (VCAM-1), endothelial-leukocyte attachment molecules 1 (ELAM-1), as well as interconnected attachment molecules 1 (ICAM-1) on blood vessels endothelial cells—all particles strongly linked to the pathophysiology of atherosclerosis—is the cause for the reduce in the spread for inflamed cells to the atheromatous debris over Intermitten Fasting[37]. The pathophysiology of CVD in PLWH was significantly influenced by the escape or transportation of stimulated lymphocytes (Figure 3). Remarkably, antibiotic-resistant bacteria have been shown to be one of the primary manufacturers of TMAO, which is elevated in HIV-related dysbiosis[38-39]. In fact, Intermittent Fasting could contribute to the reversion of the HIV-associated dysbiosis, including a drop in Proteobacterias (mostly inflammation as well as pro-glycolytic) through a potential shift to a healthy microbiome, such as Lactobacillus as well as the Formicates which produce lower TMAO (Figures 3 as well as 4).

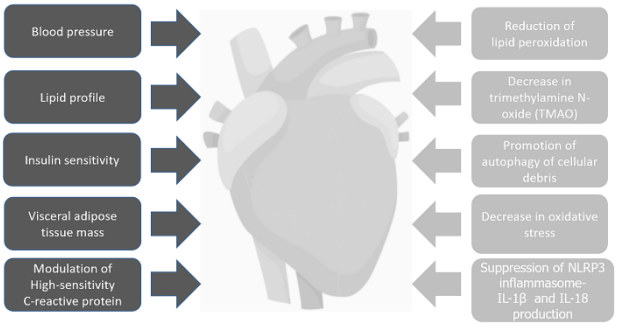

Figure 4: An overview of the direct (black) or indirect (gray) mechanisms of intermittent fasting in the context of cardiovascular disease in HIV-positive individuals.

V. FASTING AND HEALTH BENEFITS

Short-term fasting has been demonstrated in research to speed up metabolic. It is thought that Intermitten Fasting affects the gut flora, endocrine biological processes, or variable habits in order to alter the regulation of metabolism. Over many years, research the both people or rodent species are guided by this premise, which has produced a wealth of information supporting the possible benefits of fasting on losing weight as well as more so on better metabolic processes[40]. Participants in the fasting group dropped an aggregate of 2.7 kg or had significant drops in glucose levels, lipids, or abdominal fat after completing a three-month course of FMD. Furthermore, IF promotes autophagy, a mechanism that uses cell renewal for self-repair. This might prevent cognitive decline or delay the deterioration of cells. Although human models of cardiovascular dementia that went through alternate-day lack of food for 12 weeks demonstrated a substantial decrease in oxidative harm to cerebral cells as well as enhanced psychological adequateness, a research on rats determined which short-term meals restriction causes an enormous rise in the autophagy process within nerve cells[41-42]. Additionally, intermittent fasting eliminates malignant or cancerous cells, therefore combining FMDs with immunotherapy, chemotherapy, or other treatments has lately been suggested as a possible way to enhance the outcomes of cancer therapies.Eleven For light of these

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findings from human trials or animal research, scientists are currently investigating if or how FMDs impact longevity in both non-obese as well as obese individuals.

5.1 Help Regenerate the immune cells.

It combined treatment of FMDs in immunotherapy, chemotherapy, and additional treatments has lately been suggested as a possible technique to enhance the benefits of tumor medicines. Additionally, fasting intermittently eliminates. Researchers are currently examining if and how FMDs influence longevity in both obese or non-obese individuals the light of recent findings from clinical research or animal models.

5.2 Provide a robust anti-aging intervention.

There is an enhancement within autophagy, which or the body's method of dealing with cellular breakdown, as the cells adjust to fasting. By breaking down proteins as well as repurposing damaged organelles in cells to make fresh ones, this promotes equilibrium, or regular working, which may have an anti-aging impact[43-44]. A crucial component of calorie restriction's anti-aging strategy is apoptosis. This autophagic reflex occurs throughout periods of intermittent fasting. It gives cell membranes the time or room they require to expel trash or detritus. Consequently, fasting may aid in restoring or repairing the body's deterioration.

5.3 Help break unconscious habits around eating.

It's possible to ignore excessive consuming food, numerous meals, or snacking throughout the day. One may take a break from irregular eating patterns by practicing intermittent fasting. You may redirect or fine-tune the appetite impulses that physique emits by fasting[45]. A regimen of intermittent fasting may alter their connection with eating. Humans react to the pleasure of eating when it's time to eat again. The most "bland" healthy meals may tastes great when accompanied by true appetite.

Safe Ways to Fast In order to get the benefits of fasting's immune-boosting effects, proper fasting technique is necessary. The body or immunological system may be negatively impacted by fasting. If left untreated to more than a couple of days, it also significantly reduces white blood cell viability[46]. The human body can handle a two- or three-day fast more easily. One should be able to endure the 48–72 hour fast without experiencing too much pain if they follow the proper instructions. It's crucial to be ready for the fasting a several weeks in advance. In the week before the fasting, gradually remove off of booze, sweets, coffee, and additional stimulant. Reduce your intake of fish, meat, or dairy products gradually until individuals are just consuming fruits or vegetables. Soups are a great option since they are hydrating yet full, which will aid in the body's adjustment[47-48]. Fruits, seeds, or nuts are OK in moderation, although veggies should take center stage. Someone may consume additional fruit as well as vegetable smoothies two - three days prior to the fasting. It will aid in the gastrointestinal system's preparation. You may have mixed uncooked meals for a couple of day after fasting. The human body must be gradually returned to solid state. When include fish, dairy, as well as meat in their eating habits, a single ought to wait a minimum of one week. It's best to begin with meals that are lighter like grains, nuts, and seeds.

VI. METABOLISM, IMMUNITY, AND FASTING

There is a close relationship between metabolic or the immunity system. Current research indicates that the metabolism of glucose, fat acids (FAs), and amino acids (AAs) controls neutrophil stimulation, subgroup distinction, or function. Particularly, T cells primarily employ aerobic glycolysis for converting glycogen into lactate throughout stimulation.

Table 1: Most popular fasting methods.

Types	Fasting methods	Duration
IF* • cycling through periods of drastically cutting food intake with periods of healthy eating	• **16/8 fasting diet**	• Healthy eating limited to a single 8-hour window every day
	• **5:2 fasting diet**	• Healthy eating for 5 days per week, and limiting calories to between 500 and 600 for 2 days a week
	• **Alternate day fasting**	• Fasting every other day, and healthy eating during non-fasting days
	• **Warrior Diet**	• Fasting over a 20-hour window and then eating one large meal during a 4-hour evening window
	• **One meal a day (OMAD)**	• Fasting for 23 hours and eating daily calories during a 1-hour window
FMD** • cycling through periods of limiting calories intake, while providing essential nutrients such as vitamins and minerals		• Fasting 2-7 days every 15-365 days

Human may redirect or fine-tune those satiety impulses that their body emits by fasting. A regimen of intermittent fasting may alter their connection with eating[49]. People react to the pleasure of eating when it's time to eat again. The most "bland" healthy meals may tastes great when accompanied by true appetite.

6.1 Intermittent Fasting's Effect on Inflammatory Biomarkers

Globally, atherosclerosis is the primary causes of cardiovascular disease. Pathogenicity or mortality are major issues in both developed or emerging nations. Clinical symptoms including ischemia cardiac disease, coronary artery disease, or ischemia strokes are how it's expressed. It is the cause of the greatest number of heart attack fatalities worldwide, as well as severe myocardium infarct or cerebrovascular accidents[50]. The aggressive long-term condition known as atherosclerotic is characterized by the formation of atherosclerosis plaques in artery blood vessels, resulting from inflammation or constriction of the artery walls. Atherosclerosis plaques can be brought on by vascular endothelial dysfunction with prolonged exposure to risk components of cardiovascular disease. Elevated LDL (low density lipoprotein) concentrations are considered to be the most significant hazards. Oxidized LDL (oxLDL) is produced when extra LDLs build up inside the sub-epithelial layers of artery membranes. This causes plasma leukocytes,

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mostly monocytes, to adhere to the endothelium as to respond inflammatoryly. Researchers become monocytes after migrating to the vessel's outer membranes.

Macrophages internalize oxLDL, transforming them into cellular foam that expose immunological lymphocytes to antigen. Factors that aid in smooth muscle cell migration from the lateral to the interior membrane are released by stimulated cells[51-52]. External matrix protein molecules are secreted by an overabundance of arterial smooth-muscular cells. Lipids are accumulating more both outside the cell and inside cell membranes.

Most heart attack risk factors including atherosclerotic risk variables are modifiable. Following the intermittent Fasting diet represents one of the adjustments.

An essential component for growth is inflammatory. Atherosclerosis plaques develops mainly a result by inflammatory substances substances such homocysteine, interleukin (IL6), and C reactive protein (CRP). The impact of the IF meal on lowering all the amount for those aforementioned pro-inflammatory substances were shown in an investigation of Forty healthy volunteers with the appropriate bodily mass index (BMI) who fasting throughout Ramadan or twenty-eight individuals whom were chosen based on age as well as BMI index but did not fast joined the trial.

Peripheral specimens used to test the levels of the aforementioned pro-inflammatory components were obtained a week prior the beginning of Ramadan, throughout the final week of intermittent fasting, or 3 weeks later.

The levels of the collagen-like blood molecule leptin drop as insulin resistance, atherosclerosis, insulin resistance, or cardiovascular disease progress. Adipocytes secrete more leptin while following the intermittent fasting diet. Weight gain with serum adiponectin levels are inversely correlated[54]. Researchers contrasted the initial adiponectin concentrations with that which was seen following a period of dietary changes as well as increasing daily exertion. There was a 245% rise in level. The decrease in body weight corresponded with a rise in plasma levels. Adiponectin acts on the AdipoR1 or AdipoR adiponectin receptors to carry out its intended tasks. By preventing monocytes from adhering to vascular cells, it has anti-inflammatory or anti-atherosclerotic properties. Additionally, it prevents cerebrovascular endothelial units from excreting internal adhesion molecular (ICAM1), endothelial-leukocyte adhesive molecule 1 (ELAM-1), including vascular adhesion of cells molecule (VCAM-1)[55]. In addition experiments using humans aortic endothelial cells cultured under a solution with adiponectin over Eighteen hours demonstrated that, also shown. The attachment evaluate had been used with measure overall adherence of THP-1 line monocyte to humans vascular endothelium tissues, the growth of that were stimulated by tumor necrosis factor alpha (TNF-alpha). With the use of an immunosorbent assay with an enzyme-linked immunosorbent (ELISA), the molecules' concentration were quantified.. Adiponectin's anti-atherosclerotic properties have been shown in several species as well as cultures of cells.

By instance, this is proven through research through Okamoto et al. that adiponectin had anti-inflammatory effect upon human macrophages by preventing the synthesis of CXC 3 receptors cytokine ligand by the use of real-time reverse transcription polymerase chained response with ELISA testing[56-57]. In comparison with a solitary the APOE deficit, researchers observed an upsurge in IP-10 for the bloodstream, as well as an enhanced buildup among T lymphocytes within arteries as well as atherosclerotic in person experiments on rodents defective in apolipoprotein E/adiponectin.

Demonstrated that a lack about these enzyme causes intimal thickness or boosts smoother muscles cell motility as well as reproduction by up regulating the production of HB-EGF (heparin-binding epidermal growth factor) in adiponectin-deficient mice[58-59]. Research through Wan et al. shown a link between elevated leptin levels and the intermittent Fasting diet. Mice used in this research were divided into categories as well as given either an ad lib regimen or IF for a period of three months.

On alternate days, animals on an Intermittent Fasting diet were denied food for twenty-four hours. The left coronary artery of the rodents was cut to cause a heart attack. Plasma continent for ischemic is fewer as well as serum insulin content became greater for rats fed an IF regimen[60-61]. Furthermore, in contrast to rodents fed a balanced lib eating habits, notably reduced levels of leukocytes that or IL-6 have been observed.

Leptin, which was a significant enzyme released by adipocytes. It contributes to atherogenicity. Its content is higher in obese individuals or is associated with high triglycerides, blood pressure overall lipids level, the body mass index (BMI), or indicators of inflammatory[62]. Specifically, leptin levels were measured in 550 men who had either fatal coronary heart disease (CHD) or nonfatal myocardial infarction (MI), as well as in 1184 healthy individuals who were part of a prospective research investigation involving 5561 British men[63-65]. Body weight reduces while following the intermittent fasting diet because of the levels of leptin. Through lowering endothelial cell recruitment or proliferating as well as the accumulation of platelets, leptin stimulation lowers the likelihood of atherosclerosis.

An essential part of the pathophysiology of atherosclerosis is played by resistin. This cytokine is produced by adipocytes[66]. The level of it is correlated with both overweight and elevated insulin levels. It has pro-inflammatory properties. Additionally, it stimulates the production of extracellular fluid in blood vessels or the pro-inflammatory activities of neutrophils or monocytes[67-68]]. The following is accomplished by blocking that phosphorylation of AMP-activated kinase,

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or PK, which also inhibits neutrophil function. Chemical monocyte 1 protein (MCP-1) or sICAM-1 is expressed more often in vascular endothelial cells when resistin is present[69-70]. Burnett in the others observed these things when researchers treated synthetic resistance in mice cardiac endothelium tissues as a control.

Bhutani et al.'s research provides evidence that the ADF diet actively modifies adipokines. It possesses anti-sclerotic or cardio-protective properties as a consequence. There were 16 obese participants in the research: 12 women as well as 4 males[71]. There were three stages of dietary treatments throughout the course of the ten weeks[72-73]. The initial two weeks comprised the initial control phase, followed up four weeks of the ADF diet using regulated consuming times, as well as the last four weeks of the ADF diets with individuals self-feeding nourishment times.

Leptin, also levels fell during 8 weeks of the ADF diet, overall that was linked to a reduction in bodily weight as well as fat percentage[74-75]. Following the ADF diet, there was a substantial reduction of resistance level that was likely linked to a drop in body mass index.

Table 2: Impact of intermittent fasting on inflammatory markers' concentration.

First Author and Reference Number	Number of Enrolled	Participants Description	Time	Inflammatory Biomarkers	NCT Number
Harvie et al. 2013 [31]	77	Overweight or obese women	3 months	NS (IL6, TNFα, leptin, adiponectin)	NCT00869466
Varady et al. 2013 [28]	15	Overweight individuals BMI 20–29.9 kg/m²	12 weeks	↓ CRP ($p = 0.01$) ↓ Leptin ($p = 0.03$) ↑ Adiponectin ($p < 0.01$)	NCT00960505
Bhutani et al. 2013 [25]	83	Obese individuals BMI 30–39.9 kg/m²	12 weeks	NS CRP	NCT00960505
Hoddy et al. 2016 [55]	59	Obese individuals BMI 30–39.9 kg/m²	10 weeks	↓ Leptin ($p < 0.05$)	-
Chowdhury et al. 2016 [32]	23	Obese individuals BMI 30–39.9 kg/m²	6 weeks	NS (IL6, CRP, leptin, adiponectin)	-
Safavi et al. 2017 [56]	34	Male individuals 16–64 years old (Ramadan)	4 weeks	NS (adiponectin, TNFα)	-

Abbreviations: NS, not statistically significant ($p > 0.05$); IL6, interleukin 6; CRP, C-reactive protein; TNFα, tumor necrosis factor α; Only studies from the past 10 years with full data published were considered.

VII. CONCLUSION

Human Immunodeficiency Virus individuals on antiretroviral therapy (ART) have an increasing risk in cardiovascular illnesses. By both direct and indirect means, intermittent fasting may help PLWH using ART manage or prevent CVD. The context of the battle towards the increasing incidence for cardiovascular disease within PLWH, IF may be regarded like a critical, innovative, as well as affordable adjuvant to chemotherapy if these theories are validated within subsequent clinical trials. This could lead to improvements in standard of life, their survival, and reduction in clinical events. Consequently, in order to guarantee the security, effectiveness, or efficiency of IF on CVD amongst PLWH, researchers advise doing more longterm or clinical trials.

According to the latest research, FMDs can enhance one's well-being and possibly help with cancer therapy. Such assertions are still debatable, nevertheless, as the majority of research is done using animal models. Lymph metabolism of cells are regulated by biological processes are affected by fasting. Adherence to a dietary regimen which incorporates fasting may thereby inhibit the inflammatory process. The majority of documented dietary therapies for RA as well as PSA individuals have therefore recently shown positive impact for indicators including the course of their diseases.

Prior to endorsing any specific dietary habits as additional "diet therapy" for individuals having aggressive arthritides, further research is needed to fully understand the effects of various fasting periods on elderly or non-obese individuals.

The purpose of this review is to provide an overview of how human cardio metabolic fitness indicators are affected by fasting for an extended period. Time-restricted eating (TRE), the 5:2 diet, with alternate-day fasting (ADF) all resulted in significant decreases in calorie intake (10–30% from baseline) or modest to modest reductions in weight (1-3%). By lowering inflammation, glucose obstruction, or blood pressure, such routines could help cardio metabolic wellness. There is probably a reduction in low-density plasma cholesterol as well as triglycerides levels; however, results vary.

There isn't any data to support additional therapeutic advantages, which include better management of hunger as well as helpful modifications to the richness of the gut microbiota. Affecting overall, intermittent fasting was harmless as well as cannot lead to a spike in unhealthy food habits and disruptions in energy levels. In conclusion, intermittent fasting is a safe diet treatment that may help obese people lose bodyweight that is clinically relevant (>5%) as well as improve a number of vital metabolic indicators.

REFERENCES

[1] Ismahil, M. A. et al. Remodeling of the mononuclear phagocyte network underlies chronic inflammation and disease progression in heart failure: critical importance of the cardiosplenic axis. *Circ. Res.* 114, 266–282 (2014).

[2] Sager, H. B. et al. Proliferation and recruitment contribute to myocardial macrophage expansion in chronic heart failure. *Circ. Res.* 119, 853–864 (2016).

[3] Moro T, Tinsley G, Pacelli FQ, Marcolin G, Bianco A, Paoli A. Twelve months of time-restricted eating and resistance training improves inflammatory markers and Cardiometabolic risk factors. *Med Sci Sports Exerc*. (2021) 53:2577–85. doi: 10.1249/MSS.0000000000002738, :

[4] Trepanowski JF, Kroeger CM, Barnosky A, Klempel MC, Bhutani S, Hoddy KK, et al.. Effect of alternate-day fasting on weight loss, weight maintenance, and Cardioprotection among metabolically healthy obese adults: a randomized clinical trial. *JAMA Intern Med*. (2017) 177:930–8. doi: 10.1001/jamainternmed.2017.0936, :

ISSN: 2583-4053
Volume-2 Issue-6 || December 2023 || PP. 194-204
https://doi.org/10.55544/jrasb.2.6.28

[5] Harder-Lauridsen NM, Rosenberg A, Benatti FB, Damm JA, Thomsen C, Mortensen EL, et al.. Ramadan model of intermittent fasting for 28 d had no major effect on body composition, glucose metabolism, or cognitive functions in healthy lean men. *Nutrition*. (2017) 37:92–103. doi: 10.1016/j.nut.2016.12.015, :

[6] Guo Y, Luo S, Ye Y, Yin S, Fan J, Xia M. Intermittent fasting improves Cardiometabolic risk factors and alters gut microbiota in metabolic syndrome patients. *J Clin Endocrinol Metab*. (2021) 106:64–79. doi: 10.1210/clinem/dgaa644, :

[7] Varady KA, Bhutani S, Klempel MC, Kroeger CM, Trepanowski JF, Haus JM, et al.. Alternate day fasting for weight loss in normal weight and overweight subjects: a randomized controlled trial. *Nutr J*. (2013) 12:146. doi: 10.1186/1475-2891-12-146, :

[8] Cienfuegos S, Gabel K, Kalam F, Ezpeleta M, Wiseman E, Pavlou V, et al.. Effects of 4-and 6-h time-restricted feeding on weight and Cardiometabolic health: a randomized controlled trial in adults with obesity. *Cell Metab*. (2020) 32:366–78.e3. doi: 10.1016/j.cmet.2020.06.018, :

[9] Fang Y, Gu Y, Zhao C, Lv Y, Qian J, Zhu L, et al.. Impact of supervised beego, a traditional Chinese water-only fasting, on thrombosis and haemostasis. *BMJ Nutr Prev Health*. (2021) 4:4–17. doi: 10.1136/bmjnph-2020-000183, :

[10] Razavi R, Parvaresh A, Abbasi B, Yaghoobloo K, Hassanzadeh A, Mohammadifard N, et al.. The alternate-day fasting diet is a more effective approach than a calorie restriction diet on weight loss and hs-CRP levels. *Int J Vitam Nutr Res*. (2021) 91:242–50. doi: 10.1024/0300-9831/a000623, :

[11] Moro T, Tinsley G, Longo G, Grigoletto D, Bianco A, Ferraris C, et al.. Time-restricted eating effects on performance, immune function, and body composition in elite cyclists: a randomized controlled trial. *J Int Soc Sports Nutr*. (2020) 17:65. doi: 10.1186/s12970-020-00396-z, :

[12] Mindikoglu AL, Abdulsada MM, Jain A, Jalal PK, Devaraj S, Wilhelm ZR, et al.. Intermittent fasting from dawn to sunset for four consecutive weeks induces anticancer serum proteome response and improves metabolic syndrome. *Sci Rep*. (2020) 10:18341. doi: 10.1038/s41598-020-73767-w, :

[13] Liu T, Xing Y, Fan X, Chen Z, Zhao C, Liu L, et al.. Fasting and overfeeding affect the expression of the immunity-or inflammation-related genes in the liver of poultry via endogenous retrovirus. *Poult Sci*. (2021) 100:973–81. doi: 10.1016/j.psj.2020.11.057, :

[14] Adawi M. The effects of the Ramadan fasting on metabolic and immunological disorders. *Isr Med Assoc J*. (2021) 23:251–2.

[15] Wilhelm C, Surendar J, Karagiannis F. Enemy or ally? Fasting as an essential regulator of immune responses. *Trends Immunol*. (2021) 42:389–400. doi: 10.1016/j.it.2021.03.007

[16] Okawa T, Nagai M, Hase K. Dietary intervention impacts immune cell functions and dynamics by inducing metabolic rewiring. *Front Immunol*. (2021) 11:623989. doi: 10.3389/fimmu.2020.623989, :

[17] Wegman MP, Guo MH, Bennion DM, Shankar MN, Chrzanowski SM, Goldberg LA, et al.. Practicality of intermittent fasting in humans and its effect on oxidative stress and genes related to aging and metabolism. *Rejuvenation Res*. (2015) 18:162–72. doi: 10.1089/rej.2014.1624, :

[18] Moro T, Tinsley G, Bianco A, Marcolin G, Pacelli QF, Battaglia G, et al.. Effects of eight weeks of time-restricted feeding (16/8) on basal metabolism, maximal strength, body composition, inflammation, and cardiovascular risk factors in resistance-trained males. *J Transl Med*. (2016) 14:290. doi: 10.1186/s12967-016-1044-0, :

[19] Gasmi M, Sellami M, Denham J, Padulo J, Kuvacic G, Selmi W, et al.. Time-restricted feeding influences immune responses without compromising muscle performance in older men. *Nutrition*. (2018) 51-52:29–37. doi: 10.1016/j.nut.2017.12.014, :

[20] Stekovic S, Hofer SJ, Tripolt N, Aon MA, Royer P, Pein L, et al.. Alternate day fasting improves physiological and molecular markers of aging in healthy. *Non-obese Humans Cell Metab*. (2019) 30:462–76.e6. doi: 10.1016/j.cmet.2019.07.016, :

[21] McAllister MJ, Pigg BL, Renteria LI, Waldman HS. Time-restricted feeding improves markers of cardiometabolic health in physically active college-age men: a 4-week randomized pre-post pilot study. *Nutr Res*. (2020) 75:32–43. doi: 10.1016/j.nutres.2019.12.001, :

[22] Zeb F, Wu X, Chen L, Fatima S, Haq IU, Chen A, et al.. Effect of time-restricted feeding on metabolic risk and circadian rhythm associated with gut microbiome in healthy males. *Br J Nutr*. (2020) 123:1216–26. doi: 10.1017/S0007114519003428, :

[23] Xie Z, Sun Y, Ye Y, Hu D, Zhang H, He Z, et al.. Randomized controlled trial for time-restricted eating in healthy volunteers without obesity. *Nat Commun*. (2022) 13:1003. doi: 10.1038/s41467-022-28662-5, :

[24] Bhutani S, Klempel MC, Berger RA, Varady KA. Improvements in coronary heart disease risk indicators by alternate-day fasting involve adipose tissue modulations. *Obesity (Silver Spring)*. (2010) 18:2152–9. doi: 10.1038/oby.2010.54, :

[25] Sutton EF, Beyl R, Early KS, Cefalu WT, Ravussin E, Peterson CM. Early time-restricted feeding improves insulin sensitivity, blood pressure, and oxidative stress even without weight loss in men with prediabetes. *Cell Metab*. (2018) 27:1212–21.e3. doi: 10.1016/j.cmet.2018.04.010, :

[26] Bowen J, Brindal E, James-Martin G, Noakes M. Randomized trial of a high protein, partial meal replacement program with or without alternate day fasting: similar effects on weight loss, retention status, nutritional, metabolic, and behavioral

ISSN: 2583-4053
Volume-2 Issue-6 || December 2023 || PP. 194-204
https://doi.org/10.55544/jrasb.2.6.28

outcomes. *Nutrients*. (2018) 10:1145. doi: 10.3390/nu10091145, :
[27] Liu B, Hutchison AT, Thompson CH, Lange K, Heilbronn LK. Markers of adipose tissue inflammation are transiently elevated during intermittent fasting in women who are overweight or obese. *Obes Res Clin Pract*. (2019) 13:408–15. doi: 10.1016/j.orcp.2019.07.001
[28] Zouhal H, Bagheri R, Ashtary-Larky D, Wong A, Triki R, Hackney AC, et al.. Effects of Ramadan intermittent fasting on inflammatory and biochemical biomarkers in males with obesity. *Physiol Behav*. (2020) 225:113090. doi: 10.1016/j.physbeh.2020.113090, :
[29] Horne BD, Anderson JL, May HT, Le VT, Galenko O, Drakos SG, et al.. Intermittent fasting and changes in Galectin-3: a secondary analysis of a randomized controlled trial of disease-free subjects. *Nutr Metab Cardiovasc Dis*. (2022) 32:1538–48. doi: 10.1016/j.numecd.2022.03.001, :
[30] Liu B, Hutchison AT, Thompson CH, Lange K, Wittert GA, Heilbronn LK. Effects of intermittent fasting or calorie restriction on markers of lipid metabolism in human skeletal muscle. *J Clin Endocrinol Metab*. (2021) 106:e1389–99. doi: 10.1210/clinem/dgaa707
[31] Miranda ER, Fuller KNZ, Perkins RK, Kroeger CM, Trepanowski JF, Varady KA, et al.. Endogenous secretory RAGE increases with improvements in body composition and is associated with markers of adipocyte health. *Nutr Metab Cardiovasc Dis*. (2018) 28:1155–65. doi: 10.1016/j.numecd.2018.07.009, :
[32] Ozturk E, Balat O, Ugur MG, Yazıcıoglu C, Pence S, Erel Ö, et al.. Effect of Ramadan fasting on maternal oxidative stress during the second trimester: a preliminary study. *J Obstet Gynaecol Res*. (2011) 37:729–33. doi: 10.1111/j.1447-0756.2010.01419.x, :
[33] Yassin MA, Ghasoub RS, Aldapt MB, Abdulla MA, Chandra P, Shwaylia HM, et al.. Effects of intermittent fasting on response to tyrosine kinase inhibitors (TKIs) in patients with chronic myeloid leukemia: an outcome of European leukemia net project. *Cancer Control*. (2021) 28:107327482110092. doi: 10.1177/10732748211009256, :
[34] Li C, Xing C, Zhang J, Zhao H, Shi W, He B. Eight-hour time-restricted feeding improves endocrine and metabolic profiles in women with anovulatory polycystic ovary syndrome. *J Transl Med*. (2021) 19:148. doi: 10.1186/s12967-021-02817-2, :
[35] Fitzgerald KC, Bhargava P, Smith MD, Vizthum D, Henry-Barron B, Kornberg MD, et al.. Intermittent calorie restriction alters T cell subsets and metabolic markers in people with multiple sclerosis. *EBioMedicine*. (2022) 82:104124. doi: 10.1016/j.ebiom.2022.104124, :
[36] van Ginhoven TM, Dik WA, Mitchell JR, Smits-te Nijenhuis MA, van Holten-Neelen C, Hooijkaas H, et al.. Dietary restriction modifies certain aspects of the postoperative acute phase response. *J Surg Res*. (2011) 171:582–9. doi: 10.1016/j.jss.2010.03.038, :
[37] Brandhorst S, Choi IY, Wei M, Cheng CW, Sedrakyan S, Navarrete G, et al.. A periodic diet that mimics fasting promotes multi-system regeneration, enhanced cognitive performance, and Healthspan. *Cell Metab*. (2015) 22:86–99. doi: 10.1016/j.cmet.2015.05.012, :
[38] Mattson MP. Dietary factors, hormesis and health. *Ageing Res Rev*. (2008) 7:43–8. doi: 10.1016/j.arr.2007.08.004, :
[39] Fang H, Judd RL. Adiponectin regulation and function. *Compr Physiol*. (2018) 8:1031–63. doi: 10.1002/cphy.c170046, :
[40] Sun W, Liu C, Chen Q, Liu N, Yan Y, Liu B. SIRT3: a new regulator of cardiovascular diseases. *Oxidative Med Cell Longev*. (2018) 2018:1–11. doi: 10.1155/2018/7293861
[41] Liu Y, Cheng A, Li YJ, Yang Y, Kishimoto Y, Zhang S, et al.. SIRT3 mediates hippocampal synaptic adaptations to intermittent fasting and ameliorates deficits in APP mutant mice. *Nat Commun*. (2019) 10:1886. doi: 10.1038/s41467-019-09897-1, :
[42] Calabrese V, Cornelius C, Dinkova-Kostova AT, Calabrese EJ, Mattson MP. Cellular stress responses, the hormesis paradigm, and vitagenes: novel targets for therapeutic intervention in neurodegenerative disorders. *Antioxid Redox Signal*. (2010) 13:1763–811. doi: 10.1089/ars.2009.3074, :
[43] Scheiermann C, Kunisaki Y, Frenette PS. Circadian control of the immune system. *Nat Rev Immunol*. (2013) 13:190–8. doi: 10.1038/nri3386, :
[44] Álvarez J, Fernández Real JM, Guarner F, Gueimonde M, Rodríguez JM, Saenz de Pipaon M. Gut microbes and health. *Gastroenterol Hepatol*. (2021) 44:519–35. doi: 10.1016/j.gastrohep.2021.01.009
[45] Hirahatake KM, Slavin JL, Maki KC, Adams SH. Associations between dairy foods, diabetes, and metabolic health: potential mechanisms and future directions. *Metabolism*. (2014) 63:618–27. doi: 10.1016/j.metabol.2014.02.009, :
[46] Margalit O, Boursi B. Tailoring bacterial taxa for immune cell modulation. *Hepatobiliary Surg Nutr*. (2021) 10:686–8. doi: 10.21037/hbsn-21-263, :
[47] Sheng L, Jena PK, Hu Y, Wan YY. Age-specific microbiota in altering host inflammatory and metabolic signaling as well as metabolome based on the sex. *Hepatobiliary Surg Nutr*. (2021) 10:31–48. doi: 10.21037/hbsn-20-671, :
[48] Gérard P. Beneficial effect of whole-grain wheat on liver fat: a role for the gut microbiota? *Hepatobiliary Surg Nutr*. (2021) 10:708–10. doi: 10.21037/hbsn-21-332, :
[49] Engin A. The definition and prevalence of obesity and metabolic syndrome. *Adv Exp Med Biol*. (2017) 960:1–17. doi: 10.1007/978-3-319-48382-5_1
[50] Iyengar NM, Gucalp A, Dannenberg AJ, Hudis CA. Obesity and cancer mechanisms: tumor

ISSN: 2583-4053
Volume-2 Issue-6 || December 2023 || PP. 194-204
https://doi.org/10.55544/jrasb.2.6.28

microenvironment and inflammation. *J Clin Oncol*. (2016) 34:4270–6. doi: 10.1200/JCO.2016.67.4283, :
[51] Graille M, Wild P, Sauvain JJ, Hemmendinger M, Guseva Canu I, Hopf NB. Urinary 8-isoprostane as a biomarker for oxidative stress. A systematic review and meta-analysis. *Toxicol Lett*. (2020) 328:19–27. doi: 10.1016/j.toxlet.2020.04.006, :
[52] Pereira S, Cline DL, Glavas MM, Covey SD, Kieffer TJ. Tissue-specific effects of leptin on glucose and lipid metabolism. *Endocr Rev*. (2021) 42:1–28. doi: 10.1210/endrev/bnaa027, :
[53] Pérez-Pérez A, Vilariño-García T, Fernández-Riejos P, Martín-González J, Segura-Egea JJ, Sánchez-Margalet V. Role of leptin as a link between metabolism and the immune system. *Cytokine Growth Factor Rev*. (2017) 35:71–84. doi: 10.1016/j.cytogfr.2017.03.001, :
[54] Canfora EE, Meex RCR, Venema K, Blaak EE. Gut microbial metabolites in obesity, NAFLD and T2DM. *Nat Rev Endocrinol*. (2019) 15:261–73. doi: 10.1038/s41574-019-0156-z, :
[55] Pugazhenthi S, Qin L, Reddy PH. Common neurodegenerative pathways in obesity, diabetes, and Alzheimer's disease. *Biochim Biophys Acta Mol basis Dis*. (2017) 1863:1037–45. doi: 10.1016/j.bbadis.2016.04.017, :
[56] Shin BK, Kang S, Kim DS, Park S. Intermittent fasting protects against the deterioration of cognitive function, energy metabolism and dyslipidemia in Alzheimer's disease-induced estrogen deficient rats. *Exp Biol Med (Maywood)*. (2018) 243:334–43. doi: 10.1177/1535370217751610, :
[57] Alkhalefah A, Dunn WB, Allwood JW, Parry KL, Houghton FD, Ashton N, et al.. Maternal intermittent fasting during pregnancy induces fetal growth restriction and down-regulated placental system a amino acid transport in the rat. *Clin Sci (Lond)*. (2021) 135:1445–66. doi: 10.1042/CS20210137, :
[58] Ali AM, Kunugi H. Intermittent fasting, dietary modifications, and exercise for the control of gestational diabetes and maternal mood dysregulation: a review and a case report. *Int J Environ Res Public Health*. (2020) 17:379. doi: 10.3390/ijerph17249379, :
[59] Zhao X, Yang J, Huang R, Guo M, Zhou Y, Xu L. The role and its mechanism of intermittent fasting in tumors: friend or foe? *Cancer Biol Med*. (2021) 18:63–73. doi: 10.20892/j.issn.2095-3941.2020.0250, :
[60] Clifton KK, Ma CX, Fontana L, Peterson LL. Intermittent fasting in the prevention and treatment of cancer. *CA Cancer J Clin*. (2021) 71:527–46. doi: 10.3322/caac.21694, :
[61] Reich DS, Lucchinetti CF, Calabresi PA. Multiple Sclerosis. *N Engl J Med*. (2018) 378:169–80. doi: 10.1056/NEJMra1401483, :
[62] Cignarella F, Cantoni C, Ghezzi L, Salter A, Dorsett Y, Chen L, et al.. Intermittent fasting confers protection in CNS autoimmunity by altering the gut microbiota. *Cell Metab*. (2018) 27:1222–35.e6. doi: 10.1016/j.cmet.2018.05.006, :
[63] Gudden J, Arias Vasquez A, Bloemendaal M. The effects of intermittent fasting on brain and cognitive function. *Nutrients*. (2021) 13:3166. doi: 10.3390/nu13093166, :
[64] Bahr LS, Bock M, Liebscher D, Bellmann-Strobl J, Franz L, Prüß A, et al.. Ketogenic diet and fasting diet as nutritional approaches in multiple sclerosis (NAMS): protocol of a randomized controlled study. *Trials*. (2020) 21:3. doi: 10.1186/s13063-019-3928-9, :
[65] Atabilen B, Akdevelioğlu Y. Effects of different dietary interventions in multiple sclerosis: a systematic review of evidence from 2018 to 2022. *Nutr Neurosci*. (2022) 17:1–13. doi: 10.1080/1028415X.2022.2146843, :
[66] Janssen H, Kahles F, Liu D, Downey J, Koekkoek LL, Roudko V, et al. Monocytes reenter the bone marrow during fasting and alter the host response to infection. Immunity. 2023;56:783–96.e7.
[67] 2. Poller WC, Downey J, Mooslechner AA, Khan N, Li L, Chan CT, et al. Brain motor and fear circuits regulate leukocytes during acute stress. Nature. 2022;607:578–84.
[68] 3. Sohrabi Y, Reinecke H, Soehnlein O. Trilateral interaction between innervation, leukocyte, and adventitia: a new driver of atherosclerotic plaque formation. Signal Transduct Target Ther. 2022;7:249.
[69] 4. Vasamsetti SB, Florentin J, Coppin E, Stiekema LCA, Zheng KH, Nisar MU, et al. Sympathetic neuronal activation triggers myeloid progenitor proliferation and differentiation. Immunity. 2018;49:93–106.e7.
[70] 5. Jordan S, Tung N, Casanova-Acebes M, Chang C, Cantoni C, Zhang D, et al. Dietary intake regulates the circulating inflammatory monocyte pool. Cell. 2019;178:1102–14.e17.
[71] 6. de Cabo R, Mattson MP. Effects of intermittent fasting on health, aging, and disease. N Engl J Med. 2019;381:2541–51.
[72] 7. Tall AR, Fuster JJ. Clonal hematopoiesis in cardiovascular disease and therapeutic implications. Nat Cardiovasc Res. 2022;1:116–24.
[73] 8. Collins N, Han SJ, Enamorado M, Link VM, Huang B, Moseman EA, et al. The bone marrow protects and optimizes immunological memory during dietary restriction. Cell. 2019;178:1088–101.e15.
[74] 9. Nagai M, Noguchi R, Takahashi D, Morikawa T, Koshida K, Komiyama S, et al. Fasting-refeeding impacts immune cell dynamics and mucosal immune responses. Cell. 2019;178:1072–87.e14.
[75] 10. Pan C, Herrero-Fernandez B, Borja Almarcha C, Gomez Bris R, Zorita V, Saez A, et al. Time-restricted feeding enhances early atherosclerosis in hypercholesterolemic mice. Circulation. 2023;147:774–7.