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Longitudinal Study on the Impact of Diet on Blood Health: a 5-Year Prospective Cohort Analysis

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Abstract: Background: The role of dietary patterns in maintaining optimal blood health remains incompletely understood, particularly regarding long-term effects on hematological, metabolic, and inflammatory parameters.

Objective: To evaluate the 5-year impact of Mediterranean, Western, and vegetarian dietary patterns on complete blood count, lipid profile, and inflammatory biomarkers in healthy adults.

Methods: We conducted a prospective cohort study with 500 participants (18-65 years) stratified by baseline dietary patterns. Annual assessments included standardized blood tests and validated food frequency questionnaires. Statistical analyses employed linear mixed-effects models with adjustment for potential confounders.

Results: The Mediterranean diet group demonstrated significant reductions in LDL compared to Western diet consumers. Vegetarian participants showed lower hemoglobin levels (-0.8 g/dL, 95% CI -1.2 to -0.4, p=0.002) but markedly reduced CRP concentrations (-1.8 mg/L, 95% CI -2.3 to -1.3, p<0.001).

Conclusion: Sustained adherence to Mediterranean dietary patterns confers significant hematological and metabolic benefits,

while vegetarian diets require micronutrient monitoring to prevent subclinical anemia despite their anti-inflammatory advantages.

Keywords: nutritional epidemiology, hematological parameters, dietary patterns, chronic inflammation, cardiovascular prevention

Introduction

The relationship between dietary patterns and hematological health represents a critical intersection of nutritional epidemiology and preventive medicine. Mounting evidence suggests that long-term dietary habits significantly influence blood parameters through complex metabolic pathways, with profound implications for chronic disease risk [1]. Blood health biomarkers – including complete blood count indices, lipid profiles, and inflammatory markers – serve as sensitive indicators of nutritional status and predictors of cardiovascular, metabolic, and inflammatory disorders [2]. Recent advances in nutritional science have revealed that dietary patterns, rather than isolated nutrients, exert the most significant effects on these hematological parameters through synergistic interactions among food components [3].

Current epidemiological data underscore the global burden of diet-related hematological disorders. The World Health Organization estimates that 1.62 billion people worldwide suffer from anemia, with iron deficiency accounting for approximately 50% of cases [4]. Simultaneously, dyslipidemia affects nearly 39% of adults globally, contributing significantly to the 17.9 million annual deaths from cardiovascular diseases [5]. These conditions share common dietary determinants, including inadequate intake of essential nutrients and excessive consumption of pro-inflammatory foods [6]. The Mediterranean diet has emerged as promising, with numerous studies demonstrating its benefits for hematological and cardiovascular health [7].

Despite growing recognition of diet-blood health relationships, significant knowledge gaps persist in the scientific literature. Most existing studies have employed cross-sectional designs or short-term interventions, limiting their ability to establish causal relationships or assess long-term effects [8]. Furthermore, comparative analyses of different dietary patterns' longitudinal impacts remain scarce, particularly regarding their influence on comprehensive blood health profiles encompassing hematological, metabolic, and inflammatory parameters [9]. This deficiency in longitudinal data hinders the development of evidence-based dietary recommendations for maintaining optimal blood health across diverse populations.

The biological mechanisms linking diet to blood health are multifaceted and incompletely understood. Iron homeostasis provides a prime example where dietary factors influence absorption (through enhancers like vitamin C and inhibitors like phytates), utilization, and storage [10]. Lipid metabolism similarly demonstrates complex dietary regulation, with different fatty acid types affecting cholesterol synthesis, lipoprotein particle distribution, and reverse cholesterol transport [11]. At the inflammatory level, nutritional components can modulate cytokine production, oxidative stress, and endothelial function through nuclear factor-kappa B (NF-κB) and other signaling pathways [12]. These intricate relationships underscore the need for comprehensive longitudinal studies to elucidate how sustained dietary patterns influence blood health over time.

Our primary hypothesis posited that adherence to a Mediterranean diet would yield the most favorable hematological and metabolic profile. In contrast, secondary hypotheses suggested that vegetarian diets would show reduced inflammation at the potential cost of iron status.

Methods

Study Design and Population

We conducted a 5-year prospective cohort study (2018-2023) at a Private clinic in Baghdad. Participants were recruited through community screening of 2,350 potentially eligible adults, with final enrollment of 500 subjects meeting inclusion criteria.

Inclusion Criteria:

- Age 18-65 years
- Stable dietary pattern for ≥2 years
- Willingness to undergo annual assessments
- Normal baseline blood parameters (hemoglobin >12 g/dL women, >13 g/dL men; LDL <160 mg/dL)

Exclusion Criteria:

- Pregnancy or lactation
- Chronic inflammatory conditions
- Use of lipid-lowering or anti-inflammatory medications
- History of bariatric surgery or malabsorption disorders

Dietary Assessment and Group Classification

Dietary patterns were assessed using:

1. **Validated 180-item FFQ** (Nutrition Data System for Research, version 2020)
2. **3-day weighed food records** at baseline and annually
3. **Dietary pattern scores** (Mediterranean Diet Score [8], Healthy Eating Index-2020 [9])

Participants were classified into three mutually exclusive groups:

- **Mediterranean diet (n=168):** MDScore ≥8, high olive oil/fish intake
- **Western diet (n=166):** HEI-2020 <50, high processed food consumption
- **Vegetarian diet (n=166):** No meat/fish consumption ≥2 years

Blood Parameter Measurement

Fasting blood samples were collected annually using standardized protocols:

1. **Complete Blood Count:** Sysmex XN-9000 analyzer (hemoglobin, hematocrit, RBC indices)
2. **Lipid Profile:** Enzymatic colorimetry (Roche Cobas c702)
3. **Inflammatory Markers:**

- High-sensitivity CRP (immunoturbidimetry)

Statistical Analysis

Statistical analysis was done by using SPSS version 23 software.

Results and Discussion:

The study population comprised 500 participants with balanced distribution across dietary groups (Table 1). No significant differences existed in age ($p=0.451$) or sex distribution ($p=0.320$) between groups. However, BMI differed significantly ($p<0.001$), with Western diet consumers having the highest mean BMI (27.4 ± 4.1 kg/m²) compared to Mediterranean (25.1 ± 3.2 kg/m²) and vegetarian (24.8 ± 3.5 kg/m²) groups. This finding aligns with previous reports

linking Western diets to higher adiposity [14].

Table 1: Baseline Characteristics of Participants

Variable	Mediterranean (n=170)	Western (n=165)	Vegetarian (n=165)	p-value
Age (years)	42.3 ± 12.1	40.8 ± 11.7	41.5 ± 10.9	0.451
Female (%)	58%	55%	62%	0.320
BMI (kg/m²)	25.1 ± 3.2	27.4 ± 4.1	24.8 ± 3.5	<0.001

Over the 5-year follow-up period, we observed significant between-group differences in all measured blood parameters (Table 2):

Hemoglobin: Vegetarians showed a clinically relevant decline (-0.8 ± 0.4 g/dL) compared to minimal change in Mediterranean (-0.2 ± 0.5 g/dL) and slight increase in Western diet groups (+0.1 ± 0.6 g/dL, p=0.015). This supports previous findings on lower iron bioavailability in plant-based diets [15].

LDL Cholesterol: Mediterranean diet adherents demonstrated the most substantial reduction (-12.3 ± 8.1 mg/dL), contrasting with increased levels in Western consumers (+5.2 ± 6.9 mg/dL, p=0.002). Vegetarians showed intermediate improvement (-3.1 ± 7.4 mg/dL).

CRP: Vegetarians exhibited the most significant reduction (-1.8 ± 0.7 mg/L), followed by Mediterranean (-1.1 ± 0.6 mg/L), while Western diet consumers showed increased levels (+0.5 ± 0.4 mg/L, p=0.003). These findings corroborate the anti-inflammatory potential of plant-based diets [16].

Table 2: Changes in Blood Parameters Over 5 Years

Parameter	Mediterranean Δ	Western Δ	Vegetarian Δ	p-value
Hemoglobin (g/dL)	-0.2 ± 0.5	+0.1 ± 0.6	-0.8 ± 0.4	0.015
LDL (mg/dL)	-12.3 ± 8.1	+5.2 ± 6.9	-3.1 ± 7.4	0.002
CRP (mg/L)	-1.1 ± 0.6	+0.5 ± 0.4	-1.8 ± 0.7	0.003

Our longitudinal study provides compelling evidence that sustained dietary patterns exert differential effects on blood health parameters through multiple biological pathways [13]. The Mediterranean diet demonstrated the most comprehensive benefits, significantly improving lipid profiles and inflammatory markers [14]. The 12.3 mg/dL reduction in LDL cholesterol is particularly noteworthy, as this exceeds the average reduction achieved by many first-line statin therapies in primary prevention populations [15]. This effect likely stems from the synergistic action of monounsaturated fatty acids from olive oil, enhancing LDL receptor activity. At the same time, polyphenols from plant foods improve endothelial function and reduce oxidative stress [16]. The concurrent 1.1 mg/L reduction in CRP suggests broad anti-inflammatory effects that may explain the well-documented cardiovascular benefits of this dietary pattern beyond its impact on traditional lipid parameters [17].

The vegetarian diet presented a more nuanced profile, with remarkable anti-inflammatory benefits but concerning hematological changes [18]. The 1.8 mg/L CRP reduction was the most substantial among all groups, likely reflecting plant-based diets' high antioxidant and fiber content [19]. However, the decline in 0.8 g/dL hemoglobin raises critical clinical considerations, particularly for populations at risk of iron deficiency [20]. This finding suggests that while vegetarian diets may offer protection against chronic inflammation, they require careful nutritional planning to ensure adequate iron status, especially for women of reproductive age with higher iron requirements [21]. While less pronounced than in the Mediterranean group, the intermediate 3.1 mg/dL LDL reduction in vegetarians still represents a clinically meaningful improvement that could reduce cardiovascular risk [22].

The Western diet group's deteriorating metabolic and inflammatory profile provides compelling evidence of the detrimental effects of processed food consumption [23]. When extrapolated over

decades, the observed 5.2 mg/dL increase in LDL cholesterol could substantially increase cardiovascular risk [24]. The concurrent 0.5 mg/L CRP increase suggests a pro-inflammatory state that may accelerate atherosclerosis through multiple pathways, including endothelial dysfunction and plaque instability [25]. These findings are particularly concerning given the increasing global prevalence of Western dietary patterns and their association with the rising burden of chronic diseases [26].

From a clinical perspective, our results support the need for more nuanced dietary recommendations that consider individual health priorities and risk factors [27]. The Mediterranean diet is the most evidence-based option for cardiovascular prevention, offering benefits across multiple risk parameters [28]. Vegetarian diets may be particularly suitable for individuals with inflammatory conditions but require monitoring for potential micronutrient deficiencies [29]. The consistent adverse outcomes associated with Western dietary patterns underscore the urgent need for public health interventions to reduce consumption of processed foods and promote healthier alternatives [30].

In conclusion, our study provides strong evidence that long-term dietary patterns significantly influence multiple aspects of blood health. The Mediterranean diet is particularly beneficial for cardiovascular risk reduction, while vegetarian diets offer anti-inflammatory advantages that must be balanced against potential micronutrient concerns. These findings support the development of more nuanced dietary recommendations that consider individual health needs and highlight the importance of population-level strategies to promote healthier eating patterns.

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