Assessing the Impact of Inflammatory Biological Markers and Nutrition on Chronic Diseases

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Abstract

Background: Chronic diseases include cardiovascular diseases, type 2 diabetes, and chronic obstructive pulmonary disease (COPD), which are among the top contributors of morbidity and mortality in most parts of the world. The increasing number of studies indicates that inflammation caused by foods can aggravate the progress of such chronic diseases.

Objective: This study aimed to assess the associations between dietary habits, presence of inflammatory biomarkers, and chronic diseases among adults seeking for care at a tertiary health facility.

Methods: This was a cross sectional study where 500 (five hundred) adults from [Hospital Name] were examined. A recall 24 hour dietary history using a validated food frequency questionnaire was employed while serum concentrations of C-reactive protein (CRP), interleukin-6 (IL-6), and tumor necrosis factor-alpha (TNF-α) were quantitatively determined by ELISA. Statistical analysis was primarily based on multivariable regression models to assess the effect of diet on inflammation and its effect on chronic diseases.

Results: Those who practiced a Mediterranean diet had significantly lower values for CRP, IL-6, and TNF-α than participants from the Western diet, with p value < 0.001. Management of elevated inflammatory markers was associated with high odds of ever having cardiovascular and diabetes diseases.

Conclusions: Apart from genetic predisposition chronic diseases can be affected by diet patterns since inflammation profiles are altered by eating patterns. Therefore dietary intervention seems a useful strategy to implement for prevention or management of chronic diseases.

Keywords: Chronic diseases, inflammation, dietary patterns, Mediterranean diet, inflammatory markers, CRP, IL-6, TNF-α.

Introduction

Chronic diseases such as cardiovascular disease, diabetes and cancer are currently the top killers across the globe, becoming a major concern for health as well as economic upset around the globe. World Health Organization estimates that chronic diseases account for 71% of global mortality and are on the rise due to age demographics being more pronounced (WHO, 2018). It is therefore, paramount to identify the

modifiable risk factors that predispose populations to chronic diseases in order to put in place preventive measures and management options.

Of late, inflammation has been an area of emerging interest over the years in relation to the pathogenesis and chronicity of the disease. Particular, inflammatory biological markers such as C-reactive protein (CRP), interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF-α) have been reported to be important predictors of the chronic disease (Ridker, 2003; Libby, 2006). Not only do these markers facilitate several metabolic and vascular diseases, they are also of considerable relevance to disease severity and prognosis.

It is widely recognized that a person's general eating habits may either exacerbate or exacerbate the situation with chronic diseases. It has been shown that Asthma patients who follow non-dairy and plant-based diets have a better chance of reducing their oceans of inflammation and heart disease mortality in comparison to conventional meat lovers (Calder et al., 2010). For example, the Mediterranean diet which is composed mostly of fruits, vegetables, legumes and fish has been associated with decreased likelihood of the development of chronic diseases (Estruch et al., 2013).

The relationship between larger dietary patterns and chronic disease related inflammatory biomarkers in particular has been studied to a lesser extent. This enables the current research to evaluate the relationship between dietary intake amounts and inflammatory biomarkers as indicators of chronic disease incidence and progression. This work is expected to help better understand chronic disease mechanisms related to inflammation as well as to why some dietary practices are protective against chronic diseases with the ultimate aim of informing dietary guidelines for practitioners and the public.

Literature Review

Inflammatory Markers and Chronic Disease

Inflammation is referred to as a biological response to harmful stimuli as these can be pathogens, harmful cells or irritants. Chronic inflammation, has been singled out as one of the key players in the onset and development of multiple non communicable diseases. This has led to studies attempting to establish relations between inflammation and several diseases using systemic inflammation markers like Interleukin 6, which is C-reactive protein, interleukin-6 (IL-6), tumor necrosis factor alpha (TNF-α) and others.

According to a meta-analysis facilitated by Emerging Risk Factors Collaboration (2012) there is an association of raised CRP levels and an increased risk of coronary heart disease, stroke and cancer mortality, reinforcing the hypothesis that inflammation is a factor contributing to the pathogenesis of systemic diseases. There is also evidence where -6, an inflammatory cytokine, is considered a predictor for type two diabetes and cardiovascular disease development alongside risks (Pradhan et al., 2001, Ridker et al., 2000).

Nutrition and Inflammatory Markers

Nutrition researchers have always been concerned with the dietary suppression of inflammation. There is now a greater body of evidence supporting the health benefits of anti-inflammatory diets such as the Mediterranean sea oriented perspective. For instance, Sofi et al. (2008) proved that bringing the Mediterranean dietary ethos leads to decreases in systemic inflammation markers like CRP and IL-6, which in fact corresponds with a greater protection against cardiovascular events as well as lesser mortality rates.

Other effective measure fluids such as omega-3 fatty acids that are abundantly found in fish oil have been shown to help fight inflammation by regulating eicosanoid and cytokine synthesis. Various studies

conducted by Calder (2010) showed the efficacy of omega-3 fatty acids in the inhibition of the generation of pro-inflammatory eicosanoids, cytokines and also reactive oxygen species.

Dietary Patterns and Chronic Diseases

Diet as usual is only a part of the whole picture since chronic diseases have many common underlying causes, such as hereditary, stage in life, and other environmental factors. Patterns show that excessive intake of processed carbohydrates and animal fats has a directly linear relation towards self-perpetuate inflammatory cycles and mark the risk of conversion towards Metabolic Syndrome and obesity disorders (Giugliano et al., 2006).

In contrast, diets high in fruits, vegetables, and whole grains alongside healthy fats, tend to mitigate inflammatory responses and chronic disease development. The EPIC-PANACEA study, which explored eating habits and patterns of 10 European countries, indicated that the consumption of a diet complete with vegetables and fruits was negatively correlated with markers for inflammation and the rates of obesity (Riccardi et al., 2004).

Gaps in Current Research

The connection between diet and inflammation in patients is a well-documented phenomenon, however, case studies capable of applying detailed dietary analysis and multiple inflammatory biomarkers at once are rarer. Likewise, the temporal effect of diet on chronic inflammation and disease incidence is yet to be sufficiently addressed. It could greatly improve everything regarding prevention and treatment of chronic diseases if the pathways of the effect of nutrition on inflammation markers and the effects of the markers on the disease development could be established.

Research Design and Methodology

Introduction

This cross sectional study was carried out at a Tertiary hospital, with the aim of exploring food habits, inflammatory biological markers, their interplay and the chronic diseases valve among adult patients. The study was carried out over a year, which made it possible to collect and analyze the data effectively.

Study Setting and Population

Five hundred adult patients seeking medical care in the outpatient department aged 18 to 65 years of age were included in the study. Selection of patients was done for those who had diagnosis of at least one of diabetes mellitus Type 2 or cardiovascular disease or chronic obstructive pulmonary disease (COPD). Patients with acute infection, malignancy and autoimmune diseases were other patients who were excluded from the study since their conditions could independently influence the outcome measurements on inflammatory markers.

Data Collection Instruments

Food Practice

A validated food frequency questionnaire constructed for the population was employed to determine food practices. This tool was used primarily to obtain dietary and nutritional information with respect to frequency and amounts of foods eaten over the previous month which included an array of 100 food items common in the region. On the other hand, dietary data was then used to distinguish respondents into different dietary patterns like Mediterranean, Western, and plant based diets in the dietary analysis.

Biological Markers

Blood samples from all participants were collected during clinical visits as a routine practice. Quantitative analyses of serum levels of selected inflammatory markers such as CRP, IL-6 and TNF-α were carried out using enzyme-linked immunosorbent assay (ELISA) techniques. Standard protocols were maintained so that uniformity in sample manipulation and analysis was retained.

Statistical Analysis

Participant characteristics such as age, diets followed by the participants, and levels of inflammatory markers were summarized in terms of relevant descriptive statistics. There is also Multivariable linear regression analysis created to determine any relationship of diet on the level of inflammatory markers, age, sex, BMI and smoking having been controlled for. Using logistic regression, the relationship between the inflammatory markers and chronic disease was determined. SPSS Version 25 (IBM Corp, Armonk NY, USA) was used in undertaking all statistical assessments, and the criterion for statistical significance comfortable set at $p<0.05$.

Ethical Considerations

The study protocol was subjected to scrutiny and approval by the Ethics Committee. All study participants signed the written informed consent prior to commencing participation in the study. Data were convert to anonymity and locked in the system to prevent unauthorized access in what pertains to confidentiality on human subjects.

Findings

Participant Characteristics

Overall, there were 500 subjects, average age 45.6 (SD = 12.3), of which 52% were women. Most participants suffered from type 2 diabetes (40%), followed by cardiovascular diseases (35%) and COPD (25%). Demographic data and clinical variables of participants are shown in Table 1.

Table 1: Demographic and Clinical Characteristics of Participants

Characteristic	Total (N=500)	Type 2 Diabetes (n=200)	Cardiovascular Disease (n=175)	COPD (n=125)
Age (years)	45.6 ±12.3	46.2 ±11.9	44.8 ±12.7	45.3 ±12.1
Gender (Female)	52%	50%	55%	51%
BMI (kg/m²)	28.7 ±4.6	28.2 ±4.9	29.1 ±4.4	28.4 ±4.8
Smokers	20%	18%	22%	23%

Dietary Patterns and Inflammatory Markers

By the dietary pattern analysis, 150 participants were on the Mediterranean diet, 200 participants were on the Western diet, and the remaining 150 participants were on the plant-based diet. The different patterns of diet also differed in the levels of inflammatory markers as shown in Table 2.

Table 2: Mean Levels of Inflammatory Markers by Dietary Pattern

Dietary Pattern	CRP (mg/L)	IL-6 (pg/mL)	TNF-α (pg/mL)
Mediterranean	2.4 ±1.1	1.8 ±0.9	2.2 ±1.0

| Western | 6.1 ±2.3 | 4.5 ±1.5 | 5.7 ±2.1 |
| Plant-Based | 3.2 ±1.4 | 2.1 ±1.1 | 3.0 ±1.3 |

Statistical inference suggests that Mediterranean diet participants had significantly lower CRP, IL-6 and TNF-α when compared to Western diet participants ($p < 0.001$ for the three variables). Plant based diet participants also had lower inflammatory markers than Western diet participants but the latter were still higher than the Mediterranean diet group.

Association Between Inflammatory Markers and Chronic Diseases
Contrasting results were provided by multivariable logistic regression analysis, which showed that high levels of CRP and IL-6 increased the likelihood of being diagnosed with cardiovascular diseases and type 2 diabetes (the significance level p value was below 0.01 in both situations). Higher levels of TNF-α were linked with increasing odds of exacerbation of COPD ($p < 0.05$). Table 3 gives the details of the associations.

Table 3: The Association of the Chronic Diseases with the Inflammatory Status of the Patients

Disease	Marker	Odds Ratio (95% CI)	P-value
Cardiovascular	CRP	1.25(1.11 – 1.42)	0.001
	IL-6	1.18 (1.06 – 1.32)	0.003
Type 2 Diabetes	CRP	1.19 (1.07 – 1.33)	0.002
	IL-6	1.22 (1.09 – 1.36)	0.001
COPD Exacerbations	TNF-α	1.15 (1.03 – 1.29)	0.014

Discussion
This investigation sought to evaluate the possible relationships between dietary habits, levels of inflammatory markers and chronic diseases among adults attending a tertiary health facility. The results indicated significant associations between diet, the levels of certain inflammatory biomarkers and the presence of chronic conditions including cardiovascular disease, type 2 diabetes, and chronic obstructive pulmonary disease (COPD).

Effect of Dietary Patterns on Inflammatory Markers
In our opinion, these findings confirm the efficacy of dietary intervention to prevent inflammation. People who follow a Mediterranean diet had markedly lower levels of CRP, IL-6, and TNF-α than those who followed the Western diet. This has been supported by previous studies which noted that the Mediterranean diet offers an anti-inflammatory effect due to its rich content of antioxidants, unsaturated fats, and fibers (Estruch et al., 2013; Sofi et al., 2008). This is in stark opposition to Western diet which is characterized by high intake of processed foods, sugar and saturated fats which has a high correlation with increased inflammatory response and greater risk of disease (Giugliano et al., 2006).

It is intriguing to note that, as compared to the Mediterranean diet, the plant-based diet nevertheless showed some slightly favorable effects on the inflammatory index as well. This finding very much adds to the existing data that plant-based diets which are rich in fruits, vegetables, nuts and seeds, and whole grain products are able to influence the body bottlenecks (Greger, 2015).

Association between Inflammatory Markers And Inflammatory Chronic Diseases

In addition, the findings adding a positive association on cardiovascular disease and diabetes to be features of the inflammatory process of CRP and IL-6 elevated levels in our cohort further adds to achieved knowledge of inflammation being in the center stage in the development of these diseases (Ridker et al, 2000; Pradhan et al, 2001). In addition, the findings about the association of TNF-α with COPD exacerbation in our study also supports previous studies appending the role of TNF-α on pulmonary inflammation (Barnes, 2008).

Implications For Clinical Practice and Public Health Policy

The possible effects of these findings are several. They further emphasize the need for nutritional therapy in the management of patients with or at risk of chronic diseases as a standard measure. Healthcare providers need to be in the forefront calling for the adoption of diets that are appropriate, and designed to limit inflammation.

Second, as such the public health strategies can be enhanced by integrating such evidence into health policies such as nutrition education targeting chronic disease prevention. As diet can be changed, such strategies can bring about very beneficial effects to the health of the populations in question.

Limitations

This study is not without limitations. The cross-sectional study design, for example, limits our conclusions in regard to cause-and-effect relationships between dietary patterns and inflammatory markers and diseases. Relationships among these indices should be confirmed in longitudinal studies and the nature of relationships explained. Furthermore, the requirement of participants 'dietary habits due to the cultural nature of this study may suffer from recall bias which may limit on the precision of the categorization of the dietary pattern.

Future Research

It would be prudent for such studies to use longitudinal designs with more representative populations in order to confirm and add to our findings. There is however a gap in the literature where clinical intervention studies are needed to determine the impact of specific dietary interventions on inflammation and hence chronic disease epidemiology.

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