Introduction

Inflammatory bowel disease (IBD) is a chronic inflammatory disease that affects the colon as in ulcerative colitis (UC) and/or any part of the gastrointestinal tract as in Crohn’s disease (CD). While UC causes long-lasting inflammation and superficial ulcers of the inner lining layers of the large intestine (colon) and rectum, CD is characterized by inflammation of the lining of the digestive tract, particularly the ileum, which often spreads with deep ulcers of affected tissues in skipped fashion.

Several studies highlighted the independent effect of various diets and lifestyle factors on IBD risk, including dietary patterns, macro- and micro-nutrients intake, physical activity (PA), and tobacco smoking. Some risk factors of IBD are not modifiable such as genetic factors, sex and age. However, dietary patterns, PA, nutrient intake, and smoking are considered modifiable risk factors that can be targeted to modify disease outcome.

There is accumulating evidence that associates a dietary pattern, single micro- macronutrients, and food items to intestinal inflammatory response that may have a therapeutic implication. Nutrition has an important role in the management of patients with IBD which can ameliorate macro and micronutrient deficiencies in these individuals, and may reverse the physiopathological consequences of such deficiencies, and exert an anti-inflammatory therapeutic benefit.

Therefore, this study aimed to compare the differences between macro and micro-nutrients intake among IBD cases and IBD-free controls in a selected sample of Jordanian adults.
third decade of life\(^\text{10}\). Jordanians are moving towards a western lifestyle as well, with increasing consumption of processed food and decreased levels of PA\(^\text{12}\). To our knowledge, this is the first study to investigate the association between nutrients intake patterns and IBD among Jordanians. The aim of our study is to compare the differences in macro- and micronutrients intake among IBD cases and IBD-free controls adults.

**Patients and Methods**

**Study Design and Participants**

A case-control study design was used to determine nutrients intake as risk factors for inflammatory bowel disease in a selected sample of Jordanian adults.

In this study, 335 adult Jordanians were enrolled between November 2018 and December 2019. One hundred and eighty-five patients were recently diagnosed with IBD (CD, \(n = 85\) and UC, \(n = 100\)). The patients were recruited from three hospitals: University of Jordan Hospital, Zarqa Governmental Hospital, and Al Bashir Hospital. One hundred and fifty IBD-free controls were recruited from the community (the employees and visitors from the University of Jordan Hospital, Zarqa Governmental Hospital, and Al Bashir Hospital, as well as employees working in companies and organizations). However, cases and controls were matched for age and marital status. The inclusion criteria included: adult patients between 18 to 68 years of age, patients who were recently (within 3 months) diagnosed with IBD, Jordanian nationality, and able to communicate verbally and sign an informed consent. Participants who suffer from cancers, acute appendicitis, food allergy, food intolerance, infection, primary intestinal lymphoma, intestinal tuberculosis, anal fistulas; are pregnant and lactating women; and/or unable to communicate verbally were all excluded from the study. Additionally, controls who reported symptoms of irritable bowel syndrome or anal fistula up to one year before the study were excluded as well.

**Setting and Study Approval**

A hospital setting was utilized for data collection. Hospitals that offer services for patients with IBD were chosen to conduct the study. The outpatient department in each hospital was the setting for data collection. The proposal was presented to the Institutional Review Board (IRB) of each hospital to get their ethical approval. Ethical Approval from each hospital for having a private room with good physical condition to carry out the interviews was obtained (The University of Jordan Hospital IRB number was 22/2019-4312; Zarqa Governmental Hospital and Al Basheer Hospital IRB number was 3199). A signed consent was obtained before data collection from each participant. Collected information was treated confidentially in which only the researcher knew patients’ names and gave them ID. All used tools and instruments (questionnaires and test tubes) were labeled with patient number. All Patients charts were reviewed and IBD diagnosis was confirmed.

**Data Collection**

**Instrument:** A two-part package was used for collecting data that meet the purpose of the study. The package consists of two structured questionnaires: personal information sheet; Food Frequency Questionnaire (FFQ) for adult\(^\text{13}\); and physical activity questionnaire\(^\text{14}\). Face-to-face interview technique was utilized as a method for data collection and the questionnaires were completed by a trained dietitian.

**Personal Information Sheet:** This sheet consisted of questions related to age, sex, marital status, education, employment, health status, current body weight, pre-diagnosis body weight, height, and waist circumferences.

**Dietary Assessment:** Information on diet was based on a validated Arabic FFQ for dietary assessment which was tested previously for reproducibility\(^\text{15}\). The FFQ questions have tracked the information on the dietary history of study participants before IBD diagnosis, and to confirm the dietary habits of control participants. The FFQ included 111 questions on food and beverages. The estimated duration of the interview was about 30 minutes for each participant. For better portion size estimation, a standardized food models (NASCO, USA) and standard measuring tools were used (NASCO, USA). Data was collected through face-to-face interviews, how frequently, on average, participants consumed one standard serving of specific food items in nine categories (<1/month, 2–3/month, 1–2/week, 3–4/week, 5–6/week, 1/day, 2–3/day, 4–5/day, or 6/day). For some other food items, response categories provided in the FFQ were “never, 1/4 the time, 1/2 time, 3/4 the time, all the time”. Food lists in the modified FFQ questions were classified based on types of foods: 21 items of fruits and juices; 21 items of vegetables; 8 items of cereals; 9 items of milk and dairy products; 4 items of beans; 16 items of meat such as red meat (lamb and beef), chicken, fish, cold meat, and others; 4 items of soups and sauces; 5 items of drinks; 4 items of snacks and sweets; and 14 items of herbs and spices. Energy (kcal), carbohydrate (g), sugar (g), fiber (g), protein (g), fat (g), saturated fats (g), trans-fats (g), monounsaturated fats (MUFA) (g), polyunsaturated fats (PUFA) (g), cholesterol (mg), Omega 3 (g), Omega 6 (g), vitamin B6 (mg), vitamin B12 (mcg), vitamin C (mg), Beta carotene (mcg), Retinol (RE), vitamin D (mcg), vitamin E-\(\alpha\)-tocopherol (mg), folate (mcg), vitamin k (mcg), calcium (mg), iron (mg), potassium (mg), sodium (mg), zinc (mg) intakes were all assessed from the whole food items which are included in the FFQ. After completing the FFQ, the selected frequency category was converted to a daily intake. For calculating the nutrient intake, di-
etary analysis software (ESHA Food Processor SQL version 10.1.1; ESHA, Salem, OR, USA) that calculates the vitamins and minerals intake based on the food intake was used together with additional data on foods consumed in Jordan<sup>15</sup>.

7-day Physical Activity Recall (PAR)

A 7-Day PAR validated questionnaire, which is an organized questionnaire, was used to calculate a participant’s recall of time spent participating in exercise over a seven-day period<sup>14</sup>. This questionnaire helps to divide individual physical activity levels into three categories. Participants were asked to respond to a PAR question based on the way they used to behave prior undergoing coronary angiography.

Statistical Analysis

All statistical analyses were conducted using SPSS version 22.0 (IBM SPSS Statistics for Windows, IBM Corporation). Descriptive analyses were conducted to examine the frequency of different variables. Chi-square was used to detect the statistical differences among categorical variables. One-way ANOVA test coupled with Least Significant Difference (LSD) test was used to find the difference between continuous variables of cases (UC and CD) and controls. Data were presented as Mean ± SD. The significance level was set at p<0.05. Shapiro-Wilk test was used to assess the normality of the distributions of dietary intake variables. Non-normally distributed variables were log-transformed<sup>16</sup>. Multinomial logistic regression model was used to calculate odd ratios (OR) and its 95% confidence interval (CI).

Results

One hundred and eighty-five (100 UC, and n = 85 CD) Jordanian adults aged between 18-68 years who were recently diagnosed with IBD were recruited in this study. For the control group, 150 IBD-free controls were conveniently selected to match the cases in age and marital status. Table 1 shows the results of socio-demographic and health characteristics. Average age for IBD cases was 41.4 ± 12.5 years, and the mean height was 166.4 ± 7.7 cm. The mean current body weight was 74.8 ± 13.0 kg, and the mean usual body weight was 74.3 ± 12.6 kg. The mean current BMI (kg/m<sup>2</sup>) was 26.1 ± 4.6. The mean waist circumference was 86.7 ± 11.0 cm, and the mean hip circumference was 97.0 ± 10.1 cm. The mean physical activity (Met/week) was 2479.4 ± 296.8.

Table 1. Socio-demographic and Anthropometric Measurements of the Study Participants:

| Variables                        | Control (n = 150) | IBD (n = 185) | p-value<sup>*</sup> |
|----------------------------------|------------------|---------------|---------------------|
| Gender                           |                  |               | 0.244               |
| Male                             | 61 (40.7)        | 87 (47.0)     |                     |
| Female                           | 89 (59.3)        | 98 (53.0)     |                     |
| Marital Status                   |                  |               | 0.493               |
| Married                          | 112 (74.7)       | 145 (78.4)    |                     |
| Single                           | 25 (16.7)        | 29 (15.7)     |                     |
| Divorce                          | 10 (6.6)         | 6 (3.2)       |                     |
| Widow                            | 3 (2.0)          | 5 (2.7)       |                     |
| Education Level                  |                  |               | 0.205               |
| Below the high school            | 8 (5.3)          | 9 (4.9)       |                     |
| High school                      | 46 (30.7)        | 69 (37.3)     |                     |
| Diploma                          | 36 (24.0)        | 27 (14.6)     |                     |
| Bachelor                         | 47 (31.3)        | 69 (37.3)     |                     |
| Master degree                    | 10 (6.7)         | 7 (3.8)       |                     |
| Doctorate degree                 | 3 (2.0)          | 2 (2.2)       |                     |
| Work Status                      |                  |               | 0.596               |
| Yes                              | 83 (55.3)        | 97 (52.4)     |                     |
| No                               | 67 (44.7)        | 88 (47.6)     |                     |
| Smoking                          |                  |               | 0.074               |
| Yes                              | 36 (24.0)        | 62 (33.5)     |                     |
| No                               | 105 (70.0)       | 118 (63.8)    |                     |
| Former-smoker                    | 9 (6.0)          | 5 (2.7)       |                     |
| BMI Categories                   |                  |               | 0.501               |
| Underweight                      | 4 (2.8)          | 5 (2.7)       |                     |
| Normal weight                    | 54 (37.5)        | 57 (31.1)     |                     |
| Overweight                       | 60 (41.7)        | 77 (42.1)     |                     |
| Obese                            | 26 (18.0)        | 44 (24.1)     |                     |
| Physical Activity (MET/week)     |                  |               | 0.001               |
| Inactive (<600 Met/week)         | 4 (2.2)          | 49 (26.7)     |                     |
| Minimally Active (600-1499 Met/week) | 17 (9.2) | 23 (12.5) |                     |
| HEPA Active (>1500 Met/week)     | 164 (88.6)       | 78 (52.0)     |                     |
| Mean ± SD                        |                  |               |                     |
| Age (y)                          | 41.4 ± 12.5      | 39.8 ± 12.6   | 0.446               |
| Height (Cm)                      | 166.4 ± 7.7      | 164.8 ± 8.3   | 0.128               |
| Current Body Weight (Kg)         | 74.8 ± 13.0      | 71.0 ± 13.0   | 0.007               |
| Usual Body Weight (Kg)           | 74.3 ± 12.6      | 72.7 ± 13.4   | 0.460               |
| Current BMI (kg/m<sup>2</sup>)   | 26.1 ± 4.6       | 27.0 ± 4.7    | 0.050               |
| Waist Circumference (cm)         | 86.7 ± 11.0      | 88.4 ± 9.5    | 0.019               |
| Hip Circumference (cm)           | 97.0 ± 10.1      | 98.5 ± 10.4   | 0.199               |
| Physical activity (Met/week)     | 2479.4 ± 296.8   | 19018 ± 673.8 | 0.011               |

Data are presented as mean ± SD and frequencies (N) and percentages (%).
P-value ≤ 0.05 considered significant.
Table 2. Energy-adjusted nutrients intake per day for the study participants

| Nutrients               | Control (n = 150) Mean ± SD | UC (n = 100) Mean ± SD | CD (n = 85) Mean ± SD | P-Value |
|-------------------------|------------------------------|-------------------------|-----------------------|---------|
| Energy (kcal)           | 1962.6 ± 497.1               | 2073.9 ± 322.7          | 2033.4 ± 247.2        | 0.078   |
| Energy from Fat (kcal)  | 368 ± 86.1                   | 885 ± 92.9              | 866.7 ± 93.2          | 0.001   |
| Energy from saturated fat (kcal) | 174.4 ± 12.9              | 183.5 ± 29.7            | 181.4 ± 27.9          | 0.001   |
| Protein (g)             | 76.9 ± 5.5                   | 89.7 ± 12.2             | 90.1 ± 10.6           | 0.001   |
| Carbohydrate (g)        | 224.5 ± 51.1                 | 209.8 ± 26.5            | 199.7 ± 21.8          | 0.001   |
| Fiber (g)               | 21.06 ± 3.5                  | 21 ± 7.5                | 19.7 ± 3.4            | 0.001   |
| Sugar (g)               | 47.7 ± 5.8                   | 64 ± 19.0               | 58.8 ± 9.5            | 0.001   |
| Fat (g)                 | 99.5 ± 7.9                   | 99.5 ± 10.6             | 100.1 ± 12.4          | 0.856   |
| Saturated Fat (g)       | 14.5 ± 1.3                   | 20.4 ± 3.3              | 20.1 ± 6.2            | 0.949   |
| Monounsaturated Fat (g) | 25 ± 3.2                     | 28.47 ± 5.5             | 26.7 ± 5.3            | 0.002   |
| Polyunsaturated Fat (g) | 18.9 ± 3.6                   | 18.2 ± 3.5              | 17.9 ± 3.7            | 0.112   |
| Trans Fat (g)           | 4.14 ± 1.5                   | 3.27 ± 2.1              | 3.4 ± 1.8             | 0.001   |
| Cholesterol (mg)        | 341.3 ± 50.3                 | 381.3 ± 127.0           | 390.2 ± 95.1          | 0.001   |
| Omega 3 (g)             | 0.6 ± 0.2                    | 0.81 ± 0.3              | 0.7 ± 0.9             | 0.001   |
| Omega 6 (g)             | 5.9 ± 1.1                    | 7.9 ± 1.5               | 8.6 ± 1.8             | 0.001   |
| Retinol (RE)            | 858.8 ± 178.1                | 1328.9 ± 196.3          | 1602.3 ± 103.6        | 0.001   |
| Beta carotene (mcg)     | 526.6 ± 205.2                | 1186.1 ± 664.5          | 1220.1 ± 505.6        | 0.001   |
| Vitamin B6 (mg)         | 1.2 ± 0.2                    | 1.3 ± 0.3               | 1.2 ± 0.3             | 1.000   |
| Vitamin B12 (mcg)       | 4.1 ± 1.5                    | 8.6 ± 2.4               | 8.8 ± 2.3             | 0.001   |
| Vitamin C (mg)          | 82.9 ± 18.7                  | 198.1 ± 211.6           | 90.0 ± 50.9           | 0.001   |
| Vitamin D (mcg)         | 0.65 ± 0.3                   | 0.91 ± 0.4              | 0.92 ± 0.3            | 0.001   |
| Vitamin E (mg)          | 6.7 ± 1.9                    | 90 ± 1.8                | 7.9 ± 1.7             | 0.001   |
| Vitamin K (mcg)         | 71.5 ± 8.3                   | 62.9 ± 13.0             | 61.0 ± 16.8           | 0.001   |
| Folic acid (mcg)        | 437.0 ± 102.6                | 626.3 ± 129.2           | 681.3 ± 103.9         | 0.002   |
| Calcium (mg)            | 519.0 ± 148.8                | 728.6 ± 156.3           | 714.2 ± 112.4         | 0.001   |
| Zinc (mg)               | 7.6 ± 0.87                   | 9.1 ± 2.2               | 8.2 ± 1.3             | 0.001   |
| Iron (mg)               | 15 ± 3.4                     | 15.9 ± 3.4              | 15.4 ± 1.7            | 0.015   |
| Potassium (mg)          | 2000.4 ± 273.7               | 2473.6 ± 548.2          | 2136.2 ± 257.4        | 0.001   |
| Sodium (mg)             | 2736.9 ± 573.4               | 2794.0 ± 433.8          | 2912.0 ± 344.4        | 0.002   |
| Caffeine (mg)           | 163.9 ± 47.5                 | 158.2 ± 64.3            | 144.8 ± 1.8           | 0.24    |

Vitamin E as α-Tocopherol
Folic acid as dietary folic acid equivalents
Data are presented as mean ± SD
P-value for ANOVA test < 0.05 considered significant
Different three letters (a, b, c) mean that there is a significant differences between three variables

was 39.8 ± 12.6, and 41.4 ± 12.5 years for controls. The percentage of gender distribution was different between the three groups. A significant difference has been found between cases and controls in physical activity. As shown in Table 1 no significant differences were detected in marital status, work status, smoking, and education level. Significant differences in the means of physical activity, current body weight, BMI and waist circumference between controls and IBD were detected.

The mean daily intakes of total energy, macronutrients, and micronutrients are illustrated in Table 2. The IBD group reported significantly (p < 0.05) higher intakes of energy from fat, saturated fat, amount of total protein, carbohydrates, sugars, fiber, MUFA, trans-fat and cholesterol compared to the control group. Besides, the IBD group showed significant (p < 0.05) higher intakes of vitamins A, D, E, B12, C and folate, betacarotene, retinol, calcium, potassium, iron, Omega-3 and Omega-6 when compared to the control group while the control group had a higher intakes of vitamin K and caffeine when compared to the IBD group (p < 0.05).

Table 3 shows a protective association between carbohydrates intake when consumed in higher amounts in the three quartiles (OR (CI95%): Q2: 0.33(0.16–0.71); Q3: 0.39(0.18–0.85); Q4: 0.34(0.15–0.78, respectively) among CD patients. On the other hand, the increase in protein intake was associated with increased risk for patients with CD (OR (CI95%): Q2: 0.17(0.04–0.83); Q3: 14.63(5.77–37.10); Q4: 152.08(30.26–764.42, respectively) and an increased risk in two quartiles (OR (CI95%): Q3: 9.06(3.84–21.41); Q4: 122.82(25.44–593.01, respectively) of protein intake among UC patients. Fiber intake as well showed a protective effect for patients with CD in the third and fourth quartiles (OR (CI95%): Q3: 0.26(0.12–0.58); Q4: 0.24(0.09–0.65), respectively), while for the same patients, sugar intake showed a significant increased risk at the second and third quartiles OR (CI95%): Q2: 15.61(4.171–58.45); Q3: 20.29(5.39–76.49), respectively). Although, MUFA and cholesterol intakes were associated with the increased risk for UC and CD, caffeine intake showed a significant protective effect against UC and CD.
The key result of this study is consistent with prior studies for the presence of an association between IBD and nutrients intake. It sheds light on the relationship between IBD, macro and micronutrients intake in a selected sample of Jordanians adults.

We found a significant difference between UC, CD and controls in BMI. Our results showed that BMI was significantly (P-value = 0.021) lower in UC as compared to CD and controls. Several studies agree with our study findings\(^{17-19}\). Flores et al. (2015) found that BMI was decreased in patients with active UC but not in patients with CD, compared with healthy controls\(^{20}\). Ghoshal et al. (2008) revealed that IBD patients’ BMI was lower than that in non-IBD controls\(^{17}\). However, Mendall et al. (2011) found that obesity at diagnosis was more common in subjects with CD versus UC in support of our findings\(^{18}\). Finally, a large cohort of US women, measures of adiposity were associated with an increased risk of CD but not UC\(^{20}\). This can be related to adipocyte derived mediators such as TNF-α, IL-6 and Leptin, well-known proinflammatory mediators\(^{21}\). Obesity is associated with increased levels of intestinal inflammation as measured by stool calprotectin and has been linked to alterations in gut microbiome which in turn likely plays a role in the pathogenesis of CD\(^{22}\).

Our study results showed that diet is one of the important factors that may exert an effect on the IBD risk.

Table 3. Association between some nutrients intake and the risk of IBD

| Nutrients          | Q1(OR) | Q2(OR) | Q3(OR) | Q4(OR) |
|--------------------|--------|--------|--------|--------|
| Carbohydrate (gm) |        |        |        |        |
| UC                 | 1.37   | 0.56   | 0.99   |        |
| P-value            | 0.02   | 0.01   | 0.11   |        |
| CD                 | 0.33   | 0.39   | 0.34   |        |
| P-value            | 0.005  | 0.018  | 0.011  |        |
| Protein (gm)      |        |        |        |        |
| UC                 | 0.61   | 9.06   | 122.82 |        |
| P-value            | 0.01   | 0.001  | 0.001  |        |
| CD                 | 0.17   | 14.63  | 152.08 |        |
| P-value            | 0.012  | 0.001  | 0.001  |        |
| Fat (gm)           |        |        |        |        |
| UC                 | 1.65   | 0.36   | 1.13   |        |
| P-value            | 0.177  | 0.12   | 0.747  |        |
| CD                 | 1.45   | 0.67   | 1.52   |        |
| P-value            | 0.370  | 0.323  | 0.286  |        |
| Fiber (gm)         |        |        |        |        |
| UC                 | 2.4    | 0.19   | 1.89   |        |
| P-value            | 0.028  | 0.012  | 0.99   |        |
| CD                 | 1.87   | 0.26   | 0.24   |        |
| P-value            | 0.109  | 0.001  | 0.004  |        |
| Sugar (gm)         |        |        |        |        |
| UC                 | 2.17   | 5.59   | 5.69   |        |
| P-value            | 0.093  | 0.001  | 0.004  |        |
| CD                 | 15.61  | 20.29  | 20.36  |        |
| P-value            | 0.001  | 0.001  | -      |        |
| Monounsaturated fats (gm) |        |        |        |        |
| UC                 | 0.21   | 1.53   | 4.56   |        |
| P-value            | 0.001  | 0.228  | 0.001  |        |
| CD                 | 0.18   | 1.46   | 2.76   |        |
| P-value            | 0.001  | 0.334  | 0.017  |        |
| Cholesterol (mg)   |        |        |        |        |
| UC                 | 1.54   | 9.54   | 9.54   |        |
| P-value            | 0.348  | 0.001  | -      |        |
| CD                 | 1.57   | 26.66  | 26.66  |        |
| P-value            | 0.454  | 0.001  | -      |        |
| Caffeine (mg)      |        |        |        |        |
| UC                 | 6.72   | 0.34   | 0.80   |        |
| P-value            | 0.001  | 0.013  | 0.578  |        |
| CD                 | 4.89   | 0.46   | 0.39   |        |
| P-value            | 0.001  | 0.057  | 0.030  |        |

*Reference tertiles

b Adjusted for age, gender, BMI, smoking, physical activity, total energy intake, and education level
Participants’ food intake showed that intakes of protein and sugar among the IBD group were considerably higher than the control group. However, carbohydrate, fiber and MUFA intakes were significantly different in both UC and CD groups as compared to controls. Also, our results indicate that there was no significant difference between the three groups in total energy intake, fat, saturated fat and PUFA intakes. Moreover, we found that both UC and CD showed a higher consumption of protein than controls (P-value = 0.001). This is in agreement with Hou et al. (2011)23 and Jantchou et al. (2010)26 who reported a high total protein intake specifically animal protein to be significantly associated with increased risk of IBD. Both UC and CD groups revealed a higher consumption of sugar than controls in our study (P-value = 0.001). Sakamoto et al. (2005)4 and Racine et al. (2016)25 findings are similar to our study, they found that excess consumption of sugar and products containing refined carbohydrates appeared more in the intake of UC and CD patients than controls. Our UC patients’ carbohydrate consumption was higher than CD patients, and both of them consumed lower intake of carbohydrates than controls (P-value = 0.001). Tragnone et al. (1995) documented that a higher intake of carbohydrates was found in UC patients more than CD patients26.

Additionally, in the present study, we found that fiber consumption was different among the three groups (P-value = 0.001). CD patients consumed a lower amount of fiber compared with UC patients and controls. Hou et al. (2011) showed that the intake of high-fiber diet and fruits was associated with reduced risk for CD23. According to their results, patients with CD should increase the consumption of fiber to decrease the disease risk. MUFA consumption also was significantly different among the three groups (P-value = 0.002). UC and CD had a higher consumption of MUFA than controls which is opposite to what is expected. Geerling et al. (2000) found that MUFA consumption was associated with an increased risk to develop UC27. The mechanism of how MUFA can increase the risk is still unclear.

The IBD group showed significant higher intakes of vitamins A, D, E, B12, and C, folate, beta-carotene, retinol, calcium, potassium, iron, omega-3 and omega-6 (p < 0.05) when compared to the control group. However, the control group showed a higher intake of vitamin K and caffeine when compared to the IBD group (p < 0.05). Several studies showed that the IBD group had lower intakes of some micronutrients than the control group28-30. Interpretation of our results regarding the significant higher intakes of these vitamins, minerals, omega-3 and omega-6 can be attributed to the higher intake of protein by IBD cases which is considered the main source of calcium, fiber and iron. Additionally, this can be attributed to higher consumption of supplemental minerals and multivitamins by IBD patients.

Our study showed that IBD groups had lower consumption of caffeine than the control group, this is consistent with Owczarek et al. (2016)34 results; who found that some IBD patients avoid caffeine intake and had a lower consumption of caffeine than the control group. Additionally, Niewiadomski et al. (2016) findings are consistent with our results. They documented that high caffeine intake was protective against IBD (OR: 0.51, 95% CI: 0.3–0.87, P = 0.002)35. Although, no well-known biological mechanism is known for this association, it has been shown that caffeine can ameliorate acute colitis in intestinal epithelial cells33. They reported that high tea intake was found to be protective against CD, and both coffee and tea were protective against UC in an Asian-Pacific cohort. However, coffee was shown to be protective against UC in a twin study, although this did not remain significant after adjusting for smoking habits. Another association between coffee intake and protection against IBD proposed a role of caffeine in the repair of mucusol injury34.

The present study also showed that the IBD group had a lower dietary intake of vitamin K than the control group, this could be explained by lower consumption of fruits and vegetables by IBD group that are considered the main sources of vitamin K. Duggan et al., (2004)33 and Kuwabara et al., (2009)30 found that UC and CD had a lower dietary vitamin K consumption than control. They hypothesized that lower vitamin K consumption results from undernutrition and/or malabsorption caused by IBD and its treatments or due to lower consumption of soluble fiber which is subjected to fermentation by the intestinal colonic microflora.

This study is the first in Jordan to highlight the association between nutrients intake and risk of IBD. Our study has several notable strengths. First, the prospective study design and restriction of study population to newly diagnosed cases over the past three months avoids the potential for selection bias of a retrospective study. Second, the use of a validated Arabic FFQ that was modified to reflect food consumption pattern in Arab countries, especially Jordan add to the strength of our study Third, the use of standardized food models and measuring tools to estimate portion sizes is another point that can improve the accuracy of the collected data. And last, we confirmed all cases of CD and UC through medical record review and face to face questionnaire, a significant advantage over studies that rely on discharge codes.

Our study has several limitations. First, dietary questionnaire recalled dietary patterns in IBD patients for only one year, which is considered a quite short duration to have a significant impact on the pathophysiology of IBD. However, we believe that the recall period of one year (used in this study) is very likely reflective of the previous years, as most of participants indicated a constant dietary pattern during their last 5 years. Second,
similar to all retrospective studies, our findings do not allow us to establish causality. The third limitation was that the study may not be representative of the overall Jordanian population, but we included three large representative areas in the country, where a lot of rural areas seek medical therapy in these large referral hospitals.

In conclusion the present study provides evidence supporting the presence of an association between macro and micronutrients intake and the risk of IBD. Some macronutrients intake were higher in IBD group as protein, sugar, monounsaturated fat and cholesterol compared with controls. On the other hands, higher intake of carbohydrate and trans-fat were found more in controls compared to cases. Micronutrients intake like retinol, beta carotene, vitamin B12, vitamin C, vitamin D, vitamin E, folic acid, calcium, iron, potassium, sodium, zinc, omega 3 and 6 were found higher in IBD group compared to controls. These dietary differences may have a therapeutic impact on the future treatment of IBD, and calls for future carefully designed studies that analyze dietary characteristics, and the interplay between all dietary macro and micronutrients of interest in relation to IBD.

Competing interests:
The authors declare that they have no competing interest.

Author Contributions:
RFT and YMR participated in the study conception. TRQ participated in data collection, entry and performed statistical analysis. RFT, TRQ, AAS and YMR interpreted results and drafted the manuscript. All authors drafted the manuscript and approved it.

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