UNIWERSYTET MEDYCZNY
IM. PIASTÓW ŚLĄSKICH WE WROCŁAWIU

Alicja Szypowska

Ocena wartości wskaźnika potencjału zapalnego diet DII (ang. *dietary inflammatory index*) oraz jego związku z wybranymi parametrami antropometrycznymi oraz biochemicznymi czynnikami ryzyka wystąpienia chorób sercowo-naczyniowych w grupie mieszkańców województwa dolnośląskiego

ROZPRAWA DOKTORSKA

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Assessment of the dietary inflammatory index (DII) and its relationship with selected anthropometric parameters and biochemical risk factors for cardiovascular diseases in a group of inhabitants of the Lower Silesia

Rozprawa doktorska na stopień doktora
w dziedzinie nauk medycznych i nauk o zdrowiu
w dyscyplinie nauki o zdrowiu
przedkładana Radzie Dyscypliny Nauki o Zdrowiu
Uniwersytetu Medycznego im. Piastów Śląskich we Wrocławiu

Promotor: dr hab. Bożena Regulska-Ilow, prof. UMW

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Spis treści

1.Wykaz publikacji stanowiących rozprawę doktorską

Lp	Opis bibliograficzny	IF	Punkty
1	**Szypowska Alicja**, Regulska-Ilow Bożena, Zatońska Katarzyna, Szuba Andrzej: **Comparison of intake of food groups based on dietary inflammatory index (DII) and cardiovascular risk factors in the middle-age population of lower silesia: results of the PURE Poland study**, Antioxidants, 2023, vol. 12, nr 2, art.285 [18 s.], DOI:10.3390/antiox12020285	7,675*	100
2	**Szypowska Alicja**, Zatońska Katarzyna, Szuba Andrzej, Regulska-Ilow Bożena: **Dietary Inflammatory Index (DII)® and metabolic syndrome in the selected population of Polish adults: results of the PURE Poland sub-study, International Journal of Environmental Research and Public Health**, 2023, vol. 20, nr 2, art.1056 [14 s.], DOI:10.3390/ijerph20021056	4,614*	140
	Podsumowanie	12,289	240

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2. Streszczenie w języku polskim

Wprowadzenie: Przewlekły stan zapalny jest związany z patogenezą wielu chorób niezakaźnych, w tym chorób sercowo-naczyniowych. Dieta jest ważnym elementem w procesie zapalenia ogólnoustrojowego i nieprzypadkowo jest jednym z ważniejszych czynników rozwoju chorób sercowo-naczyniowych (ang. *cardiovascular disease*, CVD) związanych ze stylem życia. Nieodpowiednia dieta została powiązana z wszystkimi zaburzeniami metabolicznymi wchodzącymi w skład zespołu metabolicznego (ang. *metabolic syndrome*, MetS) a jego wszystkie elementy są modyfikowalnymi czynnikami ryzyka rozwoju CVD. Wprowadzenie odpowiednich zmian w stylu życia może zmniejszyć ryzyko ich wystąpienia. Autorzy DII (ang. *dietary inflammatory index*) ocenili związek produktów/składników diety z występowaniem markerów stanu zapalnego: interleukiny-1β (IL-1β), IL-4, IL-6, IL-10, czynnika martwicy nowotworów (ang. *tumor necrosis factor alpha*, TNF-α) i białka C- reaktywnego (ang. *C-Reactive Protein*, CRP). Określono czy poszczególne 45 składniki miały wpływ na wzrost (+1), spadek (-1), bądź czy nie miały wpływu (0) na wyżej wymienione markery stanu zapalnego. DII powiązano z wskaźnikami ogólnoustrojowego zapalenia oraz CVD.

Cel: Celem pracy była ocena potencjału zapalnego diet uczestników badania PURE Poland (Prospektywne Epidemiologiczne Badanie Stanu Zdrowia Ludności Miejskiej i Wiejskiej, ang. *Polish arm of the Prospective Urban and Rural Epidemiological*) a następnie ocena zależności między wartością wskaźnika DII i zawartością w diecie grup produktów spożywczych, wartością odżywczą diet oraz ocena zależności między DII a wybranymi parametrami antropometrycznymi i biochemicznymi czynnikami ryzyka wystąpienia chorób sercowo-naczyniowych. Dodatkowo oceniono związek potencjału zapalnego diet mieszkańców miasta i wsi Dolnego Śląska na podstawie wartości DII z występowaniem zespołu metabolicznego i jego składowymi.

Materiał i metody: W publikacjach wchodzących w skład rozprawy doktorskiej oceniono związek między wartością DII, a zawartością w diecie grup produktów spożywczych, wartością odżywczą tych diet, wybranymi parametrami antropometrycznymi i biochemicznymi oraz z występowaniem MetS wśród mieszkańców województwa dolnośląskiego, którzy zostali wyodrębnieni z populacji kohortowego badania międzynarodowego PURE w wieku 35-70 lat. Łączna liczba uczestników badania wyniosła 2039 osób. Z badania zostały wyłączone osoby, których diety nie spełniały kryterium odpowiedniej energetyczności diety (dla mężczyzn <800 kcal, >4200 kcal, dla kobiet <600 kcal, >3500 kcal). Dodatkowo wyłączono osoby, które nie miały wykonanych wszystkich badań biochemicznych. Do pierwszego badania zakwalifikowano 1791 osób, a do drugiego 1570. Sposób żywienia został oceniony metodą z wykorzystaniem Kwestionariusza Częstotliwości Spożycia Żywności (ang. *Food Frequency Questionnaire,* FFQ). Kwestionariusz został opracowany i zwalidowany dla populacji Dolnego Śląska z polskiej części badania PURE. W obu publikacjach do obliczenia wskaźnika DII użyto 37 składników diety/produktów, dodatkowo scharakteryzowano diety badanych w zależności od ich potencjału zapalnego.

Wśród 1791 badanych oceniono związek pomiędzy DII a płcią, wiekiem, miejscem zamieszkania, stanem cywilnym, poziomem wykształcenia, statusem palenia papierosów, statusem spożywania alkoholu, poziomem aktywności fizycznej, wskaźnikiem masy ciała (ang. *body mass index,* BMI), obwodem pasa (ang. *waist circumference*, WC), wskaźnikiem obwodu pasa do obwodu bioder (ang. *waist-hip ratio,* WHR), stężeniem we krwi cholesterolu całkowitego (ang. *total cholesterol*, TC), cholesterolu LDL (ang. *low-density lipoprotein cholesterol*, LDL-C), cholesterolu HDL (ang. *high-density lipoprotein cholesterol,* HDL-C), trójglicerydów (TG) i glukozy na czczo (ang. *fasting glucose*, FG) oraz ciśnieniem tętniczym. Na podstawie wybranych parametrów profilu lipidowego obliczono wskaźniki aterogenne (ang. *Atherogenic index of plasma,* AIP i ang. *Castelli's Risk Index*, CRI). W celu obliczenia

aterogenności całodziennych racji pokarmowych obliczono współczynnik P/S (wg wzoru: wielonienasycone kwasy tłuszczowe, ang. *polyunsaturated fatty acid,* PUFA/nasycone kwasy tłuszczowe*, ang. saturated fatty acid,* SFA). Określono grupy produktów i wartość odżywczą charakterystyczne dla każdego tercyla (T) DII przy wyłączeniu czynników zakłócających. Dodatkowo, wśród 1570 osób scharakteryzowano badaną populację w zależności od płci badanych i oceniono związek DII z występowaniem MetS. Wszystkie analizy statystyczne wykonano przy użyciu oprogramowania R (język i środowisko do obliczeń statystycznych, wersja 3.5.1. R Foundation for Statistical Computing, Wiedeń, Austria) z wyjątkiem analizy mocy, wykonanej w programie G*Power" (wersja 3.1.9.6).

Wyniki: W pierwszej pracy z cyklu**:** średni wynik DII diet uczestników badania wynosił -0,15 ± 2,89, co wskazuje na niewielki potencjał przeciwzapalny ich diet. Wartość energetyczna diet, zawartość cukrów prostych, udział energii w diecie z tłuszczów ogółem, SFA, PUFA oraz cholesterol wpływały dodatnio na wartości DII, natomiast udział energii w diecie z białka, węglowodanów ogółem, jednonienasyconych kwasów tłuszczowych (ang. *monounsaturated fatty acids,* MUFA), wartość stosunku PUFA/SFA wpływały ujemnie na wartości DII. Dieta prozapalna, określona w T3 była ujemnie związana z zawartością owoców, warzyw, nasion roślin strączkowych, napojów, niskotłuszczowego drobiu, zup, orzechów, nasion i rodzynek, herbaty w porównaniu do zawartości tych produktów w T1 (określającym dietę przeciwzapalną). Diety badanych w T3 były dodatnio związane ze spożyciem ryb, soków, rafinowanych zbóż, czerwonego mięsa, przetworzonego czerwonego mięsa i jego przetworów, wysokotłuszczowego/przetworzonego drobiu, słodyczy (ogółem i czekolady), cukru i miodu, tłuszczów bez olejów roślinnych, mleka i produktów mlecznych niskotłuszczowych, wysokotłuszczowych serów i śmietan, ziemniaków, frytek, alkoholu, jaj. Obwód pasa był istotnie wyższy wśród kobiet im dieta była bardziej prozapalna, podobną zależność zaobserwowano przy wskaźniku WHR w grupie kobiet. Stężenie TG było niższe wśród

badanych w T1 w porównaniu z T2 i T3, zaś FG były istotnie niższe wśród badanych z T1 i T2 w porównaniu z T3. Średnia wartość wskaźnika AIP wśród badanych wskazywała na zwiększone ryzyko rozwoju CVD niezależnie od tercyli DII, z kolei wartość wskaźnika CRI była optymalna wśród badanych znajdujących się w T1. Wyższe wartości obu wskaźników były w T2 i T3 w porównaniu do T1.

W drugiej pracy z cyklu: nie zaobserwowano zwiększonej częstości występowania MetS i jego składowych dla DII T3 w porównaniu do T1, z wyjątkiem wzrostu częstości występowania komponentu TG w T3 w porównaniu z T1 (OR 1,34; 95% CI = 1,01 – 1,78) w modelu niedostosowanym. W modelu dostosowanym zaobserwowano mniejszą częstość występowania komponentu nieprawidłowej glukozy na czczo w T2, w porównaniu do T1 (OR 0,71; 95% CI = 0,54 – 0,94).

Wnioski: (1) Uczestnicy badania, których diety określono jako bardziej prozapalne, mieli wyższe średnie stężenie TG, FG, wyższe wartości wskaźników aterogennych krwi wśród wszystkich badanych oraz większy obwód pasa i wskaźnik WHR wśród kobiet. **(2)** Wyżej wymienione parametry antropometryczne i biochemiczne były korzystniejsze wśród uczestników, których diety charakteryzowały się większą zawartością warzyw, owoców, orzechów, nasion, rodzynek, nasion roślin strączkowych, niskotłuszczowego drobiu, herbaty. Spożycie napojów w odniesieniu do potencjału zapalnego diety wymaga dalszych badań. **(3)** Diety badanych określone jako bardziej prozapalne były związane z wyższym spożyciem: rafinowanych produktów zbożowych, słodyczy, soków, czerwonego mięsa, wysokotłuszczowych serów i śmietany, alkoholu, tłuszczów bez olejów roślinnych, ziemniaków, cukru i miodu, frytek, smażonych ryb oraz przetworzonego/wysokotłuszczowego drobiu. Wśród tych uczestników pozostałe składniki diety tj. mleko i produkty mleczne niskotłuszczowe oraz jaja mogą być związane z ogólnie niezdrowymi nawykami/wzorami żywieniowymi, stąd ich wyższa zawartość występowała w diecie prozapalnej, jednak ich

zawartość w diecie nie powinna być uznawana za niezależny czynnik ryzyka CVD. **(4)** Nie było istotnych związków między MetS, jego składowymi i DII, obliczonego przy użyciu kwestionariusza FFQ, z wyjątkiem TG w modelu surowym. Brak związku między DII a MetS w tym badaniu może być związany z faktem, że czynniki ryzyka rozwoju chorób przewlekłych działają przez długi czas, aż do kumulacji rozwoju choroby. **(5)** Powyższe wyniki mają charakter informacyjny i stanowią istotną podstawę dla dalszych badań nad jakością diety i żywienia.

Słowa kluczowe: choroby układu krążenia, ryzyko sercowo-naczyniowe, dietetyczny wskaźnik stanu zapalnego; dieta, badanie PURE, zespół metaboliczny, stan zapalny, odżywianie

3. Streszczenie w języku angielskim (Abstract)

Introduction: Chronic inflammation is implicated in the pathogenesis of many non-communicable diseases, including cardiovascular disease (CVD). Diet is an important element in the process of systemic inflammation and it is no coincidence that it is one of the most important factors in the development of lifestyle-related cardiovascular diseases. Inadequate diet has been associated with all metabolic disorders included in the metabolic syndrome (MetS), and all its components are modifiable risk factors for the development of CVD. Making appropriate lifestyle changes can reduce the risk of their occurrence. The DII authors evaluated the association of dietary components with 6 inflammatory biomarkers i.e., interleukin-1β (IL-1β), IL-4, IL-6, IL-10, tumor necrosis factor alpha (TNF-α) and C-Reactive Protein (CRP). The inflammatory potential for each food parameter was scored according to whether it increased (+1), decreased (-1), or had no effect (0) on 6 inflammatory biomarkers. It has been linked to indicators of systemic inflammation and CVD.

Purpose: The aim of the study was to assess the inflammatory potential of participants` diets enrolled in the Polish arm of the Prospective Urban and Rural Epidemiological (PURE) study, and then to evaluate the association between the DII score with the dietary content, the nutritional value of diets and to determine the correlation of DII score with selected anthropometric parameters and biochemical risk factors for CVD. In addition, the relationship between inflammatory potential of diets of urban and rural residents of Lower Silesia based on DII with the incidence of MetS and its components was assessed.

Material and methods: Publications assessed the relationship between DII and current diet, nutritional value of diets and determined the correlation of DII score with selected anthropometric and biochemical parameters and with the incidence of MetS and its components of the inhabitants of the Lower Silesian Voivodship who were selected from the population of the PURE international cohort study aged 35-70. There were total of 2039 study participants.

Individuals who did not meet the criterion of adequate dietary energy intake (for men < 800 kcal, >4200 kcal, for women < 600 kcal, >3500 kcal) were excluded. In addition, participants were excluded from the study due to missing data for more than one variable. Finally, a total of 1791 individuals were included in the first study and 1570 in the second study. Participants' habitual food intake was assessed with the Food Frequency Questionnaire (FFQ), which was developed and validated for the population of PURE study Lower Silesia. Thirty-seven dietary food components and products were used to calculate the DII score in both publications, additionally diets were characterized depending on their inflammatory potential.

Among 1791 participants, the relationship between DII and sex, age, place of living, marital status, education, smoking, alcohol consumption, physical activity, body mass index (BMI), waist circumference (WC), waist-hip ratio (WHR), total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), triglycerides (TG), fasting glucose (FG) and blood pressure were assessed. Based on selected parameters of the lipid profile, atherogenic indexes (Atherogenic index of plasma, AIP and Castelli's Risk Index, CRI) were calculated. In order to calculate the atherogenicity of daily food rations, the polyunsaturated fatty acid (PUFA [g])/saturated fatty acid (SFA [g]) equation was used. Product groups and nutritional value specific to each tercile of DII were defined, excluding confounding factors. In addition the study group (n = 1570) was characterized according to sex and the relationship between DII and the occurrence of MetS was assessed. All statistical analyzes were performed using R software (statistical language and environment, version 3.5.1. R Foundation for Statistical Computing, Vienna, Austria) with the exception of the power analysis performed in the G*Power program (version 3.1.9.6).

Results: The first study: the mean DII score of study participants was -0.15 ± 2.89, indicating slightly anti-inflammatory potential of their diets. The energy value of diets, the intake of simple sugars, the proportion of dietary energy from total fats, SFAs, PUFAs, and

cholesterol level were reflected by positive DII scores. The proportion of dietary energy from protein, total carbohydrates, MUFAs, and the PUFA/SFA ratio was reflected by negative DII scores. Pro-inflammatory diet, defined as T3, was negatively associated with the intake of fruits, vegetables, legumes, beverages, low-fat poultry, soups, nuts, seeds, raisins, and tea compared to their intake in T1. Participants in T3 consumed more fish, juices, refined cereals, processed and unprocessed red meat, high-fat/processed poultry, sweets (including chocolate), sugar and honey, fats except for vegetable oils, low-fat milk and dairy, high-fat cheese and cream, potatoes, French fries, alcohol, and eggs. In the group of women, significantly higher WC and WHR were associated with more pro-inflammatory diets. TG concentrations were lower in T1 compared to T2 and T3. FG levels were significantly lower in T1 and T2 compared to T3. The mean value of AIP in all study participants indicated an increased risk of developing CVD regardless of the DII terciles. CRI was optimal in T1 group. Higher values of both indices were reported in T2 and T3 compared to T1.

The second study: Overall, no increased incidence of MetS and its components was observed for DII Tercile (T) 3 compared to T1, except for an increase in the incidence of the TG component of T3 compared to T1 (odds ratios [OR] 1.34; 95% confidence intervals [CI] = 1.01 to 1.78) in the unadjusted model. In the adjusted model, a lower incidence of the abnormal fasting glucose component was observed at T2 compared to T1 (OR 0.71 95% CI = 0.54 to 0.94).

Conclusions: **(1)** Among participants with pro-inflammatory diets, higher mean values of TG, FG, API, and CRI in the group of men and women, and higher WC and WHR in the group of women were reported. **(2)** Anthropometric and biochemical parameters were more favorable among study participants whose diets had higher content of vegetables, fruits, nuts, seeds, raisins, pulses, low-fat poultry, and tea. The association of beverages consumption with dietary inflammatory potential requires further study. **(3)** Study participants, whose diets were

pro-inflammatory, consumed more refined grain products, sweets, juices, red meat, high-fat cheese and cream, alcohol, fats (except for vegetable oils), potatoes, sugar and honey, French fries, fried fish, and processed/high-fat poultry. Moreover, higher consumption of milk, low-fat dairy, and eggs in study participants with pro-inflammatory diets was reported, which may be due to the fact that these food products are associated with unhealthy dietary habits. However, their consumption should not be considered as an independent CVD risk factor. **(4)** No association was found between the DII and MetS as calculated using the FFQ, except for TG in the crude model. The lack of association between DII and MetS in this study may be related to the fact that risk factors for the development of chronic diseases act for a long time, until the accumulation of disease development. **(5)** Results of this study are informative and provide an important basis for further research on the quality of diet and nutrition.

Key words: cardiovascular diseases; cardiovascular risk; dietary inflammatory index; diet; PURE study; metabolic syndrome; inflammation; nutrition

4. Wykaz stosowanych skrótów

AGE's - Advanced glycationend - products (pl., końcowe produkty glikacji)

AIP - Atherogenic index of plasma (pl., wskaźnik aterogenności osocza)

BMI - body mass index (pl., wskaźnik masy ciała)

CI - confidence intervals (pl., przedział ufności)

CRI - Castelli's Risk Index (pl., wskaźnik Castelliego)

CRP - C-Reactive Protein (pl., białko C-reaktywne)

CVD - cardiovascular disease (pl., choroby sercowo-naczyniowe)

DASH - Dietary Approaches to Stop Hypertension

DII - dietary inflammatory index (pl., dietetyczny wskaźnik stanu zapalnego)

FFQ - Food Frequency Questionnaire (pl., kwestionariusz częstotliwości spożycia żywności)

FG - fasting glucose (pl., stężenie glukozy na czczo)

H - height (pl., wysokość)

HDL-C - high-density lipoprotein (pl., lipoproteina wysokiej gęstości)

IL - interleukin (pl., interleukina)

IPAQ - International Physical Activity Questionnaire (pl., Międzynarodowy kwestionariusz aktywności fizycznej)

LDL-C - low-density lipoprotein cholesterol (pl., lipoproteina o małej gęstości)

MAPK - mitogenactivated protein kinase (pl., kinazy aktywowane mitogenami)

MET - metabolic equivalent (pl., ekwiwalent metaboliczny)

MetS - metabolic syndrome (pl., zespół metaboliczny)

MUFA - monounsaturated fatty acids (pl., jednonienasycone kwasy tłuszczowe)

NF-kB - nuclear factor-kB (pl., jądrowy czynnik transkrypcyjny NF kappa)

OR - odds ratios (pl., iloraz szans)

PUFA - polyunsaturated fatty acid (pl. wielonienasycone kwasy tłuszczowe)

PURE study - Prospective Urban and Rural Epidemiological study (pl., Prospektywne Epidemiologiczne Badanie Ludności Miejskiej i Wiejskiej)

P/S - stosunek [g] PUFA do [g] SFA

SFA - saturated fatty acid (pl., nasycone kwasy tłuszczowe)

T - tercile (pl., tercyle)

TC - total cholesterol (pl., cholesterol całkowity)

TG - triglycerides (pl., trójglicerydy)

TNF-α - tumor necrosis factor alpha (pl., czynnik martwicy nowotworów)

W - weight (pl., masa ciała)

WC - waist circumference (pl., obwód pasa)

WHR - waist-hip ratio (pl., wskaźnik pas-biodra)

5. Wprowadzenie

Przewlekły stan zapalny jest związany z patogenezą wielu chorób niezakaźnych, w tym chorób sercowo-naczyniowych (ang. *cardiovascular diseases,* CVD) [1]. CVD w Europie pozostaje najczęstszą przyczyną zgonów [2]. Na podstawie danych z 2020 roku, w Polsce z CVD było związanych 41% wszystkich zgonów wśród kobiet i 33% wśród mężczyzn [3]. Zapobieganie CVD na poziomie jednostki i populacji jest jednym z głównym wyzwań dla personelu medycznego i polityków [4,5]. W europejskich zaleceniach dotyczących profilaktyki, duży nacisk jest kładziony na działania poza farmakologiczne tj. badania przesiewowe w kierunku oceny występowania markerów lub czynników ryzyka CVD, utrzymywanie odpowiedniego poziomu aktywności fizycznej, odpowiednie modyfikacje diety, redukcję masy ciała zgodnie z wskazaniami, identyfikację palaczy, w tym porady dotyczące rzucenia palenia, rozpoznanie oraz odpowiednie leczenie nadciśnienia, hiperglikemii i hiperlipidemii [4].

Pacjenci, u których zdiagnozowano zespół metaboliczny (ang. *metabolic syndrome*, MetS) są dwukrotnie bardziej narażeni na rozwój chorób układu krążenia w przeciągu 5-10 lat i mają pięciokrotnie większe ryzyko wystąpienia cukrzycy typu 2 w przyszłości [6]. Wyróżnia się wiele czynników i mechanizmów w rozwoju MetS, w tym insulinooporność, dysfunkcję tkanki tłuszczowej, przewlekły stan zapalny, stres oksydacyjny, nieprawidłową mikrobiotę, czynniki genetyczne [6,7]. Przewlekłe zapalenie wiąże się z insulinoopornością oraz otyłością trzewną. Tkanka tłuszczowa jako narząd wydzielania wewnętrznego może uwalniać wiele bioaktywnych peptydów, w tym adiponektynę, interleukinę-6 (IL-6), rezystynę, białko wiążące retinol-4 (RBP4), leptynę i czynnik martwicy nowotworów (ang. *tumor necrosis factor alpha*, TNF-α). Rozregulowanie aktywności tkanki tłuszczowej wiąże się z nadmiernym wydzielaniem szkodliwych adipokin i niedostatecznym wydzielaniem korzystnych [8,9]. Czynnikiem wyzwalającym powyższe procesy może być dieta wysokoenergetyczna i związana z tym śmierć komórek, które wywołują miejscowy stan zapalny [7,10]. Nieodpowiednia dieta

została powiązana z wszystkimi zaburzeniami metabolicznymi które obejmują MetS, a jego wszystkie składowe są modyfikowalnymi czynnikami ryzyka rozwoju CVD, co oznacza, że wprowadzenie odpowiednich zmian w stylu życia może zmniejszyć ryzyko ich wystąpienia [11,12].

Dieta jest ważnym elementem w procesie zapalenia ogólnoustrojowego i nieprzypadkowo jest jednym z ważniejszych czynników rozwoju CVD związanych ze stylem życia [5]. Najlepiej przebadaną dietą, równocześnie o działaniu przeciwzapalnym jest dieta Śródziemnomorska. Zalecane jest prewencyjne stosowanie powyższej diety (lub diety DASH, ang. *Dietary Approaches to Stop Hypertension*) w celu redukcji ryzyka CVD [4,13]. Na podstawie badań epidemiologicznych wykazano, że zdrowe wzorce żywieniowe, tj. duże spożycie owoców, warzyw, nasion roślin strączkowych, produktów pełnoziarnistych, ryb, niskotłuszczowego nabiału, a także grup produktów bogatych w przeciwutleniacze i kwasy tłuszczowe omega-3 były związane ze zmniejszeniem stanu zapalnego o niskim stopniu nasilenia, stresu oksydacyjnego a także z poprawą funkcji śródbłonka [14–17]. Podczas gdy dieta, określona jako zachodnia, bogata w żywność wysoko przetworzoną, węglowodany proste, produkty zbożowe rafinowane, czerwone przetworzone mięso, żywność bogatą w nasycone kwasy tłuszczowe i sód była związana z przewlekłym stanem zapalnym [18,19].

Wskaźnik DII (ang. *dietary inflammatory index*) został opracowany w celu określenia potencjału zapalnego diet i powiązano go z wskaźnikami ogólnoustrojowego zapalenia [21,22] oraz CVD [23–25]. Powyższy wskaźnik został opracowany na podstawie światowego piśmiennictwa z okresu od 1950 roku do 2010, łącznie autorzy DII przeanalizowali 1943 artykuły z 45 wyselekcjonowanymi składnikami diety [20]. Autorzy DII ocenili związek produktów/składników diety z występowaniem markerów stanu zapalnego (IL-1β, IL-4, IL-6, IL-10, TNF-α i białka C-reaktywnego [ang. *C-Reactive Protein*, CRP]). Określono czy

poszczególne 45 składników diety miało wpływ na wzrost (+1), spadek (-1), bądź czy nie miały wpływu (0) na wyżej wymienione markery stanu zapalnego [20].

Istnieje niewiele badań z udziałem populacji polskiej, w której określono potencjał zapalny diet badanych. Szczegółowe określenie poszczególnych grup produktów w zależności od potencjału zapalnego diety wydaje się być kluczowe, w celu formułowania odpowiednich zaleceń żywieniowych. W badaniu Sokol i wsp. [26], oceniono zależności między DII i komponentami MetS wśród populacji polskiej, która znajduje się w południowo-wschodniej części kraju (województwo świętokrzyskie), natomiast to badanie dotyczy populacji polskiej będącej z regionu południowo-zachodniego (województwo dolnośląskie).

Dodatkowo nie ma wielu badań, w których wykorzystano by markery kardiometaboliczne do porównania związków z DII w populacji europejskiej. Biorąc pod uwagę fakt, że Polska jest krajem wysokiego ryzyka wystąpienia CVD [4], użycie narzędzi nieinwazyjnych, konkretnych, szybkich dla zidentyfikowania osób z wysokim ryzykiem rozwoju CVD wydaje się być niezwykle ważne [27]. Wskaźniki: *Atherogenic Index of Plasma* (AIP) oraz *Castelli risk indexes* (CRI) zostały stworzone do prognozowania aterogenności i zdarzeń sercowo-naczyniowych [27,28]. Ostatnie badania obejmujące dane z *National Health and Nutrition Examination Survey* wykazały, że AIP był silniejszym predyktorem ryzyka sercowo-naczyniowego niż *individual cholesterol risk factors* [29].

6. Cel pracy

Celem pierwszej publikacji była ocena potencjału zapalnego diet uczestników badania PURE Poland a następnie ocena zależności między wartością wskaźnika DII i zawartością w diecie grup produktów, wartością odżywczą diety ocenianej na podstawie DII oraz ocena zależności między DII a wybranymi parametrami antropometrycznymi i biochemicznymi czynnikami ryzyka wystąpienia chorób sercowo-naczyniowych.

Celem drugiej publikacji była ocena związku potencjału zapalnego diet mieszkańców miasta i wsi Dolnego Śląska na podstawie wartości wskaźnika DII z występowaniem MetS i jego składowymi. Dodatkowo scharakteryzowano diety badanych w zależności od tercyli DII.

7. Materiał i metody

7.1 Charakterystyka grupy badanej

Prospektywne Epidemiologiczne Badanie Ludności Miejskiej i Wiejskiej (ang. *Prospective Urban Rural Epidemiological,* PURE) to kohortowe badanie międzynarodowe, w którym początkowo uczestniczyło 153 996 osób dorosłych z 17 krajów o niskich, średnich i wysokich dochodach. Polacy zostali zaliczeni do krajów o średnich dochodach. Łączna liczba uczestników badania wynosiła 2039 osób. Kryterium włączenia do badania stanowił wiek 35-70 lat, miejsce stałego pobytu w mieście lub na wsi w województwie dolnośląskim. Do polskiej części badania zakwalifikowano uczestników za pośrednictwem ogłoszeń radiowych i telewizyjnych. Kryterium wyłączenia z badania były osoby, których diety nie miały odpowiedniej energetyczności (dla mężczyzn <800 kcal, >4200 kcal, dla kobiet <600 kcal, >3500 kcal [32]) oraz które nie miały pełnych danych medycznych dotyczących badanych zmiennych. Łącznie, do określenia wartości wskaźnika przeciwzapalnego diet badanych i związków z CVD zakwalifikowano 1791 osób (publikacja pierwsza), a do określenia wartości wskaźnika przeciwzapalnego diet badanych i związków z MetS zakwalifikowano 1570 osób (publikacja druga).

7.2 Pomiar czynników ryzyka sercowo-naczyniowego

Dla oceny czynników ryzyka CVD wykorzystano następujące parametry: stężenie glukozy na czczo (ang. *fasting glucose*, FG), trójglicerydów (TG), lipoprotein o dużej gęstości (ang. *high-density lipoprotein cholesterol*, HDL-C), cholesterolu całkowitego (ang. *total cholesterol*, TC), lipoprotein o niskiej gęstości (ang. *low-density lipoprotein cholesterol*, LDL-C), ciśnienie tętnicze krwi skurczowe i rozkurczowe, obwód pasa (ang. *waist*

circumference, WC), wskaźnik BMI (ang. *body mass index*), stosunek obwodu pasa do obwodu bioder (ang. *waist-to-hip ratio,* WHR).

FG, TG, HDL-C, TC badano w próbkach krwi żylnej. Do zmierzenia stężenia HDL-C i TG wykorzystano metodę enzymatyczną, tj. test SPINREACT (Sant Esteve De Bas, Girona, Spain). Obliczenie stężenia cholesterolu LDL wykonano za pomocą wzoru Friedewalda (LDL- C = TC – HDL-C – TG/5), wykorzystując wcześniej oznaczone: TC, HDL-C, TG (dla wyników TG niższych niż 400 mg/dl). FG mierzono po całonocnym poście za pomocą *Ascensia Entrust Glucometer* (Bayer, Germany). Powyższe zmienne były wyrażone w mmol/l z wyjątkiem FG, która była wyrażona w mg/dl. Ciśnienie krwi skurczowe i rozkurczowe mierzono za pomocą certyfikowanego cyfrowego ciśnieniomierza (Omron HEM-711 IntelliSense, Tokyo, Japan) i wyrażono w mmHg. Przed badaniem ciśnienia krwi, polecono pacjentom odpoczynek przez 5 minut. W badaniu PURE uwzględniono średnie wartości ciśnienia tętniczego krwi, mierzone dwukrotnie u każdego uczestnika. WC mierzono w punkcie środkowym pomiędzy dolnym brzegiem łuku żebrowego i górnym grzebieniem kości biodrowej, za pomocą standardowej taśmy pomiarowej z dokładnością do 0,5 cm. Wysokość ciała (ang. *height*, H) mierzono bez butów, z dokładnością do 0,5 cm przy użyciu stadiometru. Masę ciała (ang. *weight,* W) mierzono bez butów i szat wierzchnich, za pomocą analizatora masy ciała Tanita BC-554 (Japonia) z dokładnością do 0,1 kg. Wskaźnik BMI został obliczony na podstawie masy ciała w kilogramach i wzrostu w metrach, wg wzoru: BMI = W (kg)/H^2(m^2). Obwód bioder mierzono w najszerszym rozciągnięciu bocznym bioder i wyrażono w centymetrach z dokładnością 0,5 cm. Stosunek pasa do bioder (ang. *waist-to-hip ratio,* WHR) obliczono dzieląc obwód pasa przez obwód bioder.

7.3 Obliczanie wskaźników aterogenności krwi

Na podstawie parametrów profilu lipidowego obliczono wskaźniki aterogenne AIP i CRI. AIP obliczono kolejno wg. wzoru log (TG [mg/dl]/HDL-C[mg/dl]), gdzie wyniki <0,11 wskazywał na niskie, 0,11-0,21 na umiarkowane, a >0,21 na zwiększone ryzyko rozwoju CVD. CRI obliczono z wzoru: TC [mg/dl]/HDL-C[mg/dl], gdzie wyniki <3,5 oznaczały niskie, 2,5-4,5 umiarkowane, a >4,5 wysokie ryzyko CVD [33].

7.4 Obliczanie wskaźnika aterogenności diety

W celu obliczenia aterogenności całodziennych racji pokarmowych obliczono współczynnik P/S, wg wzoru: PUFA g/SFA g (wg wzoru: wielonienasycone kwasy tłuszczowe, ang. *polyunsaturated fatty acid*, PUFA/nasycone kwasy tłuszczowe, ang. *saturated fatty acid,* SFA). Przy założeniu, że PUFA stanowią minimalnie 6% udziału energii w diecie, a SFA 10%, wartość współczynnika minimalna powinna wynosić 0,6, natomiast optymalna powinna wynosić powyżej 1 [34,35].

7.5 Definicja zespołu metabolicznego

Definicja MetS została określona zgodnie z *International Diabetes Federation/U.S.* Do rozpoznania MetS zastosowano zharmonizowane kryteria *National Heart, Lung, and Blood Institute/American Heart Association/World Heart Federation* dla MetS [6], obejmujące obecność trzech lub więcej kryteriów:

- FG ≥ 5.6 mmol/l (100 mg/dl) lub leczenie farmakologiczne podwyższonego stężenia glukozy;
- ciśnienie skurczowe ≥130 mmHg lub rozkurczowe ≥85 mmHg lub leczenie lekami hipotensyjnymi wcześniej rozpoznanego nadciśnienia tętniczego;
- HDL-C <1,0 mmol/l (40 mg/dl) u mężczyzn i <1,3 mmol/l (50 mg/dl) u kobiet lub historia leczenia farmakologicznego tych nieprawidłowości;

- WC ≥80 cm u kobiet i ≥ 94 cm u mężczyzn [6].

7.6 Ocena sposobu żywienia

Sposób żywienia został oceniony na podstawie Kwestionariusza Częstotliwości Spożycia Żywności (ang. *Food Frequency Questionnaire,* FFQ), który został opracowany i walidowany dla populacji Dolnego Śląska z polskiej części badania PURE [36]. Częstość spożycia w kwestionariuszu określono za pomocą 10 możliwości, tj.: nigdy, mniej niż raz w miesiącu; 1 - 3 razy w miesiącu, 1 raz w tygodniu, 2 - 4 razy w tygodniu, 5 - 6 razy w tygodniu, 1 raz dziennie, 2 - 3 razy dziennie, 4 - 5 razy dziennie, > 6 razy dziennie. Powyższy FFQ był specyficzny dla badanego kraju, uwzględniający jego kulturę. FFQ odnosił się do spożycia produktów w ciągu roku poprzedzającego badanie. Określono w nim częstotliwość spożycia 154 produktów. Wartość odżywcza diet została obliczona na podstawie „Tabel wartości odżywczej produktów spożywczych i potraw" [37]. W celu oceny średniej wielkości porcji żywności użyto „Album fotografii produktów i potraw" [38]. Dokładny opis FFQ oraz jego standaryzacja zostały opisane wcześniej [39].

7.7 Czynniki demograficzne

Miejsce zamieszkania zaklasyfikowano do kategorii: wieś lub miasto, wykształcenie: podstawowe/nieznane lub zawodowe, średnie/licealne oraz wyższe. Do obliczenia aktywności fizycznej wykorzystano Międzynarodowy kwestionariusz aktywności fizycznej (ang. *International Physical Activity Questionnaire,* IPAQ) i wyrażono go jako ekwiwalent metaboliczny minut na tydzień (MET) i podzielono na 3 kategorie: niewystarczającej (poniżej 600), dostatecznej (600–3000) lub wysokiej (powyżej 3000 MET) [40]. Status palenia papierosów określono w 3 kategoriach: nigdy, w przeszłości i obecnie.

7.8 Obliczanie dietetycznego wskaźnika stanu zapalnego (DII)

Wskaźnik DII stanowi algorytm, który pozwala na klasyfikację diet w zależności od ich potencjału zapalnego. Do pracy wykorzystano zmodyfikowaną i uaktualnioną wersję obliczania DII, przedstawioną przez Shivappę i wsp. [20]. Dokładny opis zaktualizowanego wskaźnika został opisany w autorskiej publikacji [20]. DII został opracowany na podstawie światowego piśmiennictwa od 1950 do 2010 roku, łącznie autorzy DII przeanalizowali 1943 artykuły z 45 wyselekcjonowanymi składnikami diety. Shivappa i wsp. [20] ocenili związek produktów/składników diety z występowaniem markerów stanu zapalnego (IL-1β, IL-4, IL-6, IL-10, TNF-α i CRP). Określono czy poszczególne 45 składników miały wpływ na wzrost (+1), spadek (-1), bądź czy nie miały wpływu (0) na wyżej wymienione markery stanu zapalnego. Dodatkowo autorzy DII [20] obliczyli światowe dzienne spożycie poszczególnych składników diety/produktów, wraz z odchyleniem standardowym, na podstawie analizy danych z 11 krajów świata (USA, Australia, Królestwo Bahrajnu, Dania, Indie, Japonia, Nowa Zelandia, Tajwan, Korea Południowa, Meksyk, Wielka Brytania). Spożycie składników diety/produktów przez uczestników badania z województwa dolnośląskiego było odnoszone do wyżej opisanego aktualnego średniego spożycia na świecie na podstawie obliczonego parametru *z-score*. Ten parametr został obliczony poprzez odjęcie od wartości określającej dzienne spożycie składników diety/produktów badanych, wartości określającej dzienne średnie światowe spożycie tego składnika/produktu, które było podane w autorskiej publikacji. Następnie uzyskany wynik został podzielony przez odchylenie standardowe, określone dla dziennego światowego spożycia, co miało na celu standaryzację wyników. Uzyskane wartości dla każdego z badanych zamieniano na perecentyle, a przedział wartości przeskalowano z 0-1 do -1-1. Zmodyfikowane w powyższy sposób wartości mnożono przez całkowite końcowe efekty pro- i antyzapalne dla poszczególnych składników diety/produktów. Następnie wszystkie wyniki dla diet badanych zsumowano. Uzyskane wyższe wyniki wskazywały na bardziej prozapalny

charakter diety, a im więcej wartości ujemnych tym diety oceniano jako bardziej antyzapalne. W autorskiej publikacji zakres uzyskanych wyników mieścił się w przedziale od 7,98 (maksymalnie prozaplane) do -8,87 (maksymalnie przeciwzapalne) [20].

Do obliczenia wskaźnika DII użyto 37 składników diety/produktów, w tym: 29 składników przeciwzapalnych: MUFA, PUFA, kwasy tłuszczowe n-3, n-6, błonnik pokarmowy, alkohol, witaminy: A, D, E, C and B_6, β-karoten, tiamina, ryboflawina, niacyna, kwas foliowy, magnez, selen, cynk, flavan-3-ole, flawony, flawonole, flawonony, antocyjanidyny, izoflawony, kofeina, czosnek, cebula, zielona/czarna herbata oraz 8 elementów prozapalnych: węglowodany, białko, tłuszcz ogółem, SFA, kwasy tłuszczowe typu trans, cholesterol, żelazo i witamina B_{12}. Zastosowano metodę gęstości składników odżywczych, przeliczając składniki DII na 1000 kcal, w celu zmniejszenia wpływu zróżnicowanej energetyczności diet badanych [41]. Uczestnicy badania zostali podzieleni na tercyle, w zależności od potencjału zapalnego ich diet, określonego na podstawie DII: T1 (diety badanych o niskim potencjale zapalnym), T2 (diety o średnim potencjale zapalnym) oraz T3 (diety o wysokim potencjale zapalnym).

7.9 Obliczenia statystyczne

W dwóch publikacjach zmienne nominalne przedstawiono jako n (% grupy), zmienne ciągłe jako średnią ± SD lub medianę (T1; T3). Normalność rozkładu w podgrupach oceniono za pomocą testu Kołmogorowa-Smirnowa, wartości skośności i kurtozy oraz na podstawie wizualnej oceny histogramów. W pierwszej publikacji wykonano wieloczynnikowe modele regresji liniowej dostosowane do zmiennych: wieku, płci, miejsca zamieszkania, stanu cywilnego, wykształcenia, palenia, alkoholu, aktywności fizycznej i BMI. DII włączono do modeli regresji zarówno jako zmienną ciągłą, jak i czynnikową (tercyle). Dodatkowo przeprowadzono test trendu liniowego uwzględniający wartość mediany dla każdego tercyla DII jako zmienną ciągłą w modelu regresji i po dostosowaniu do wyżej wymienionych

współzmiennych, co jest powszechnym podejściem w kilku badaniach o podobnej tematyce [42-45].

W drugiej publikacji zastosowano analizę regresji logistycznej w celu określenia ilorazów szans (ang. *odds ratios,* ORs) z 95% przedziałami ufności (CIs) dla zespołu metabolicznego i jego składowych zgodnie z tercylami DII. Dolny tercyl DII (T1) został użyty jako kategoria odniesienia. Określono zarówno modele jednowymiarowe, jak i wielowymiarowe. Modele wieloczynnikowe obejmowały wiek, płeć, miejsce zamieszkania, poziom wykształcenia, poziom aktywności fizycznej, palenie tytoniu i BMI jako potencjalne czynniki zakłócające.

Wszystkie testy były dwustronne z poziomem istotności 0,05. Wymienione powyżej analizy przeprowadzono przy użyciu oprogramowania R (Język i środowisko do obliczeń statystycznych, wersja 3.5.1. R Foundation for Statistical Computing, Wiedeń, Austria).

W pierwszej publikacji wykonano dodatkowo analizę mocy za pomocą oprogramowania G*Power (wersja 3.1.9.6), którą przeprowadzono w odniesieniu do jednokierunkowej analizy ANOVA z efektem stałym i regresji liniowej. Do obliczeń przyjęto poziom istotności statystycznej $\alpha = 0,05$, N (liczba próby) = 1791, k (liczba podgrup) = 3, jednakowa liczebność podgrup (n = 597). W teście mocy ANOVA wykorzystano wielkość efektu f, która jest zdefiniowana jako: $f = \sigma_m/\sigma$, gdzie σ_m jest odchyleniem standardowym średniej grupy μ_i, a σ wspólnym odchyleniem standardowym w obrębie k grup. Analiza mocy została obliczona na 97%, czyli znacznie więcej niż 80% uznawane za powszechnie akceptowalny poziom mocy [46]. Wielkość efektu w regresji wielokrotnej wyraża się jako $f^2 = V_S/V_E$, gdzie V_S jest proporcją wariancji wyjaśnioną przez zestaw predyktorów, a V_E jest resztą błędu wariancji ($V_E + V_S = 1$). Proporcja wyjaśnionej wariancji jest określona przez $V_S = R^2$, a wariancja resztkowa przez $V_E = 1 – R^2$. Analiza mocy została obliczona na 99,5%, czyli znacznie więcej niż 80% uznawane za powszechnie akceptowalny poziom mocy [47].

8. Publikacje

8.1 Publikacja nr 1

Alicja Szypowska, Bożena Regulska – Ilow, Katarzyna Zatońska, Andrzej Szuba

“Comparison of Intake of Food Groups Based on Dietary Inflammatory Index (DII) and Cardiovascular Risk Factors in the Middle-Age Population of Lower Silesia: Results of the PURE Poland Study”

antioxidants

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Article

Comparison of Intake of Food Groups Based on Dietary Inflammatory Index (DII) and Cardiovascular Risk Factors in the Middle-Age Population of Lower Silesia: Results of the PURE Poland Study

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Abstract: Chronic inflammation is involved in the pathogenesis of many non-infectious diseases, including cardiovascular diseases (CVD), a leading cause of death in Europe. The aim of the study was to assess the inflammatory potential of the diets of participants enrolled in the Polish arm of the Prospective Urban and Rural Epidemiological (PURE) study, evaluate the association between the dietary inflammatory index (DII) score with the dietary content, and to determine the correlation of DII score with selected anthropometric parameters and biochemical risk factors for CVD. Diets were assessed with the Food Frequency Questionnaire (FFQ). Among participants with pro-inflammatory diets, we reported higher mean values of triglycerides (TG), fasting glucose (FG), atherogenic index of plasma (AIP), and the Castelli's risk index (CRI) in the group of men and women, and higher waist circumference (WC) and waist-to-hip ratio (WHR) in the group of women. Pro-inflammatory diets were associated with higher intake of refined grains, sweets, juices, red meat, high-fat cheese and cream, alcohol, fats except for vegetable oils, potatoes, sugar and honey, French fries, fried fish, and processed/high-fat poultry. Moreover, study participants with pro-inflammatory diets consumed more milk, low-fat dairy, and eggs associated with unhealthy dietary habits, but this should not be considered as an independent CVD risk factor. Anthropometric and biochemical outcomes were more favorable among study participants who consumed more vegetables, fruits, nuts, seeds, raisins, pulses, low-fat poultry, and tea. However, association of beverage consumption with dietary inflammatory potential requires further study.

Keywords: cardiovascular diseases; cardiovascular risk; dietary inflammatory index; diet; PURE study

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1. Introduction

Chronic inflammation is involved in the pathogenesis of many non-infectious diseases, including cardiovascular diseases (CVD) [1], a leading cause of death in Europe [2]. Based on 2020 data, CVD in Poland was associated with 41% of all deaths among women and 33% among men [3]. Preventing CVD on individual and population levels is one of the main challenges for medical personnel and policy makers [4,5]. The European Society of Cardiology (ESC) guidelines on CVD prevention put a great emphasis on non-pharmacological interventions, i.e., screening for CVD markers and risk factors, maintaining adequate exercise, diet modifications, weight reduction, identifying smokers and providing advice on smoking cessation, diagnosing, and appropriate treatment of hypertension, hyperglycemia, and hyperlipidemia [4].

Diet is one of the most important lifestyle factors in the development of CVD as it can increase systemic inflammation [5]. The Mediterranean diet is the best studied diet

in the world. It has been found that preventive use of a Mediterranean diet (or a Dietary Approaches to Stop Hypertension-DASH diet) reduces the risk factors for CVD [4,6]. Results of epidemiological studies showed that healthy dietary patterns, i.e., a high intake of fruits, vegetables, legumes, whole grains, fish, low-fat dairy, and foods rich in antioxidants (omega-3 fatty acids, flavonoids) is associated with a reduction of low-grade inflammation, oxidative stress, and improved endothelial function [7–10]. On the other hand, consumption of the Western-pattern diets, which is characterized by high intakes of highly processed foods, simple carbohydrates, refined grains, red processed meats, and foods rich in saturated fatty acids and sodium, has been associated with chronic inflammation [11,12].

Dietary inflammatory index (DII) is a scoring algorithm based on an extensive review of the literature from 1950 to 2010. In total, DII authors reviewed 1943 articles with 45 selected food parameters. Dietary inflammatory index score, developed to indicate the inflammatory potential of a diet, can be associated with systemic inflammation [13,14] and CVD indicators [15–17]. The DII authors evaluated the association of dietary components with six inflammatory biomarkers i.e., interleukin-1β (IL-1β), IL-4, IL-6, IL-10, tumor necrosis factor alpha (TNF-α), and C-Reactive Protein (CRP). The inflammatory potential for each food parameter was scored according to whether it increased (+1), decreased (−1), or had no effect on the six inflammatory biomarkers [18].

Shivappa et al. [19] reported a 36% increased risk of CVD incidence and mortality among individuals with the highest DII scores (pro-inflammatory diet) compared to individuals with the lowest DII scores (anti-inflammatory diet). Despite the well-studied association between inflammatory biomarkers and chronic inflammation-related disease endpoints, the relationship between DII and intermediate biomarkers of cardiometabolic health remains largely unknown.

A recent meta-analysis showed that adherence to a pro-inflammatory dietary pattern had a significant positive association with 27 (71%) of the included health outcomes ($p < 0.005$), however Class I evidence was identified only for myocardial infarction along with a higher, i.e., more pro-inflammatory DII score. The strength of evidence was limited for most health outcomes so there is a need for further research [20].

Recently, only a few studies have analyzed the association between the DII score and cardiometabolic markers in the European population [15–17]. Given the fact that Poland was classified as a country at high-risk of CVD [4], it is of utmost importance to use non-invasive, concrete, rapid tools to identify individuals at high risk of developing CVD [21]. Besides, detailed identification of specific food groups according to their inflammatory potential seems relevant to formulate appropriate dietary recommendations. The Atherogenic index of plasma (AIP) and Castelli's Risk Index (CRI) have been developed to estimate the risk of CVD [21,22]. A recent study including data from the National Health and Nutrition Examination Survey indicated that AIP may be a stronger predictor of cardiovascular risk than individual cholesterol risk factors [23].

The aim of the study was to assess the inflammatory potential of the diets of participants enrolled in the Polish arm of the Prospective Urban and Rural Epidemiological (PURE) study, evaluate the association between the DII score with the dietary content, and to determine the correlation of DII score with selected anthropometric parameters and biochemical risk factors for CVD.

2. Materials and Methods

2.1. Study Population

The PURE study is an international cohort study which at baseline involved 153,996 adults from 17 countries with different income levels. The Polish participants of the PURE study were low-, middle- and high-income Polish adults. The inclusion criteria for the survey were: age between 35–70 and a permanent place of residence in an urban or rural area of the Lower Silesia in Poland. Individuals were recruited to the Polish arm of the PURE study through the radio and television announcements. The aim of the study was to calculate

the association between the urbanization level and CVD prevalence and risk factors. The main results of the study have been previously published [24,25]. The first stage of the study was conducted between 2007 and 2009 and included a food frequency questionnaire (FFQ), blood draw, blood pressure measurements, spirometry, and anthropometric measurements. There was a total of 2039 study participants. Individuals who did not meet the criterion of adequate dietary energy intake (for men < 800 kcal, >4200 kcal, for women < 600 kcal, >3500 kcal) were excluded. The above criteria were established in accordance with recommendations [26]. In addition, participants were excluded from the study due to missing data for more than one variable. Finally, a total of 1791 individuals were included in the study.

2.2. Measurement of Cardiovascular Risk Factors

The concentrations of fasting glucose (FG), triglycerides (TG), high-density lipoprotein (HDL-C), and total cholesterol (TC) were measured in venous blood samples. SPINREACT enzymatic test kit (Sant Esteve De Bas, Girona, Spain), was used to measure HDL-C and TG concentrations. If participants had a TG concentration lower than 400 mg/dL, low-density lipoprotein cholesterol (LDL-C) was calculated based on the Friedewald equation (LDL-C = TC − HDL-C − TG/5). Fasting glucose was measured after an overnight fasting period with the Ascensia ENTRUST Glucometer kit (Bayer, Germany). The above variables were expressed in mmol/L except for FG, which was expressed in mg/dL. Systolic and diastolic blood pressure was measured with a certified automatic blood pressure monitor (Omron HEM-711 IntelliSense, Tokyo, Japan) and expressed in mmHg. Study participants were recommended to rest for 5 min before blood pressure measurement. In the PURE study, blood pressure was measured twice. Waist circumference (WC) was measured midway between the lowest rib and the upper iliac crest, with a standard measuring tape, to the nearest 0.5 cm. Height (H) was measured without shoes, with a stadiometer, and recorded to the nearest 0.5 cm. Weight (W) was measured without shoes or outer garments to the nearest 0.1 kg using a body composition monitor Tanita BC-554 (Japan). Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared, according to the equation: BMI = W(kg)/H^2(m^2). Hip circumference was measured at the level of the largest lateral extension of the hips and expressed in centimeters to the nearest 0.5 cm. Waist-to-hip ratio (WHR) was calculated as WC divided by hip measurement.

2.3. Atherogenic Lipid Indices

Lipid profile parameters were used to calculate the atherogenic indices (AIP and CRI). The AIP was calculated as log TG (mg/dL)/HDL-C(mg/dL), where results <0.11 indicated low, 0.11–0.21 moderate, and >0.21 increased risk of CVD. Castelli's risk index was calculated as TC[mg/dL]/HDL-C[mg/dL], where results <3.5 indicated low, 2.5–4.5 moderate, and >4.5 high risk of CVD [27].

2.4. Atherogenic Diet Index

To calculate the atherogenicity of daily food rations, we used the polyunsaturated fatty acid (PUFA)g/saturated fatty acid (SFA)g equation. Assuming that dietary intake of PUFAs should not be less than 6% of a person's total energy consumption and of SFAs up to 10%, the minimum value of the ratio should be 0.6, and the optimal ratio be above 1.0 [28,29].

2.5. Dietary Intake Assessment

Participants' habitual food intake was assessed with the FFQ, which was developed and validated for the population of PURE study Lower Silesia [30]. The frequency of consumption of selected foods was assessed with 10 possible responses: never, less than once a month; 1–3 times a month, once a week, 2–4 times a week, 5–6 times a week, once a day, 2–3 times a day, 4–5 times a day, and >6 times a day. The FFQ, which was country- and culture-specific, asked about the average consumption during the year preceding

the survey and assessed the frequency of consumption of 154 food products, which were divided into 27 food groups (Table 1). The nutritional value of diets was calculated using Polish national food composition tables [31]. The "Album of photographs of food products and dishes" by the National Food and Nutrition Institute in Warsaw was used to determine the average size of the consumed portion [32]. The FFQ and its standardization have been described previously [33].

Table 1. Characteristics of the food groups.

No.	Food Groups	FFQ Dietary Products
1.	Milk and low-fat dairy	Low-fat milk, 1–2% fat, milk, 3.2% fat, buttermilk, 0.5% fat, cocoa with milk, cottage cheese, quark, fresh cheese, low-fat yoghurt, yogurt, 2–8% fat, kefir
2.	High-fat cheese and cream	Feta cheese, hard cheese, cheese, "fromage" naturel, cheese, Edam type, fat, cream, 12% fat, cream, 18% fat
3.	Fats without oils	Margarine, soft, butter, lard, Finea/Masmix, mayonnaise
4.	Fruits	Apple, banana, grapefruit, grapes, tangerine, strawberries, kiwi fruit, lemon, orange, peach, pear, plum, raspberries
5.	Vegetables	Beets, cooked, broccoli, green, cabbage, red (raw), cabbage, Shantung, cabbage, white (raw), cabbage, white (boiled), carrot (fresh), carrot (boiled), cauliflower (raw), cauliflower (boiled with butter), chives, cucumber (raw), garlic (raw), lettuce, mushroom (fried), onion (raw), parsley, leaves, horseradish, pepper (cooked), pepper, red (raw), radish, tomato (raw), tomato (cooked), tomato sauce, spinach (cooked), squash, summer (cooked), string beans (boiled),sweet corn (canned, drained), shantung cabbage, salad with mayonnaise, sauerkraut salad, lettuce with sour cream salad
6.	Legumes	Beans, white (boiled), peas green (canned, drained)
7.	Chips	Potato (French fried)
8.	Potatoes	Potato (boiled), potato (mashed)
9.	Red meat	Beef steaks, pork, belly (no bone, boiled), pork cutlets (breaded, fried), organ meat (liver, tongue, heart), beef and pork minced cutlets (fried)
10.	Processed red/mixed meat	Beef, ham (cooked), Frankfurter/Hotdog, luncheon meat (pork), pork ham sausage Slaska (pork, cooked), sausage Krakowska (pork and beef), sausage Biala (pork), sausage Szynkowa (turkey), Head Cheese, white and black chicken pate (canned)
11.	Low-fat poultry	Low-fat poultry Chicken without skin (cooked/fried), turkey (roasted)
12.	High-fat/processed poultry	Chicken fillets (breaded, fried), chicken ham, chicken with skin (cooked/fried), turkey, ham
13.	Fish	Cod fillets (breaded and fried), herring in cream, mackerel (smoked)
14.	Unrefined grains	Rye, brown bread, wheat-rye bread with sunflower seeds, pasta (cooked), buckwheat groats (boiled), pearl barley groats (boiled), soup, milk with rolled oats
15.	Refined grains	Wheat bread, rice (boiled), wheat rolls (kajzerki), wheat rolls (wroclawskie), wheat-rye bread/white bread, cold cereal (cornflakes)
16.	Mixed dishes	Baked beans with meat, cabbage leaves, stuffed, Polish dumplings, with meat, sauerkraut with sausage and meat (bigos, stewed), dumplings with potato filling (Ruskie, boiled), vegetable salad (cooked with mayonnaise)
17.	Soups	Broth, soup with vegetables, soup, Krupnik with pearl barley groats, soup, Zurek sour rye, soup, tomato, soup, sauerkraut, soup, white bean
18.	Juices	Orange juice, carrot juice, apple juice, grapefruit juice, blackcurrant juice, multifruit juice from Polish fruits, multifruit juice from exotic fruits
19.	Beverages	Raspberry juice, fruits drink, soft drink (regular), soft drink (low calorie)
20.	Alcohol	Beer, red wine, vodka
21.	Sweets	Ice cream, biscuits, yeast cake, short-cake, gingerbread cake, sponge cake, cheesecake (Krakowski), halva with vanilla, drops, sweets
22.	Chocolate	Bitter chocolate, milk chocolate
23.	Sugar and honey	Honey, sugar
24.	Nuts, seeds and raisins	Nuts, raisins, dried, seeds, walnuts
25.	Eggs	Eggs boiled/fried
26.	Coffee	Coffee
27.	Tea	Tea, green/herb, Tea, black

2.6. Demographic Factors

Place of residence was classified as rural or urban and education: elementary/unknown, trade, and secondary/high school or university. The International Physical Activity Questionnaire (IPAQ) was used to calculate physical activity and expressed as metabolic equivalent minutes per week. The number of metabolic equivalent (MET)-min/week lower than 600 was considered low, 600–3000—moderate, and above 3000—high [34]. Smoking status was classified into 3 categories: non-smoker, ex-smoker, and current smoker.

2.7. Calculation of Dietary Inflammatory Index

The DII is an algorithm developed to categorize various diets according to their inflammatory potential. A modified and updated version of DII calculation designed by Shivappa et al. [18] was used in this study. A detailed description of the updated DII has been previously described [18]. DII was compiled based on an extensive review of the literature from 1950 to 2010. In total, DII authors reviewed 1943 articles with 45 selected food parameters. Authors of DII evaluated the association of dietary components with 6 inflammatory biomarkers (IL-1β, IL-4, IL-6, IL-10, TNF-α and CRP). The inflammatory potential for each food parameter was scored according to whether it increased (+1), decreased (−1), or had no effect on 6 inflammatory biomarkers. Authors of DII calculated the global daily average intake of each dietary food product, along with the standard deviation, based on 11 data sets from around the world (USA, Australia, the Kingdom of Bahrain, Denmark, India, Japan, New Zealand, Taiwan, South Korea, Mexico, and United Kingdom). Dietary intake of the DII components was compared to the standard global as a Z-score, which was achieved by subtracting the standard mean from the amount reported and dividing this value by its standard deviation [18]. Then, this value was converted to a centered percentile score. To achieve a symmetrical distribution with values centered on 0 (null) and bounded between −1 (maximally anti-inflammatory) and +1 (maximally pro-inflammatory), each percentile score was doubled and then '1' was subtracted. The centered percentile values were then multiplied by the overall pro- and anti-inflammatory effect score for each dietary component. Finally, all results were summed. Higher scores indicated that the diet was more pro-inflammatory, and lower DII scores represented a more anti-inflammatory diet. Results ranged from 7.98 (maximally pro-inflammatory) to −8.87 (maximally anti-inflammatory) [18]. Thirty-seven dietary food components and products were used to calculate the DII score, including: 29 anti-inflammatory elements: monounsaturated fatty acids (MUFAs), PUFAs, n-3 fatty acids, n-6 fatty acids, fiber, alcohol, vitamins A, D, E, C, and B_6, β-carotene, thiamine, riboflavin, niacin, folic acid, magnesium, selenium, zinc, flavan-3-ol, flavones, flavonols, flavonones, anthocyanidins, isoflavones, caffeine, garlic, onion, green/black tea, and 8 pro-inflammatory elements: carbohydrates, protein, total fat, SFAs, trans fat, cholesterol, iron, and vitamin B_{12}. Energy-adjusted values (the nutrient density method) were used to decrease the influence of different energy intakes among study participants [35].

2.8. Statistical Analysis

Nominal variables are presented as n (% of group), continuous variables as mean ± SD or median (tercile [T]1; T3). Normality of distribution in subgroups was evaluated using Kolmogorov–Smirnov test, skewness, and kurtosis values, and based on visual assessment of histograms. Subgroups based on DII terciles were created. Comparison of parameters between DII tercile groups was made using chi-square test for nominal variables and with one-way ANOVA or Kruskal–Wallis test for continuous variables (as appropriate). Post-hoc test (Tukey test for ANOVA and Dunn test for Kruskal–Wallis test) was used with Bonferroni correction for multiple comparisons. Multivariate linear regression models were used adjusting for covariates: age, sex, place of living, marital status, education, smoking, alcohol, physical activity, and BMI. DII was included in regression models as both continuous and factorial variables (terciles). Additionally, we carried out a test for linear trend including the median value for each DII tercile as a continuous variable in the regression model and after adjusting for above mentioned covariates, which is a common approach in several studies from similar topics [36–39]. All tests were two-tailed with a significance level of 0.05. Statistical analysis was conducted using R software (A language and environment for statistical computing, version 3.5.1. R Foundation for Statistical Computing, Vienna, Austria).

The power analysis was performed in relation to one-way ANOVA with fixed effect and linear regression. Statistical significance level $\alpha = 0.05$, N (sample size) = 1791, k (number of subgroups) = 3, equal size of subgroups (n = 597) was assumed for calculation.

It was conducted using the software G*Power (version 3.1.9.6). In the ANOVA power test, the effect size f was used, which is defined as: $f = \sigma_m/\sigma$, where σ_m is the standard deviation of the group mean μ_i and σ, the common standard deviation within k groups. The power analysis was calculated as 97%, which is much higher than 80%, considered commonly acceptable power level [40]. The effect size in the multiple regression is expressed as $f^2 = V_S/V_E$, where V_S is the proportion of variance explained by a set of predictors, and V_E is the residual of error variance ($V_E + V_S = 1$). The proportion of variance explained is given by $V_S = R^2$ and the residual variance by $V_E = 1 - R^2$. The power analysis was calculated as 99.5%, which is much higher than 80%, considered commonly acceptable power level [41].

3. Results

The mean DII score of study participants was −0.15 ± 2.89, indicating slightly anti-inflammatory potential of their diets. The minimum DII score (anti-inflammatory) was −7.85, and the maximum DII score (pro-inflammatory) was 7.32 (unset data). Table 2 presents socioeconomic and lifestyle characteristics of 1791 study participants who were divided into terciles, according to the inflammatory potential of diets estimated by DII. Differences were reported in mean DII scores, gender, place of residence, education, smoking status, alcohol consumption, and physical activity level. The remaining data were not considered statistically significant.

Table 2. Characteristics of 1791 participants of PURE Poland study population by dietary inflammatory index (DII) terciles.

	Total Group n = 1791	**Tercile 1 n = 597**	**Tercile 2 n = 597**	**Tercile 3 n = 597**	*p*
DII, mean ± SD	−0.15 ± 2.89	−3.37 ± 1.44	−0.15 ± 0.77	3.06 ± 1.34	<0.001
Sex, n (%)					
Female	1120 (62.5)	446 (74.7)	372 (62.3)	302 (50.6)	<0.001
Male	671 (37.5)	151 (25.3)	225 (37.7)	295 (49.4)	
Age, years, mean ± SD	54.61 ± 9.80	54.87 ± 8.63	54.35 ± 9.38	54.62 ± 11.21	0.656
Place of living, n (%)					
Rural	699 (39.0)	115 (19.3)	236 (39.5)	348 (58.3)	<0.001
Urban	1092 (61.0)	482 (80.7)	361 (60.5)	249 (41.7)	
Marital status, n (%)					
Married/living together	1334 (74.5)	435 (72.9)	449 (75.3)	450 (75.4)	0.290
Never married	129 (7.2)	54 (9.0)	41 (6.9)	34 (5.7)	
Separated/divorced/widowed	327 (18.3)	108 (18.1)	106 (17.8)	113 (18.9)	
Education, n (%)					
Primary/trade	538 (30.0)	96 (16.1)	170 (28.5)	272 (45.6)	<0.001
Secondary and high secondary	703 (39.3)	234 (39.2)	263 (44.1)	206 (34.5)	
University	550 (30.7)	267 (44.7)	164 (27.5)	119 (19.9)	
Smoking, n (%)					
Currently Uses Tobacco Products	372 (20.8)	108 (18.1)	121 (20.3)	143 (24.0)	0.029
Formerly Used Tobacco Products	570 (31.8)	210 (35.2)	195 (32.7)	165 (27.6)	
Never Used Tobacco Products	849 (47.4)	279 (46.7)	281 (47.1)	289 (48.4)	
Alcohol, n (%)					
Currently use alcohol products	1237 (69.1)	426 (71.4)	404 (67.7)	407 (68.2)	0.001
Formerly used alcohol products	177 (9.9)	44 (7.4)	51 (8.5)	82 (13.7)	
Never used alcohol products	377 (21.0)	127 (21.3)	142 (23.8)	108 (18.1)	
Physical activity, n (%)					
Low and moderate	505 (28.2)	202 (33.8)	170 (28.5)	133 (22.3)	<0.001
High	1286 (71.8)	395 (66.2)	427 (71.5)	464 (77.7)	

Tercile groups compared with chi-square test for nominal variables and with ANOVA analysis for age.

Table 3 presents the nutritional value and food groups according to DII terciles. The average energy value, simple sugars, the proportion of energy from fats, SFAs, PUFAs, and cholesterol were significantly higher in T3 compared to T1. In contrast, the proportion of

energy from protein, carbohydrates, and MUFAs was significantly higher in T1 compared to T3.

Table 3. Nutrients intake and food groups according to the terciles of the dietary inflammatory index (DII) among 1791 participants of PURE Poland study population.

Parameter	Total Group	Tercile 1	Tercile 2	Tercile 3	*p*	Post-Hoc
Nutrients intake						
Energy (kcal/day)	2032.03 ± 657.34	1660.31 ± 529.41	2011.53 ± 614.86	2424.26 ± 588.61	<0.001	1 < 2 < 3
Fiber (g/day)	30.72 ± 11.52	30.61 ± 11.92	31.13 ± 12.37	30.41 ± 10.16	0.542	
Sugars (g/day)	91.58 ± 40.27	77.00 ± 32.90	89.68 ± 38.54	108.08 ± 42.59	<0.001	1 < 2 < 3
Protein intake (% energy)	15.08 ± 2.12	15.55 ± 2.17	15.08 ± 2.11	14.61 ± 1.97	<0.001	1 > 2 > 3
Total fat intake (% energy)	31.99 ± 5.75	29.41 ± 5.09	31.63 ± 5.29	34.94 ± 5.46	<0.001	1 < 2 < 3
Carbohydrates intake (% energy)	54.32 ± 6.77	57.12 ± 6.72	54.61 ± 6.24	51.22 ± 5.98	<0.001	1 > 2 > 3
SFA (% energy)	12.37 ± 3.48	10.61 ± 2.58	12.02 ± 3.15	14.47 ± 3.49	<0.001	1 < 2 < 3
PUFA (% energy)	10.87 ± 2.13	10.11 ± 2.13	10.83 ± 2.00	11.69 ± 1.96	<0.001	1 < 2 < 3
MUFA (% energy)	4.99 ± 1.04	5.11 ± 1.16	5.02 ± 1.01	4.83 ± 0.92	<0.001	1 > 2, 3
PUFA/SFA	0.44 ± 0.15	0.51 ± 0.16	0.44 ± 0.13	0.36 ± 0.12	<0.001	1 > 2 > 3
Cholesterol (mg/day)	277.62 ± 128.53	203.33 ± 86.87	260.44 ± 97.41	369.10 ± 135.54	<0.001	1 < 2 < 3
Food groups						
Fruits (g/day)	293.44 ± 184.37	332.84 ± 201.11	297.71 ± 185.60	249.79 ± 154.02	<0.001	1 > 2 > 3
Vegetables (g/day)	281.40 ± 175.17	340.01 ± 206.55	273.11 ± 172.99	231.10 ± 116.29	<0.001	1 > 2 > 3
Legumes (g/day)	17.38 (5.57;17.38)	12.14 (5.57;17.38)	17.38 (5.57;17.38)	17.38 (5.57;23.95)	0.154	
Fish (g/day)	13.11 (6.56;17.56)	9.84 (6.56;16.98)	13.11 (6.56;17.56)	13.70 (9.84;20.84)	<0.001	1, 2 < 3
Beverages (g/day)	49.18 (16.39;250.00)	35.71 (0.00;266.39)	49.18 (16.39;212.82)	52.11 (16.39;212.82)	0.436	
Juices (g/day)	101.29 (32.79;178.57)	81.97 (16.39;139.93)	101.29 (35.71;172.72)	114.75 (49.18;214.29)	<0.001	1 < 2 < 3
Refined grains (g/day)	75.57 ± 62.94	41.53 ± 46.20	73.79 ± 57.32	111.39 ± 63.49	<0.001	1 < 2 < 3
Unrefined grains (g/day)	63.96 ± 47.54	65.64 ± 46.07	67.13 ± 51.99	59.12 ± 43.89	0.008	1, 2 > 3
Red meat (g/day)	25.95 ± 16.63	20.64 ± 14.40	26.92 ± 17.15	30.30 ± 16.76	<0.001	1 < 2 < 3
Processed red/mixed meat (g/day)	46.04 ± 33.16	31.24 ± 23.75	43.99 ± 29.88	62.89 ± 36.58	<0.001	1 < 2 < 3
Low-fat poultry (g/day)	6.56 (0.00;14.29)	8.52 (1.97;14.29)	8.52 (1.97;14.29)	6.56 (0.00;14.29)	<0.001	1, 2 > 3
High-fat/processed poultry (g/day)	43.11 ± 31.39	33.43 ± 25.90	42.03 ± 30.73	53.88 ± 33.66	<0.001	1 < 2 < 3
Mixed dishes (g/day)	32.79 (19.67;40.52)	26.23 (13.11;39.34)	32.79 (19.67;40.52)	32.79 (20.84;41.69)	<0.001	1 < 2, 3
Soups (g/day)	244.50 ± 138.77	241.87 ± 156.71	253.30 ± 142.95	238.33 ± 112.77	0.150	
Sweets without chocolate (g/day)	38.04 ± 28.82	25.09 ± 20.40	36.37 ± 26.39	52.67 ± 31.57	<0.001	1 < 2 < 3
Chocolate (g/day)	6.56 (3.28;7.14)	3.28 (0.00;7.14)	6.56 (3.28;7.14)	6.56 (3.28;10.42)	<0.001	1 < 2 < 3
Sugar and honey (g/day)	16.64 ± 15.78	10.52 ± 12.30	16.96 ± 15.47	22.46 ± 16.90	<0.001	1 < 2 < 3
Fats without oils (g/day)	19.81 ± 15.75	11.18 ± 7.94	17.31 ± 12.31	30.94 ± 18.04	<0.001	1 < 2 < 3
Milk and low-fat dairy	152.14 (72.83;290.46)	117.50 (57.75;238.21)	147.86 (65.74;285.71)	190.27 (98.14;339.15)	<0.001	1 < 2 < 3
High-fat cheese and cream	33.97 ± 24.25	24.19 ± 19.39	33.36 ± 23.70	44.36 ± 24.98	<0.001	1 < 2 < 3
Potatoes	82.13 ± 57.09	72.09 ± 54.85	86.40 ± 57.60	87.90 ± 57.52	<0.001	1 < 2, 3
Chips	0.00 (0.00;7.54)	0.00 (0.00;7.54)	0.00 (0.00;7.54)	7.54 (0.00;16.43)	<0.001	1 < 2 < 3
Nuts, seeds and raisins	10.36 (1.43;14.69)	11.02 (5.44;18.20)	10.36 (2.57;14.80)	6.06 (0.00;11.24)	<0.001	1 > 2 > 3
Alcohol	12.13 (0.00;49.67)	12.13 (0.00;47.14)	12.13 (0.00;47.14)	15.45 (0.00;56.45)	0.436	
Eggs	19.29 (6.43;19.29)	6.43 (2.95;19.29)	6.43 (6.43;19.29)	19.29 (6.43;19.29)	<0.001	1 < 2 < 3
Coffee	326.77 ± 264.55	344.47 ± 270.43	303.35 ± 251.89	332.47 ± 269.65	0.022	1 > 2
Tea	427.18 ± 321.04	429.33 ± 344.07	431.27 ± 323.93	420.93 ± 293.56	0.840	

Data presented as mean ± SD or median (tercile [T1];T3), depending on data distribution. Tercile groups compared with ANOVA analysis or Kruskal–Wallis test. For ANOVA-post-hoc Tukey test was applied, for Kruskal–Wallis test-post-hoc Dunn test was applied. PUFA: Polyunsaturated fatty acid, MUFA: Monounsaturated fatty acid, and SFA: Saturated fatty acid. To calculate DII scores, energy-adjusted values (the nutrient density method) were used to decrease the influence of different energy intakes among study participants.

The average PUFA/SFA ratio was most favorable in T1 compared to T3. Diets of study participants in T1 had the highest content of fruits, vegetables, nuts, seeds, and raisins compared to T3, and the lowest content of juices, refined cereals, processed and unprocessed red meat, high-fat/processed poultry, sweets (total) and chocolate, fats except for vegetable oils, low-fat milk and dairy, high-fat cheese and cream, potatoes, French fries, and eggs. The content of unrefined cereals and low-fat poultry was similar in T1 and T2, and lower in T3. The content of mixed meals and potatoes was similar in T2 and T3. More fish was consumed by study participants in T3 compared to T1 and T2.

Coffee consumption was higher in T1 compared to T2. The remaining components were considered not statistically significant.

Table 4 presents the relationships between participants' diets and DII scores, taking into account confounding factors (age, sex, place of living, marital status, education, smoking status, alcohol, physical activity, and BMI). The energy value of the diets, the intake of simple sugars, the proportion of dietary energy from total fats, SFAs, PUFAs, and cholesterol level were reflected by positive DII scores. The proportion of dietary energy from protein, total carbohydrates, MUFAs, and the PUFA/SFA ratio was reflected by negative DII scores.

Table 4. Associations between dietary inflammatory index (DII) and diet ingredients in total study group.

Parameter	DII Continuous [a,d]			DII Terciles [b,d]			*p*-Trend [c,d]
	β	95%CI for β	*p*	T1	T2: β (95%CI)	T3: β (95%CI)	
Nutrients intake							
Energy (kcal/day)	0.002	0.0018 to 0.0022	<0.001	Ref.	328.93 (261.65 to 396.22)	729.40 (657.38 to 801.41)	<0.001
Fiber (g/day)	0.01	−0.003 to 0.018	0.183	Ref.	0.81 (−0.52 to 2.15)	0.71 (−0.72 to 2.14)	0.336
Sugars (g/day)	0.02	0.019 to 0.025	<0.001	Ref.	12.83 (8.41 to 17.25)	31.29 (26.56 to 36.02)	<0.001
Protein intake (% energy)	−0.21	−0.27 to −0.15	<0.001	Ref.	−0.41 (−0.66 to −0.17)	−0.86 (−1.12 to −0.60)	<0.001
Total fat intake (% energy)	0.19	0.17 to 0.21	<0.001	Ref.	2.09 (1.49 to 2.71)	5.29 (4.63 to 5.94)	<0.001
Carbohydrates intake (% energy)	−0.14	−0.16 to −0.12	<0.001	Ref.	−2.31 (−3.08 to −1.58)	−5.42 (−6.20 to −4.64)	<0.001
SFA (% energy)	0.39	0.36 to 0.42	<0.001	Ref.	1.53 (1.17 to 1.88)	4.09 (3.71 to 4.47)	<0.001
PUFA (% energy)	0.33	0.27 to 0.39	<0.001	Ref.	0.48 (0.25 to 0.71)	1.12 (0.87 to 1.36)	<0.001
MUFA (% energy)	−0.46	−0.57 to −0.34	<0.001	Ref.	−0.19 (−0.31 to −0.07)	−0.48 (−0.60 to −0.35)	<0.001
PUFA/SFA	−8.27	−8.96 to −7.58	<0.001	Ref.	−0.08 (−0.09 to −0.06)	−0.18 (−0.19 to −0.16)	<0.001
Cholesterol (mg/day)	0.01	0.011 to 0.013	<0.001	Ref.	46.68 (34.44 to 58.91)	144.62 (131.53 to 157.72)	<0.001
Food groups							
Fruits (g/day)	−0.002	−0.002 to −0.001	<0.001	Ref.	−22.80 (−43.77 to −1.83)	−55.41 (−77.85 to −32.97)	<0.001
Vegetables (g/day)	−0.003	−0.003 to −0.002	<0.001	Ref.	−46.47 (−65.77 to −27.16)	−67.78 (−88.44 to −47.12)	<0.001
Legumes (g/day)	−0.007	−0.01 to 0.001	0.082	Ref.	−1.52 (−3.43 to 0.38)	−2.37 (−4.41 to −0.34)	0.023
Fish (g/day)	0.01	0.0003 to 0.02	0.045	Ref.	−0.25 (−1.48 to 0.98)	1.41 (0.09 to 2.72)	0.035
Beverages (g/day)	−0.001	−0.0007 to 0.001	0.084	Ref.	−47.96 (−88.17 to −7.76)	−44.49 (−87.52 to −1.45)	0.045
Juices (g/day)	0.002	0.001 to 0.002	0.001	Ref.	13.84 (−1.69 to 29.37)	25.83 (9.21 to 42.45)	0.002
Refined grains (g/day)	0.017	0.015 to 0.019	<0.001	Ref.	25.51 (19.07 to 31.94)	57.28 (50.39 to 65.17)	<0.001
Unrefined grains (g/day)	−0.001	−0.003 to 0.002	0.582	Ref.	4.19 (−1.34 to 9.71)	−0.87 (−6.78 to 5.05)	0.759
Red meat (g/day)	0.03	0.02 to 0.04	<0.001	Ref.	4.89 (3.05 to 6.73)	7.57 (5.59 to 9.54)	<0.001
Processed red/mixed meat (g/day)	0.03	0.02 to 0.03	<0.001	Ref.	8.37 (4.98 to 11.77)	22.75 (19.12 to 26.38)	<0.001
Low-fat poultry (g/day)	−0.02	−0.03 to −0.01	0.001	Ref.	−0.16 (−1.44 to 1.11)	−1.99 (−3.36 to −0.63)	0.004
High-fat/processed poultry (g/day)	0.02	0.017 to 0.024	<0.001	Ref.	6.44 (2.98 to 9.90)	16.17 (12.47 to 19.87)	<0.001
Mixed dishes (g/day)	0.01	0.001 to 0.01	0.024	Ref.	3.24 (0.82 to 5.66)	2.09 (−0.50 to 4.68)	0.119
Soups (g/day)	−0.001	−0.002 to 0.001	0.071	Ref.	2.59 (−13.58 to 18.75)	−19.62 (−36.93 to −2.32)	0.025
Sweets without chocolate (g/day)	0.04	0.03 to 0.04	<0.001	Ref.	10.57 (7.51 to 13.63)	26.01 (22.74 to 29.29)	<0.001
Chocolate (g/day)	0.05	0.04 to 0.06	<0.001	Ref.	4.55 (3.08 to 6.02)	7.96 (6.39 to 9.53)	<0.001
Sugar and honey (g/day)	0.05	0.04 to 0.05	<0.001	Ref.	5.39 (3.66 to 7.14)	10.03 (8.17 to 11.89)	<0.001
Fats without oils (g/day)	0.09	0.09 to 0.10	<0.001	Ref.	5.27 (3.74 to 6.79)	18.47 (16.83 to 20.10)	<0.001
Milk and low-fat dairy (g/day)	0.003	0.003 to 0.004	<0.001	Ref.	48.32 (24.79 to 71.84)	120.85 (95.68 to 146.03)	<0.001
High-fat cheese and cream (g/day)	0.04	0.03 to 0.05	<0.001	Ref.	10.55 (7.93 to 13.18)	22.58 (19.77 to 25.39)	<0.001
Potatoes (g/day)	0.005	0.003 to 0.007	<0.001	Ref.	13.22 (6.66 to 19.79)	16.19 (9.18 to 23.22)	<0.001
Chips (g/day)	0.06	0.04 to 0.07	<0.001	Ref.	1.13 (0.18 to 2.08)	3.46 (2.45 to 4.47)	<0.001
Nuts, seeds and raisins (g/day)	−0.006	−0.01 to 0.01	0.075	Ref.	0.65 (−1.56 to 2.87)	−2.55 (−4.92 to −0.17)	0.034
Alcohol (g/day)	0.002	0.001 to 0.003	0.002	Ref.	10.70 (−2.91 to 24.32)	22.06 (7.49 to 36.64)	0.003
Eggs (g/day)	0.04	0.03 to 0.04	<0.001	Ref.	1.04 (−0.62 to 2.70)	6.29 (4.52 to 8.08)	<0.001
Coffee (g/day)	−0.003	−0.01 to 0.001	0.895	Ref.	−37.19 (−66.59 to −7.80)	−4.94 (−36.41 to 26.52)	0.779
Tea (g/day)	−0.0004	−0.001 to −0.00001	0.046	Ref.	−14.60 (−51.96 to 22.76)	−44.22 (−84.21 to −4.24)	0.030

[a] Models with DII as a continuous variable. DII was included into each model as an independent variable with diet parameters as dependent variables (one model for one dependent parameter); [b] Models with DII as a factorial parameter with 3 terciles (Tercile 1 as a baseline); [c] p-trend determined through the median approach; [d] All models adjusted for age, sex, place of living, marital status, education, smoking, alcohol, physical activity, and BMI. Coding of covariates was according to categories in Table 2.

Pro-inflammatory diet, defined as T3, was negatively associated with the intake of fruits, vegetables, legumes, beverages, low-fat poultry, soups, nuts, seeds, raisins, and tea compared to their intake in T1. Participants in T3 consumed more fish, juices, refined cereals, processed and unprocessed red meat, high-fat/processed poultry, sweets (including chocolate), sugar and honey, fats except for vegetable oils, low-fat milk and dairy, high-fat cheese and cream, potatoes, French fries, alcohol, and eggs.

Table 5 compares DII scores with anthropometric, biochemical, and atherogenic risk factors for CVD. In the group of women, significantly higher WC and WHR were associated with more pro-inflammatory diets. TG concentrations were lower in T1 compared to T2 and T3. FG levels were significantly lower in T1 and T2 compared to T3. The mean value of AIP in all study participants indicated an increased risk of developing CVD regardless of the DII tercile. CRI was optimal in T1 group. Higher values of both indices were reported in T2 and T3 compared to T1.

Table 5. Comparison of anthropometric, biochemical, and atherogenic risk factors of 1791 participants of PURE Poland study population by dietary inflammatory index (DII) terciles.

Parameter		Total Group	Tercile 1	Tercile 2	Tercile 3	*p*	Post-Hoc
Systolic blood pressure, mmHg		145.32 ± 21.39	146.36 ± 21.21	145.30 ± 21.67	144.31 ± 21.27	0.253	
Diastolic blood pressure, mmHg		85.87 ± 11.24	86.06 ± 10.80	86.12 ± 11.65	85.43 ± 11.25	0.508	
Waist circumference, cm	Females	88.15 ± 13.53	87.35 ± 12.80	87.20 ± 13.29	89.90 ± 14.33	0.009	1, 2 < 3
	Males	99.23 ± 12.49	98.06 ± 11.97	99.53 ± 10.96	100.10 ± 14.27	0.206	
WHR	Females	0.84 ± 0.08	0.83 ± 0.07	0.83 ± 0.08	0.85 ± 0.08	<0.001	1, 2 < 3
	Males	0.96 ± 0.07	0.96 ± 0.08	0.96 ± 0.07	0.96 ± 0.08	0.858	
BMI, kg/m^2		28.07 ± 5.06	28.23 ± 5.14	27.92 ± 4.81	28.06 ± 5.24	0.579	
TC, mmol/L		5.07 ± 1.00	5.05 ± 1.01	5.08 ± 0.99	5.08 ± 0.99	0.839	
TG, mmol/L		1.40 ± 0.74	1.32 ± 0.70	1.43 ± 0.78	1.43 ± 0.74	0.009	1 < 2, 3
HDL-C, mmol/L	Females	1.61 ± 0.40	1.62 ± 0.40	1.63 ± 0.40	1.59 ± 0.40	0.321	
	Males	1.33 ± 0.33	1.32 ± 0.28	1.30 ± 0.31	1.37 ± 0.37	0.089	
Fasting glucose, mg/dL		96.00 (88.00;105.00)	94.00 (87.00;104.00)	95.00 (88.00;105.00)	97.00 (89.00;107.00)	0.001	1, 2 < 3
LDL-C, mmol/L		2.92 ± 0.92	2.88 ± 0.91	2.93 ± 0.92	2.95 ± 0.92	0.423	
Atherogenic index of plasma (AIP)		0,28 ± 0.28	0,25± 0.28	0,30 ± 0.28	0,31 ± 0.28	<0.001	1 < 2, 3
Castelli's Risk Index (CRI)		3.56 ± 1.09	3.42 ± 1.05	3.61 ± 1.08	3.66 ± 1.11	<0.001	1 < 2, 3

Data presented as mean ± SD or median (T1;T3), depending on data distribution. Tercile groups compared with ANOVA analysis or Kruskal–Wallis test. For ANOVA—post-hoc Tukey test was applied, for Kruskal–Wallis test—post-hoc Dunn test was applied. WHR—waist-hip ratio; BMI—body mass index; TC—total cholesterol; HDL-C—HDL cholesterol; LDL-C—LDL cholesterol; and TG—triglycerides.

4. Discussion

We evaluated the DII score to determine anti- and proinflammatory potential of a diet (its energy value, proportion of energy from carbohydrates, proteins and fats, content of dietary fiber, and cholesterol) in the context of CVD risk among residents of Lower Silesia. According to the 2021 European Society of Cardiology (ESC) [4] guidelines on CVD prevention, replacing SFAs with unsaturated fatty acids is associated with a reduced risk of coronary heart disease (CHD) [42–44]. Long-chain fatty acids found in vegetable oils, i.e., palm oil (palmitic acid, C16:0), and in meat and dairy (palmitic acid and stearic acid, C18:0), have been reported to activate a number of inflammatory pathways, including mitogen-activated protein kinase (MAPK), high activation of the nuclear factor-kB (NF-kB), and activator protein (AP)-1, which directly increases expression of toll-like receptors (TLRs), leading toward an increased local and peripheral inflammation [10].

We reported a higher proportion of energy intake from SFAs in most pro-inflammatory diets ($\beta = 4.09$ CI_{95} [3.71; 4.47], $p < 0.001$) which amounted to 14.47%. Similar results were reported by other authors using the DII score calculation [16,45–47]. A higher proportion of SFAs in pro-inflammatory diets (T3) can be related to the higher content of non-vegetable fats ($\beta = 18.47$ CI_{95} [18.63; 20.10], $p < 0.001$), which contribute to a higher risk of CHD [4]. In addition, the PUFA/SFA ratio was the least favorable in T3, i.e., 0.36 ± 0.12/1, and its higher values were negatively correlated with pro-inflammatory diet ($\beta = -0.18$ CI_{95} [−0.19; 0.16], $p < 0.001$) compared to DII in T1. The optimal PUFA/SFA ratio should be above 1.0 [28,29]. Lower levels of SFAs in the diet are associated with decreased consumption of foods high in dietary cholesterol whose higher intake increased with the inflammatory potential of the diet (T3 vs. T1 $\beta = 144.62$ CI_{95} [131.53; 157.72], $p < 0.001$). However, current guidelines no longer recommend an upper limit for dietary cholesterol intake, but rather focus on adopting healthy dietary patterns (e.g., the Mediterranean-style and DASH diets) which are inherently low in cholesterol [48]. In other studies based on DII score calculation, higher

cholesterol intake was associated with a pro-inflammatory diet [45–47]. Similarly, dietary intake of eggs should be estimated according to the dietary pattern, because observations on egg consumption may be associated with other dietary components. Eggs can be consumed as part of an unhealthy dietary pattern, such as the Western pattern diet. In this study, eggs were associated with an overall unhealthy diet (T1 compared to T2 β = 6.29 CI_{95} [−4.52; 8.08], $p < 0.001$), similarly in other studies [49,50].

It is recommended to limit intake of added sugars to less than 10% of the daily total energy intake [51,52]. Higher intake of added sugars is associated with poorer diet quality, because consuming energy-dense foods low in nutrients leads to overweight and obesity that, in turn, increase the risk of type 2 diabetes and CVD [52]. Besides, higher intake of fructose causes dysbiosis of the microbiota, leading to an increased permeability of the gut barrier [53]. In this study, the intake of simple sugars was higher in T3 compared to T1 (β = 31.29 CI_{95} [26.56; 36.02], $p < 0.001$). The Mean daily intake of foods containing simple sugars was positively associated with T3 compared to T1, respectively: sweets except for chocolate (β = 26.01 CI_{95} [22.74; 29.29]; $p < 0.001$), juices (β = 25.83 CI_{95} [9.21; 42.54], $p = 0.002$), sugar and honey (β = 10.03 CI_{95} [8.17; 11.89], $p < 0.001$), and chocolate (β = 7.96 CI_{95} [6.39; 9.53], $p < 0.001$), which was consistent with the results of other studies using the DII score calculation [38,54].

Fruits, vegetables, and whole grain products are particularly recommended due to their high nutritional value. They are rich dietary sources of carotenoids, vitamin C, flavonoids, fiber, potassium, and magnesium [7,8]. Their higher intake is associated with lower serum CRP levels and a lower risk of elevating other pro-inflammatory markers [10]. In our study using the DII score calculation, participants' diets indicated as more pro-inflammatory (T3) were negatively associated with fruits and vegetables intake compared to diets indicated as more anti-inflammatory (T1) (β = −55.41 CI_{95} [−77.85; −32.97], $p < 0.001$, β = −67.78 CI_{95} [−88.44; −47.12], $p < 0.001$, respectively), which is consistent with other studies using DII calculations [16,38,45,47,54]. Potatoes and French fries, which were not classified as vegetables, were positively associated with a pro-inflammatory diet (T3 vs. T1, respectively: β = 16.19 CI_{95} [9.18; 23.22], $p < 0.001$; β = 3.46 CI_{95} [2.45; 4.47], $p < 0.001$). Potatoes, rich in amylopectin starch, have a high glycemic index (GI) and load. The American Heart Association (AHA) guidelines state that dietary patterns rich in fruits and vegetables, with the exception for potatoes, are associated with a reduced risk of CVD [5].

Similarly, refined grains were positively associated with T3 compared to T1 (β = 57.28 CI_{95} [50.39;65.17], $p < 0.001$). Refined grains contain less dietary fiber, vitamins and minerals than their whole grain counterparts, have a higher GI, and may increase inflammation [10,38,50].

In addition, a pro-inflammatory diet was positively associated with processed red/mixed meat (β = 22.75 CI_{95} [19.12; 26.38], $p < 0.001$), high fat/processed poultry (β = 16.17 CI_{95} [12.47; 19.87], $p < 0.001$, respectively), and red meat (β = 7.57 CI_{95} [5.59; 9.54], $p < 0.001$), which is consistent with other studies using DII calculations [38,45,47,50]. According to the 2021 ESC guidelines on CVD prevention, consumption of processed and unprocessed meat was associated with a higher risk of atherosclerotic cardiovascular disease (ASCVD) by, respectively, 7% and 3% [52]. Besides, their lower consumption is additionally beneficial due to salt intake reduction [4]. In this study, among all types of meat products, the pro-inflammatory diet (T3) was negatively associated with low-fat poultry, a recommended protein source in healthy dietary patterns (T3 compared to T1 β = −1.99 CI_{95} [−3.66; −0.63], $p = 0.004$) [55].

The 2021 AHA [5] dietary guidance to improve cardiovascular health recommends choosing mostly protein from plants (legumes and nuts). In our study, mean intake of legumes and nuts was negatively associated with the pro-inflammatory diet compared to the anti-inflammatory diet (respectively: β = −2.37 CI_{95} [−4.41; 0.34], $p = 0.023$ and β = −2.55 CI_{95} [−4.92; −0.17], $p = 0.034$), similarly in other studies [16,45,50]. Most legumes contain phytochemicals: bioactive compounds, including enzyme inhibitors, phytohemagglutinins (lectins), phytoestrogens, oligosaccharides, saponins, and phenolic

compounds, which may provide health benefits, protecting against diseases or disorders such as CVD and inflammation [56]. The most abundant and active isoflavone in soy is genistein, which acts as a natural selective estrogen receptors-β modulator and positively regulates some cardiovascular risk markers [57]. Squadrito et al. [58] in a randomized trial, including 120 postmenopausal women with metabolic syndrome (MetS), found that one year of treatment with genistein improved surrogate endpoints associated with risk for diabetes and CVD. Among three prospective cohorts of US men and women, a higher intake of isoflavones and tofu was associated with a moderately lower risk of developing CHD (isoflavones: pooled hazard ratio [HR] comparing the extreme quintiles: 0.87 [95%CI, 0.81–0.94]; $p = 0.008$, tofu: pooled HRs [95%CIs] of 0.82 [0.70–0.95; $p = 0.005$]). In addition, among women the favorable association of tofu was more pronounced in young women and postmenopausal women without hormone therapy ($P_{interaction} = 0.002$) [59].

In our study, dairy products, regardless of fat content, were positively associated with pro-inflammatory diet. Park et al. [60] investigated the associations between dairy product intake and hypertriglyceridemia in obese Korean adults, but a recent systematic review [61] did not confirm any association between consumption of dairy products and a pro-inflammatory effect in healthy individuals, or the association of low- and regular-fat dairy consumption with higher risk of CVD, except for a positive association of high-fat milk and an inverse association of cheese with CHD risk. In Spanish [16] and Mexican [50] studies higher dairy intake was associated with anti-inflammatory diets, but the results of the Italian study [45] were similar to our own.

Authors of epidemiological studies indicate decreased risk of CVD among abstainers and that any amount of alcohol increases blood pressure and BMI [4]. In our study, alcohol consumption was positively associated with a pro-inflammatory diet compared to an anti-inflammatory diet (T3 compared to T1 β = 22.06 CI_{95} [7.49;36.64], $p = 0.003$). In the TOSCA.IT study, higher alcohol consumption was associated with a pro-inflammatory diet (Q4) compared to an anti-inflammatory diet (Q1), $p < 0.0001$ [45]. However, an inverse association was observed in the Diabetes Mellitus Survey administered in Mexico City (DMS-MC), where alcohol intake in Q5 (pro-inflammatory diet) was lower than in Q1 (anti-inflammatory diet, $p < 0.0001$) [50].

In our study, higher intake of coffee was assessed in DII T1 compared to DII T2 and DII T3, but after excluding confounding factors, only tea was negatively associated with DII T3 compared to DII T1. Contrasting results were obtained in the Korean study, where coffee and tea intake was reduced in study participants with more pro-inflammatory diets [46]. Phenolic compounds found in coffee and tea have anti-inflammatory and antioxidant effects. In addition to a reduction of pro-inflammatory markers (IL-1, IL-6, and TNF-α), phenolic compounds also lower LDL-C oxidation, leading to decreased vascular inflammation, risk of platelet aggregation, and a reduction in oxidative stress and nitric oxide (NO) effects [8]. However, according to the ESC 2021 guidelines, unfiltered coffee should be consumed in moderation due to its lipid-raising components: kahweol and cafestol [62].

Our study raises some contentious issues regarding fish and soft drinks. According to the ESC 2021 guidelines, it is recommended to avoid sweetened beverages, including fruit juices, as well as sweetened carbonated and non-carbonated soft drinks [4,5]. In the European Prospective Investigation into Cancer and Nutrition (EPIC) study, consumption of artificially sweetened and sugar-sweetened soft drinks was associated with overall mortality, and consumption of artificially sweetened soft drinks was directly associated with CVD [51]. In our study, after excluding confounding factors, soft drinks were negatively associated with a pro-inflammatory diet. In other studies based on DII scores, higher consumption of soft drinks was associated with a more pro-inflammatory diet [38,47,50].

Oily fish should be consumed twice a week as a source of omega-3 fatty acids. However, in contrast to other analyses based on DII score calculations [16,38,45,50,54], in this study overall mean fish consumption was higher in participants with a pro-inflammatory diet (T3 compared to T1 β = 1.41 CI_{95} [0.09; 2.72], $p = 0.035$). This can be associated with the fact that half of the consumed fish (53.9%, unset data) was lean (i.e., cod) and processed

(coated with batter and breading). The authors of another dietary inflammatory index determining anti-inflammatory potential of diets classified fish as pro-inflammatory due to inappropriate preparation methods [63]. A recent meta-analysis involving individual data of 191,558 people from 58 countries found that eating 175 g of fish per week was associated with a significant reduction in the risk of CVD events (16%) and decreased death rate (18%) in secondary prevention. The benefits were observed only for oily fish, preferably not fried [64]. Well-done or browned fried fish may have a stronger pro-inflammatory potential and increase the risk of chronic diseases [65].

The Western pattern diet is characterized by a higher intake of proinflammatory (T3) food products, i.e., refined grains, simple sugars, red and processed meat, eggs, high-fat dairy, and low intake of fruits, vegetables, whole grains, nuts, or legumes [12]. This diet contributes to weight gain and to the proliferation of visceral adipose tissue which, as an endocrine organ significantly contributes to inflammatory processes by releasing pro-inflammatory factors, including leptin, TNF- α, and IL-6 [10]. Besides, such diet is characterized by a higher content of pro-inflammatory advanced glycation end-products (AGE's). However, it is worth noting that the method of cooking (i.e., frying) has a significant impact on AGE formation. Chronic low-grade systemic inflammation and a pro-inflammatory diet may increase CVD risk and severity [8]. Plant-based (PB) diets are associated with good health and are also recommended for environmental sustainability. The Mediterranean diet has also been included in definitions of PB, due to the emphasis on some components [66]. Kent et al. [66] found that participants on the PB diet more often met recommended intakes of carbohydrates, dietary fiber, and vitamin E, and less often met recommendations for protein, vitamin B_{12}, and iodine compared to omnivores. Intakes of protein, omega-3 fatty acids, iron, and zinc were sufficient from the PB diet. It is worth emphasizing that the bioavailability of these nutrients is lower in PB diet compared to animal-derived products [66]. Recent high-quality evidence supports the Mediterranean diet (rich in i.e., vegetables, fruits, wholegrains, legumes, nuts, and olive oil) in secondary prevention of CVD with impacts on atherosclerosis progression. It may be caused by the reduction of systemic inflammation, irrespective of changes in weight or cholesterol. The Mediterranean diet is characterized by a low DII, showing its anti-inflammatory potential [67]. A healthy balanced diet, adjusted energy intake, and expenditure to achieve and maintain a healthy body weight with proper supplementation could provide a possible further strategy to effectively prevent and control noncommunicable diseases. An et al. [68], in the 884 randomized controlled intervention trials evaluating 27 types of micronutrients among 883,627 participants, found that omega-3 fatty acids supplementation decreased CVD mortality (relative risk [RR]: 0.93; 95%CI: 0.88–0.97), myocardial infarction (RR: 0.85; 95%CI: 0.78–0.92), and CHD events (RR: 0.86; 95%CI: 0.80–0.93). Folic acid supplementation decreased the stroke risk (RR: 0.84; 95%CI: 0.72–0.97), and coenzyme Q10 supplementation decreased all-cause mortality events (RR: 0.68; 95%CI: 0.49–0.94). Additionally, Pontes et al. [69], based on twenty-six randomized controlled trials (n = 1720) found a significant effect of probiotics in reducing body weight (mean deviation [MD]:−0.70 kg; 95%CI:−1.04, −0.35 kg; $p < 0.0001$), BMI (MD:−0.24 kg/m^2; 95%CI:−0.35, −0.12 kg/m^2; $p = 0.0001$), WC (MD:−1.13 cm; 95%CI:−1.54, −0.73 cm; $p < 0.0001$), fat mass (MD:−0.71 kg; 95%CI:−1.10, −0.32 kg; $p = 0.0004$), TNF-α (MD:−0.16 pg/mL; 95%CI:−0.24, −0.08 pg/mL; $p = 0.0001$), insulin (MD:−0.85 mcU/mL; 95%CI:−1.50, −0.21 mcU/mL; $p = 0.010$), TC (MD:−0.16 mmol/L; 95%CI:−0.26, −0.05 mmol/L; $p = 0.003$), and LDL-C (MD:−0.09 mmol/L; 95%CI:−0.16, −0.03 mmol/L; $p = 0.006$) compared with control groups. They observed a substantial decrease in body weight, BMI, and WC using both single and multi-bacterial species.

In our study we also evaluated the association of the DII score with CVD risk parameters among urban and rural residents of Lower Silesia (Table 5). The anti-inflammatory diet, according on DII score calculations, was associated with lower WHR and WC in the group of women and lower TG, FG, and atherogenicity indices in the group of men and women, confirming the benefits of an anti-inflammatory diet on CVD-related parameters. In another Polish study, WC was associated with a pro-inflammatory diet, but only in the

group of men [70]. Other study has also indicated an association between WC and WHR with pro-inflammatory values on the DII [16].

Obesity is a low-grade chronic inflammation due to an imbalance between intake and expenditure of energy. Similar to our study results, other authors have also found an association between a pro-inflammatory diet and higher dietary energy expenditure based on the DII score calculation [47,71]. The storage of excess energy in adipocytes results in hyperplasia and hypertrophy adipose tissue, associated with the release of macrophages secreting high levels of pro-inflammatory receptors toll-like receptors (TLRs), tumor necrosis factor receptors (TNFRs), interleukin−1- receptor (IL-1R), and activation of NF-kB transcription factors for pro-inflammatory molecules. As a further consequence, low-grade inflammation can affect insulin sensitivity leading to impaired metabolism and an increased risk of other non-communicable diseases [72,73]. In addition, excess lipids are redirected into other organs (liver, skeletal muscle, and blood vessels), inducing the expression of pro-inflammatory mediators, differentiation of monocytes into macrophages, and M1 systemic macrophages recruitment. This may lead to a vicious cycle characterized by increased central fat, intrahepatic fat accumulation, vascular inflammation, and impaired endothelial function [74].

In our study, participants with DII T3 diets consumed more dietary energy from fats. The consequences of an excessive fat intake high-fat diet (HFD), besides obesity, hyperinsulinemia, dyslipidemia, comprise dysbiosis, gut barrier dysfunction, and increased intestinal permeability, can strongly contribute to the development of low-grade systemic inflammation [12]. The microbiome of the inhabitants of the Lower Silesia region is worth assessing in future studies in order to better formulate dietary recommendations.

The Geelong Osteoporosis Study (GOS) involving 1363 men, found that the adjusted odds ratio (OR, 95%CI) for CVD risk factors was 2.0 (1.01–3.96) for individuals with pro-inflammatory diet compared to individuals with anti-inflammatory diet, as indicated by higher DII scores [75]. Similarly, authors of the Primary Prevention of Cardiovascular Disease with a Mediterranean Diet (PREDIMED) study, which included 7216 participants (men aged 55–80 years and women aged 60–80 years) with high CVD risk, after medial follow-up of 4.8 years, diagnosed CVD in 277 study participants consuming a pro-inflammatory diet. The adjusted HR (95%CI) for CVD in Q4 vs. Q1 was 1.73 (1.15–2.60) [15]. In the SUN study, the HR for participants between the highest (Q1) and the lowest quartile (Q5) was 2.03 (95%CI; 1.06–3.88), proving a linear trend with overall CVD risk [76]. In contrast, the SU.VI.MAX study, which included 7743 men and women (11.4-year follow-up), found no statistically significant association between DII score and the risk of cardio-metabolic disorders (CMDs) [17].

To the best of our knowledge, our study is the first to assess atherogenic indices depending on DII scores and accurately determine different product groups in DII terciles, while considering demographic confounding factors. Recent studies have investigated the association between a pro-inflammatory diet, as determined by DII score, and the increased risk of dyslipidemia [71], elevated triglycerides/HDL-C, and apolipoprotein (B) [77]. A Brazilian study [78] supported the hypothesis that a pro-inflammatory diet is associated with a higher atherogenic risk in schoolchildren. Determination of atherogenicity indices is a noteworthy method to complement cardiometabolic risk screening and monitoring [27,79,80].

Due to the cross-sectional nature of the study, it was impossible to establish the association between DII scores and selected CVD risk factors. However, this study design allowed for the assessment of the relationship between the variables and establish management strategies to protect health. Moreover, it is unclear whether overweight or obese individuals are more likely to choose pro-inflammatory diets, or whether pro-inflammatory diets contribute to promoting obesity. This should be confirmed in prospective analyses. The fact that this study was carried out with standardized methods and a validated high-quality FFQ including 154 food products and dishes specific to the Lower Silesia region, is a definite strength of the study. However, this method is limited, because some DII

components were not included in the questionnaire (i.e., saffron, eugenol, ginger, turmeric, pepper, rosemary, and thyme). However, this is the first cross-sectional study to determine the inflammatory potential of the diets of Poland's Lower Silesia inhabitants, in which DII scores were calculated based on 37 food components and products. Also, due to the cross-sectional nature of the study design, study results correspond to the actual dietary habits of study participants.

So far, no studies have identified product groups specific to each DII tercile after excluding confounding factors, as assessed in this study (Table 4). To conduct more thorough analysis/get more accurate results, future studies should assess the role of inflammatory markers. The results of this study are informative and provide an important basis for further research on the quality of diet and nutrition.

5. Conclusions

Among participants with pro-inflammatory diets, we reported higher mean values of TG, FG, API, and CRI in the group of men and women, and higher WC and WHR in the group of women. Study participants on pro-inflammatory diets consumed more refined grain products, sweets, juices, red meat, high-fat cheese and cream, alcohol, fats (except for vegetable oils), potatoes, sugar and honey, French fries, fried fish, and processed/high-fat poultry. Moreover, we reported higher consumption of milk, low-fat dairy, and eggs in study participants with pro-inflammatory diets, which may be due to the fact that these food products are associated with unhealthy dietary habits. However, their consumption should not be considered as an independent CVD risk factor. Anthropometric and biochemical parameters were more favorable among study participants whose diets had higher content of vegetables, fruits, nuts, seeds, raisins, pulses, low-fat poultry, and tea. However, the association of beverage consumption with dietary inflammatory potential requires further study.

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8.2 Publikacja nr 2

Alicja Szypowska, Katarzyna Zatońska, Andrzej Szuba, Bożena Regulska – Ilow,

“Dietary Inflammatory Index (DII)® and Metabolic Syndrome in the Selected Population of Polish Adults: Results of the PURE Poland Sub-Study”

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Article

Dietary Inflammatory Index (DII)® and Metabolic Syndrome in the Selected Population of Polish Adults: Results of the PURE Poland Sub-Study

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Abstract: The aim of the study was to assess the relationship between the inflammatory potential of the diets of residents of Lower Silesia, based on the Dietary Inflammatory Index (DII), with the incidence of metabolic syndrome (MetS) and its components. Diets were characterized according to DII terciles. The study group consisted of 1570 individuals enrolled in the Polish arm of the Prospective Urban and Rural Epidemiological (PURE) study. Participants' diets in DII T1 (most anti-inflammatory diet) had the highest intake of vegetables (except for potatoes), fruits, nuts and seeds, low-calorie beverages, tea, and coffee (all $p < 0.001$). On the other hand, participants' diets in DII T3 (most pro-inflammatory diet) contained a lot of whole-fat products, refined cereals, fats (except for vegetable oils), fruit juices, red meat, processed meat/meat products, sugar-sweetened beverages, sweets, sugar, and honey (all $p < 0.001$). Overall, we did not find an increased prevalence of MetS and its individual components in DII tercile 3 (T3) compared to DII tercile 1 (T1), except for an increased prevalence of abnormal TG in DII T3 compared to T1 (OR 1.34; 95% CI = 1.01 to 1.78) in the crude model. In the adjusted model, a lower prevalence of abnormal fasting glucose (FG) was found in DII T2 compared to DII T1 (OR 0.71; 95% CI = 00.54 to 0.94). Results of this study are informative and provide an important basis for further research on the quality of diet and nutrition.

Keywords: Dietary Inflammatory Index; metabolic syndrome; inflammation; nutrition; PURE study

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1. Introduction

Metabolic syndrome (MetS) is a major health hazard of modern world [1]. According to the most current criteria accepted in 2009 by the International Diabetes Federation (IDF), the American Heart Association and National Heart, Lung and Blood Institute (AHA/NLBI) diagnose MetS if three of the following five features are found: elevated blood pressure (BP), elevated fasting glucose (FG), elevated triglyceride (TG), abdominal obesity, and reduced high-density lipoprotein cholesterol (HDL-C) [2]. Metabolic syndrome is associated with the development of cardiovascular disease, diabetes, non-alcoholic fatty liver disease, chronic kidney disease, some cancers, and even increased mortality [1,3–5]. Patients with MetS are at twice the risk of developing cardiovascular disease (CVD) over the next 5–10 years and a 5-fold increase in risk for type 2 diabetes mellitus [2].

There are many factors and mechanisms in the development of MetS, including insulin resistance, adipose tissue dysfunction, chronic inflammation, oxidative stress, abnormal microbiota, and genetics [2,6]. Chronic inflammation is associated with insulin resistance and visceral obesity. These factors are linked to the secretion of pro-inflammatory cytokines interleukin-1 (IL-1), IL-6, tumor necrosis factor alpha (TNF-α), adiponectin, and leptin [7,8].

This may be caused by a high-energy diet and cell death that induces local inflammation [6,9]. Inadequate dietary patterns have been linked to all metabolic disorders in MetS, and all of MetS individual components are modifiable risk factors for the development of CVD, meaning that making appropriate lifestyle changes can reduce the risk of their occurrence [10,11].

Dietary patterns rich in fruits, vegetables, whole grains, nuts, legumes, fish, olive oil and minimally processed foods, i.e., the Mediterranean and Dietary Approaches to Stop Hypertension (DASH) diets, are associated with the lowering of systemic inflammation and lower C-Reactive Protein (CRP) compared to unhealthy dietary patterns [12–14]. On the other hand, the consumption of a Western diet, rich in processed foods, simple carbohydrates, refined grains, red processed meat, saturated fatty acids, and sodium, leads to chronic inflammation and increased CVDs markers [15,16].

The Dietary Inflammatory Index (DII) is a scoring algorithm to classify individuals' diets according to their inflammatory potential [17]. The authors of DII evaluated the association of dietary components with six inflammatory markers: IL-1β, IL-4, IL-6, IL-10, TNF-α, and CRP [17]. Currently, there is an increasing number of studies on the association between DII scores and the prevalence of MetS, but the obtained results are inconsistent [18–23]. A 2021 umbrella review showed that anti-inflammatory dietary patterns play a significant role in the prevention of chronic diseases [24]. However, studies on MetS and DII were identified as having no evidence (Class V) with no statistical significance using a p-value of > 0.05, except for MetS individual components whose associations were identified as suggestive (for waist circumference, WC), or weak (for systolic BP and FG).

There are few studies that assessed dietary patterns with DII among the Polish population. Sokol et al. [18] examined the association between the DII and some MetS components among the Polish population from a specific geographic region (Świętokrzyskie Province and the city of Kielce). They found that mean waist-to-hip ratio (WHR) and diastolic blood pressure were greater among those in DII quartile 4 compared to 1 [18]. Our study evaluates the Polish population from Poland's Lower Silesia Province and the city of Wroclaw. The prevalence of MetS among residents of Wroclaw has been evaluated previously [25]. In a randomized study by Ilow et al. [25] (n = 18,583) MetS occurred in 28.5% of the study group and its prevalence increased with age.

The aim of the study was to evaluate the relationship between inflammatory potential of the diets of urban and rural residents of Lower Silesia based on DII with the incidence of MetS and its components. Diets were characterized according to DII terciles (T).

2. Materials and Methods

2.1. Study Population

The study group consisted of 1570 individuals enrolled in the Prospective Urban and Rural Epidemiological (PURE) Poland sub-study. The inclusion criteria for the study were: aged 35–70 and permanent residence in urban or rural area of the Lower Silesia region. Individuals were recruited to the Polish arm of the PURE study through the radio and television announcements. The aim of the study was to calculate the association between urbanization and CVD prevalence. The main results of the study have been previously published [26,27]. The first stage of the study was conducted between 2007 and 2009, and it included a Food Frequency Questionnaire (FFQ), blood draws, BP measurements, spirometry, and anthropometric measurements. There were a total of 2039 study participants. Individuals who did not meet the criterion of adequate dietary energy intake (for men <800 kcal, >4200 kcal, and for women <600 kcal, >3500 kcal) were excluded. The study inclusion criteria were established in accordance with recommendations [28]. Participants were excluded from the study due to missing data for more than one variable (n = 221). Finally, a total of 1570 individuals were included in the study.

2.2. Data Collection

The concentrations of FG, TG, and HDL-C were measured from venous blood samples. A SPINREACT enzymatic test kit (Sant Esteve De Bas, Girona, Spain) was used to measure HDL-C and TG concentrations. FG was measured after an overnight fasting period with the Ascensia ENTRUST Glucometer kit (Bayer, Germany). The above variables were expressed in mmol/L. Systolic and diastolic BP was measured with a certified automatic BP monitor (Omron HEM-711 IntelliSense, Tokyo, Japan) and expressed in mm Hg. Study participants were recommended to rest for 5 min before BP measurement.

In the PURE study, BP was measured twice. Waist circumference was measured once, midway between the lowest rib and the upper iliac crest, with a standard measuring tape to the nearest 0.5 cm.

2.3. Definition of the Metabolic Syndrome

The definition of MetS as declared by the IDF, and AHA/NLBI harmonized criteria for MetS [2], was used for MetS diagnosis, comprising of the presence of three or more of the following components:

- FG $\geq$ 5.6 mmol/L (100 mg/dL), or drug treatment for elevated glucose;
- Systolic BP $\geq$ 130 mm Hg, or diastolic BP $\geq$ 85 mm Hg, or antihypertensive drug treatment for previously diagnosed hypertension;
- HDL-C < 1.0 mmol/L(40 mg/dL) in males and <1.3 mmol/L (50 mg/dL) in women, or a history of drug treatment for this abnormality;
- WC $\geq$ 80 cm in women and $\geq$94 cm in men [2].

2.4. Dietary Intake Assessment

Participants' habitual food intake was assessed with the country- and culture-specific FFQ, which was developed and validated for the population of PURE study from Lower Silesia [29]. The FFQ asked about the average consumption of food products during the year preceding the survey and assessed the frequency of consumption of 154 products, which were divided into 26 food groups (Table 1) [30]. The frequency of consumption of selected foods was assessed with 10 possible responses: never, less than once a month, 1–3 times a month, once a week, 2–4 times a week, 5–6 times a week, once a day, 2–3 times a day, 4–5 times a day, and >6 times a day. The nutritional value of the diets was calculated based on the Polish Food Composition Tables [31]. "The Album of photographs of food products and dishes" developed by the National Food and Nutrition Institute in Warsaw was used to determine the average size of the consumed portion [32]. The FFQ has been published previously [33]. The place of residence was classified as rural or urban, and education as elementary/unknown, trade, secondary/high school, or university. The International Physical Activity Questionnaire (IPAQ) was used to calculate physical activity and expressed as metabolic equivalent (MET) minutes per week. The number of MET-min/week lower than 600 was considered low, 600–3000 as moderate, and above 3000 as high [34]. Smoking status was classified into 3 categories: non-smoker, ex-smoker, and current smoker.

Table 1. Characteristics of food groups [30].

No.	Food Groups	FFQ Dietary Products
1.	Low-fat dairy products	Milk 1–2% fat, Buttermilk 0.5% fat Cocoa w/ milk 1–2% fat, Cottage cheese, Low-fat yoghurt, Kefir
2.	Full-fat dairy products	Milk 3.2% fat, Milk 3.2% fat (from mixed dish—oatmeal w/ milk), Feta Greek cheese Granulated cottage cheese w/ sour cream, Cheese, Edam cheese, Fromage cheese, Yoghurt 2–8% fat, Sour cream 12% fat, Sour cream 18% fat Sour cream 18% fat (from mixed dish—salad w/sour cream)

Table 1. *Cont.*

No.	Food Groups	FFQ Dietary Products
3.	Whole grains	Whole-meal rye bread, Mixed bread w/ rye and wheat flour w/ sunflower seeds, Buckwheat groats, boiled, Barley groats, boiled, Pasta w/ durum, boiled, Oatmeal (from mixed dish—oatmeal w/milk)
4.	Refined grains	Wheat bread, white, White rice, boiled, Wheat roll, white, Mixed bread w/ rye and wheat flour, white, Cornflakes
5.	Fats w/o oils	Butter, Lard, Fat spread w/ butter, Mayonnaise, Margarine, soft
6.	Raw fruit	Apple, Banana, Grapefruit, Grapes, Mandarin, Strawberries, Kiwi fruit, Lemon, Orange, Pear, Peach, Prunes, Raspberries
7.	Fruit juices	Orange juice; Raspberry juice; Carrot juice; Apple juice; Grapefruit juice; Black currant juice; Multifruit juice (local fruits); Multifruit juice (exotic fruits)
8.	Raw vegetables	Cabbage red, raw; Chinese cabbage, raw; Cabbage white, raw; Carrot, raw Cauliflower, raw; Chives; Cucumber, raw; Garlic cloves, raw; Salad, leaves; Onion, raw Parsley, leaves; Horseradish; Red pepper, raw; Radish; Tomato, raw; Sauerkraut salad Chinese cabbage salad w/ mayonnaise; Salad (from mixed dish—salad w/ sour cream)
9.	Cooked vegetables	Kidney beans, cooked; Beetroot, cooked; Broccoli; Cabbage white, cooked; Carrot, cooked; Cauliflower, cooked, w/butter; Mushrooms, fried; Red pepper, cooked Tomatoes, cooked; Tomato passata; Spinach, cooked; Zucchini, cooked Green beans, cooked; Corn, canned; Peas, canned; Salad of mixed cooked vegetables w/ mayonnaise
10.	Potatoes	Potatoes, boiled; Potatoes, mashed; French fries
11.	Lean meat	Chicken w/ skin boiled/fried; Chicken w/o skin boiled/fried Turkey, roasted
12.	Red meat	Beef, cutlets; Beef ham, boiled; Pork, bacon; Cutlets of ground beef and pork, fried; Offal
13.	Meat w/ breadcrumbs	Chicken nuggets; Pork chops, w/ breadcrumbs
14.	Processed meat/charcuterie	Chicken ham; Sausage; Luncheon meat, pork; Pork ham; Sausage, pork, smoked (traditional polish); Sausage, mixed beef/pork, smoked (traditional polish); Sausage, pork, white, boiled (traditional polish); Turkey ham; Turkey sausage ham; Brawn; Chicken pâté
15.	Eggs	Eggs, boiled/fried
16.	Fish	Codfish, fried, w/ breadcrumbs; Herring, w/ cream; Mackerel, smoked
17.	Mixed dishes	Baked beans w/ tomato sauce; Meat and rice stuffed cabbage w/ tomato Sauce; Dumplings w/ meat, boiled; Dumplings w/ potatoes and cottage cheese, Boiled; Sauerkraut and meat stew
18.	Beverages w/ added sugar	Fruit drink; Soft drink w/ added sugar
19.	Low-calorie beverages	Low-calorie soft drink
20.	Tea, coffee	Coffee; Tea, black; Tea, green/herb
21.	Alcohol	Beer; Wine; Vodka
22.	Sweets	Milk chocolate; Dark chocolate; Tea biscuit; Yeast cake; Shortbread cake; Gingerbread; Pound cake; Cheesecake; Halvah; Caramel candy; Other sweets; Candy; Ice cream
23.	Honey and sugar	Honey; Sugar
24.	Dried fruits	Raisins
25.	Nuts and seeds	Walnuts; Other nuts; Seeds
26.	Soups	Broth; Sour rye soup; Vegetable soup; Barley soup; Tomato soup; Bean soup; Sauerkraut soup

w/, with; w/o, without.

2.5. Dietary Inflammatory Index (DII)® Calculation

DII is a scoring algorithm to classify individuals' diets according to their inflammatory potential. A modified and updated version of DII developed by Shivappa et al. [17] was used in this study. Its detailed description has been described in Shivappa et al.'s [17] publication. Authors of DII calculated the global daily intake of individual dietary food components/food products, along with the standard deviation, based on 11 data sets from around the world (USA, Australia, the Kingdom of Bahrain, Denmark, India, Japan, New Zealand, Taiwan, South Korea, Mexico, and the UK). Dietary intake of the DII components by study participants was compared to the standard global as a Z-score, which was achieved by subtracting the standard mean from the amount reported and dividing this value by its standard deviation [17]. Then, this value was converted to a centered percentile score. To achieve a symmetrical distribution with values centered on 0 (null) and bounded between −1 (maximally anti-inflammatory) and +1 (maximally pro-inflammatory), each percentile score was doubled and then '1' was subtracted. The centered percentile values were then multiplied by the overall pro- and anti-inflammatory effect score for each dietary component. Finally, all results were summed up. Higher DII scores indicated that the diet was more pro-inflammatory, and lower DII scores represented a more anti-inflammatory diet. Thirty-seven dietary components and food products were used to calculate the DII score, including 29 anti-inflammatory elements; monounsaturated fatty acids, polyunsaturated fatty acids, n-3 fatty acids, n-6 fatty acids, fiber, alcohol, vitamins A, D, E, C, and B_6, β-carotene, thiamine, riboflavin, niacin, folic acid, magnesium, selenium, zinc, flavan-3-ol, flavones, flavonols, flavonones, anthocyanidins, isoflavones, caffeine, garlic, onion, and green/black tea, and 8 pro-inflammatory elements; carbohydrates, protein, total fat, saturated fatty acids, trans fat, cholesterol, iron, and vitamin B_{12}. Energy-adjusted values (the nutrient density method) were used to decrease the influence of different energy intake among study participants [35].

2.6. Statistical Analysis

Nominal variables are presented as *n* (% of group), and continuous variables as mean ± SD or median (T1; T3). Normality of distribution in subgroups was evaluated using the Kolmogorov-Smirnov test, skewness, and kurtosis values, and were based on visual assessment of histograms. Comparison of diet parameters between DII terciles groups was made using one-way ANOVA or Kruskal-Wallis test (as appropriate). A post-hoc test (Tukey test for ANOVA and Dunn test for Kruskal-Wallis test) was used with Bonferroni correction for multiple comparisons. Additionally, logistic regression analysis was used to determine odds ratios (ORs) with 95% confidence intervals (CIs) for metabolic syndrome and its components according to the DII terciles. The bottom DII tercile (T1) was used as a reference category. We created both univariate and multivariable models. Multivariate models included age, sex, place of residence, education level, physical activity level, smoking status, and body mass index (BMI) as potential confounders. All tests were two-tailed with a significance level of 0.05. Statistical analysis was conducted using R software (a language and environment for statistical computing, v. 3.5.1. R Foundation for Statistical Computing, Vienna, Austria).

2.7. Ethical Approval

The study has been approved by the Polish Ethics Committee (No. KB-443/2006). All participants were volunteers and signed an informed consent form prior to all examinations. All participants were examined according to the global PURE [36] study protocol.

3. Results

Table 2 presents characteristics of the study group (*n* = 1570); socio-demographic, anthropometric, lifestyle-related data (smoking status, physical activity), prevalence of MetS and its components, as well as DII scores of participants' diets. More than half of the study participants were women (*n* = 1000). The mean age of the study group was

54.65 ± 9.83. The mean BMI was 28.17 ± 5.15. Most of participants (74.3%) were married or cohabiting. More than half of the study participants had a high school education or less (70.8%) and reported smoking cigarettes currently or in the past, with men being more likely to smoke (64.8% vs. 55.3%). Most of Lower Silesia inhabitants (79.2%) declared current or previous alcohol consumption. The mean DII score in the study group was −0.11 ± 2.91. A significantly lower DII score was found in the group of women compared to the group of men (−0.61 ± 2.88 vs 0.77 ± 2.75, $p < 0.001$). The minimum DII score was −7.88, and the maximum DII score was 7.33. Metabolic syndrome was diagnosed in 42.3% of the study participants. The prevalence of MetS and its components was as follows: MetS (42.3%); BP (77.6%); WC (69.7%); HDL-C (19.7%); TG (24.6%); and FG (39.1%). Metabolic syndrome and abnormal levels of BP and TG were significantly more frequent in the group of men compared to the group of women (46.1% vs. 40.1%; 88.4% vs. 71.4%; 30.7% vs. 1.2%, respectively). Abnormal HDL-C levels were significantly more frequent in the group of women compared to the group of men (23.4% vs 13.3%). Other MetS components were not statistically significant.

Table 2. Characteristics of study group by sex and total.

	Total ***n*** **= 1570**	**Females** ***n*** **= 1000**	**Males** ***n*** **= 570**	***p*** *
Age, years, mean ± SD	54.65 ± 9.83	54.90 ± 9.74	54.22 ± 9.99	0.193
BMI, [kg/m^2] mean ± SD	28.17 ± 5.15	27.84 ± 5.39	28.75 ± 4.66	0.001
Place of living, *n* (%)				
Rural	685 (43.6)	443 (44.3)	242 (42.5)	0.512
Urban	885 (56.4)	557 (55.7)	328 (57.5)	
Marital status, *n* (%)				
Married / living together	1166 (74.3)	667 (66.7)	499 (87.5)	<0.001
Never married	112 (7.1)	75 (7.5)	37 (6.5)	
Separated / divorced / widowed	291 (18.5)	258 (25.8)	33 (5.8)	
Education, *n* (%)				
Primary/trade	499 (31.8)	305 (30.5)	194 (34.0)	0.034
Secondary and high secondary	612 (39.0)	414 (41.4)	198 (34.7)	
University	459 (29.2)	281 (28.1)	178 (31.2)	
Smoking, *n* (%)				
Currently Uses Tobacco Products	332 (21.1)	200 (20.0)	132 (23.2)	<0.001
Formerly Used Tobacco Products	490 (31.2)	253 (25.3)	237 (41.6)	
Never Used Tobacco Products	748 (47.6)	547 (54.7)	201 (35.3)	
Alcohol, *n* (%)				
Currently use alcohol products	1081 (68.9)	633 (63.3)	448 (78.6)	<0.001
Formerly used alcohol products	162 (10.3)	98 (9.8)	64 (11.2)	
Never used alcohol products	327 (20.8)	269 (26.9)	58 (10.2)	
Physical activity, *n* (%)				
Low and moderate	418 (26.6)	254 (25.4)	164 (28.8)	0.163
High	1152 (73.4)	746 (74.6)	406 (71.2)	
DII, mean ± SD	−0.11 ± 2.91	−0.61 ± 2.88	0.77 ± 2.75	<0.001
DII, (min; max)	−7.88 to 7.33	−7.88 to 6.70	−6.75 to 7.33	
Metabolic syndrome, *n* (%)	664 (42.3)	401 (40.1)	236 (46,1)	0.023

Table 2. *Cont.*

	Total n = 1570	Females n = 1000	Males n = 570	p *
Waist Component, *n* (%)	1094 (69.7)	698 (69.8)	396 (69.5)	0.938
BP Component, *n* (%)	1218 (77.6)	714 (71.4)	504 (88.4)	<0.001
FG Component, *n* (%)	614 (39.1)	379 (37.9)	235 (41.2)	0.213
TG Component, *n* (%)	387 (24.6)	212 (21.2)	175 (30.7)	<0.001
HDL Component, *n* (%)	310 (19.7)	234 (23.4)	76 (13.3)	<0.001

Groups compared with chi-square test for nominal variables and with *t*-test for continuous variables. * Statistical difference between groups of females and males. A *p*-value of <0.05 is considered statistically significant. Waist Circumference of ≥94 cm for males or ≥80 for females. A blood pressure (BP) component of >130 is systolic or >85 is diastolic. High-density lipoprotein (HDL-C) is <40 mg/dL in men and <50 in women. The triglyceride (TG) component is >149 mg/dL. The fasting glucose (FG) component is >99 mg/dL.

Table 3 presents detailed characteristics of participants' diets according to the DII terciles. Diets were assessed by calculating DII scores and then divided into terciles. The most anti-inflammatory diet (T1) ranged from −7.88 to −1.53, the moderate diet (T2) from −1.52 to 1.21, and the most proinflammatory diet (T3) from 1.22 to 7.33. Participants' diets in T1 had the highest intake of vegetables (except for potatoes), fruits, nuts and seeds, low-calorie beverages, tea, and coffee. Pro-inflammatory diets (T3) had the highest intake of whole-fat foods, refined cereals, fats except for vegetable oils (butter, lard, fat spread, mayonnaise, soft margarine), fruit juices, red meat, processed meat, sugar-sweetened beverages, sweets, sugar, and honey. Moderate and pro-inflammatory diets (T2 and T3) had a similar intake of potatoes, breaded meat, boiled and fried eggs, mixed dishes, and soups. Fish intake was similar in T1 and T2. The remaining food components were not statistically significant.

Table 3. Comparison of diet parameters (g/day) between DII terciles in total study group.

No.	Parameter	Total Group	Tercile 1	Tercile 2	Tercile 3	p	Post-Hoc
1.	Low-fat dairy Products	81.36 (39.22; 178.58)	83.50 (40.00; 192.58)	86.43 (37.07; 209.70)	74.93 (42.14; 142.82)	0.145	
2.	Full-fat dairy products	73.35 (38.22; 162.15)	46.02 (25.71; 83.21)	67.85 (39.87; 140.04)	150.00 (71.14; 284.98)	<0.001	1 < 2 < 3
3.	Whole grains	48.53 (30.00; 87.43)	51.69 (29.98; 93.53)	49.70 (29.65; 91.42)	46.17 (30.67; 73.55)	0.097	
4.	Refined grains	73.40 (21.08; 118.80)	25.71 (9.83; 64.29)	72.86 (27.27; 107.24)	110.71 (76.97; 155.71)	<0.001	1 < 2 < 3
5.	Fats w/o oils	17.81 (10.62; 29.75)	12.14 (6.43; 17.58)	17.30 (11.04; 25.36)	35.85 (18.94; 47.35)	<0.001	1 < 2 < 3
6.	Raw fruit	241.84 (160.29; 398.04)	266.85 (188.59; 448.69)	249.15 (157.10; 397.84)	217.14 (142.73; 324.01)	<0.001	1 > 2 > 3
7.	Fruit juices	117.68 (49.18; 214.29)	98.36 (32.79; 159.25)	114.75 (49.18; 194.96)	153.40 (68.50; 266.39)	<0.001	1 < 2 < 3
8.	Raw vegetables	134.92 (91.54; 197.90)	169.75 (111.21; 242.01)	128.49 (84.49; 191.57)	122.45 (82.84; 157.30)	<0.001	1 > 2 > 3
9.	Cooked vegetables	117.80 (79.75; 162.60)	125.62 (85.98; 184.93)	115.27 (76.44; 167.00)	112.02 (78.74; 147.77)	<0.001	1 > 2.3
10.	Potatoes	88.77 ± 57.66	75.58 ± 54.92	94.66 ± 58.60	96.06 ± 57.23	<0.001	1 < 2.3
11.	Lean meat	15.08 (13.11; 28.57)	14.29 (10.84; 28.57)	15.08 (13.11; 28.57)	15.08 (14.29; 22.81)	0.102	

Table 3. *Cont.*

No.	Parameter	Total Group	Tercile 1	Tercile 2	Tercile 3	*p*	Post-Hoc
12.	Red meat	18.57 (10.84; 28.59)	15.08 (8.52; 24.19)	17.70 (10.84; 28.59)	22.04 (13.47; 31.69)	<0.001	1 < 2 < 3
13.	Meat w/ breadcrumbs	20.84 (13.11; 28.57)	14.29 (6.56; 20.84)	20.84 (13.11; 28.57)	20.84 (13.11; 28.57)	<0.001	1 < 2.3
14.	Processed meat/charcuterie	50.07 (29.39; 89.33)	36.27 (20.32; 55.75)	46.24 (30.48; 80.56)	86.08 (42.61; 127.94)	<0.001	1 < 2 < 3
15.	Eggs	19.29 (6.43; 19.29)	6.43 (2.95; 19.29)	19.29 (6.43; 19.29)	19.29 (6.43; 19.29)	<0.001	1 < 2.3
16.	Fish	13.11 (6.56; 20.84)	9.84 (6.56; 16.98)	13.11 (6.56; 17.56)	14.29 (9.84; 20.84)	<0.001	1.2 < 3
17.	Mixed dishes	26.23 (13.11; 33.96)	19.67 (6.56; 28.57)	26.23 (14.29; 33.96)	26.23 (19.67; 33.96)	<0.001	1 < 2.3
18.	Beverages w/ added sugar	14.29 (6.56; 42.27)	6.56 (0.00; 22.95)	15.34 (6.56; 42.27)	16.39 (6.56; 50.00)	<0.001	1 < 2 < 3
19.	Low-calorie beverages	0.00 (0.00; 35.71)	0.00 (0.00; 250.00)	0.00 (0.00; 35.71)	0.00 (0.00; 0.00)	<0.001	1 > 2 > 3
20.	Tea, coffee	952.58 ± 459.02	1 081.96 ± 509.61	903.61 ± 438.31	872.26 ± 394.32	<0.001	1 > 2.3
21.	Alcohol	9.31 (0.00; 47.14)	9.31 (0.00; 47.14)	9.31 (0.00; 42.63)	12.13 (0.00; 49.96)	0.354	
22.	Sweets	41.48 (23.13; 63.36)	26.09 (13.44; 43.01)	40.76 (25.65; 61.41)	58.39 (40.43; 82.28)	<0.001	1 < 2 < 3
23.	Honey and sugar	15.43 (2.86; 21.14)	6.86 (1.31; 16.00)	16.00 (3.91; 22.29)	17.31 (9.71; 40.00)	<0.001	1 < 2 < 3
24.	Dried fruits	4.92 (0.00; 4.92)	4.92 (0.00; 4.92)	4.92 (0.00; 4.92)	4.92 (0.00; 4.92)	0.073	
25.	Nuts and seeds	5.44 (0.00; 9.00)	6.10 (1.43; 11.88)	5.44 (0.52; 9.33)	1.95 (0.00; 6.10)	<0.001	1 > 2 > 3
26.	Soups	223.89 (162.06; 307.26)	214.52 (157.38; 307.25)	228.57 (162.06; 317.92)	245.43 (183.61; 281.03)	0.026	1 < 2.3

w/, with; w/o, without; DII: Dietary Inflammatory Index. Data presented as mean ± SD or median (T1;T3), depending on data distribution. Tercile groups compared with ANOVA analysis or Kruskall-Wallis test. For ANOVA—a post-hoc Tukey test was applied, and for Kruskall-Wallis test—a post-hoc Dunn test was applied.

Table 4 presents logistic regressions of MetS and its components according to the DII tertiles. Age, sex, place of living, education, physical activity, smoking status, and BMI were excluded as confounders. Overall, in the crude model we did not find an increased prevalence of MetS and its components in T3 compared to T1, except for increased TG levels (OR 1.34; 95% CI = 1.01 to 1.78). In the adjusted model, we found a lower prevalence of FG in T2 compared to T1 (OR 0.71; 95% CI = 00.54 to 0.94).

Table 4. Logistic regression odds ratio of metabolic syndrome and its components by DII terciles.

DII Tercile	Present *n* (%)	Absent *n* (%)	OR (95% CI)	Adjusted OR (95% CI) [1]
		Metabolic syndrome		
1	216 (32.5)	307 (33.9)	Ref.	Ref.
2	218 (32.8)	306 (33.8)	1.01 (0.79 to 1.29)	0.92 (0.69 to 1.23)
3	230 (34.6)	293 (32.3)	1.12 (0.87 to 1.43)	0.77 (0.56 to 1.06)

Table 4. *Cont.*

DII Tercile	Present *n* (%)	Absent *n* (%)	OR (95% Cl)	Adjusted OR (95% Cl) [1]
		Raised WC		
1	362 (33.1)	161 (33.8)	Ref.	Ref.
2	356 (32.5)	168 (35.3)	0.94 (0.73 to 1.22)	1.02 (0.68 to 1.54)
3	376 (34.4)	147 (30.9)	1.14 (0.87 to 1.49)	1.22 (0.79 to 1.90)
		Raised BP		
1	416 (34.2)	107 (30.4)	Ref.	Ref.
2	394 (32.3)	130 (36.9)	0.78 (0.58 to 1.04)	0.83 (0.59 to 1.15)
3	408 (33.5)	115 (32.7)	0.91 (0.68 to 1.23)	0.90 (0.63 to 1.29)
		Reduced HDL-C		
1	95 (30.6)	428 (34.0)	Ref.	Ref.
2	113 (36.5)	411 (32.6)	1.24 (0.91 to 1.68)	1.27 (0.91 to 1.77)
3	102 (32.9)	421 (33.4)	1.09 (0.80 to 1.49)	1.02 (0.71 to 1.47)
		Raised TG		
1	113 (29.2)	410 (34.7)	Ref.	Ref.
2	133 (34.4)	391 (33.1)	1.23 (0.93 to 1.65)	1.14 (0.83 to 1.55)
3	141 (36.4)	382 (32.3)	1.34 (1.01 to 1.78)	1.01 (0.73 to 1.41)
		Raised FG		
1	204 (33.2)	319 (33.4)	Ref.	Ref.
2	186 (30.3)	338 (35.4)	0.86 (0.67 to 1.11)	**0.71 (0.54 to 0.94)**
3	224 (36.5)	299 (31.3)	1.17 (0.92 to 1.50)	0.78 (0.58 to 1.05)

DII: Dietary Inflammatory Index; OR: odds ratio; CI: confidence interval; Ref.: reference; BP, blood pressure; FG, fasting glucose; HDL-C, high-density lipoprotein cholesterol; TG, triglycerides; WC, waist circumference. [1] logistic regression models adjusted for sex, age, BMI, place of residence, education level, physical activity level, and smoking.

4. Discussion

We found no significant association between the inflammatory potential of the diet assessed by the DII and the risk of MetS. In this study, the prevalence of MetS was higher (i.e., 42.3% overall, 40.1% among women, and 42.3% among men) than in other studies conducted in the Polish population [18,25], which may be related to adopting different criteria. Our study adopted the IDF definition of MetS for Europeans [2,37]. Also, no association between the DII and MetS was reported in another Polish cross-sectional study conducted among inhabitants of Poland's Świętokrzyskie Province and the city of Kielce, whose authors [18] observed an increased prevalence of abnormal WC among men in the DII quartile 4 (Q4) compared to those in quartile 1 (OR = 1.65; 95%CI = 1.01 to 2.69). Moreover, no association between the DII and MetS was reported in few European studies: the cross-sectional study "Observation of Cardiovascular Risk Factors in Luxembourg" (ORISCAV-LUX, *n* = 1352) [19] and the Spanish prospective study "Seguimiento Universidad de Navarra" (SUN) [23]. The ORISCAV-LUX study [19] found the association between proinflammatory DII scores (>1) and increased adjusted odds of having a low HDL-C. However, authors of the SUN study (median follow-up of 8.3 years, *n* = 6851), observed a significant association of a pro-vegetarian diet with a lower risk for developing MetS, but no significant association between DII and MetS [23].

In America, the authors of "The Buffalo Cardio-Metabolic Occupational Police Stress" (BCOPS, *n* = 464) found no correlation between a pro-inflammatory diet assessed by DII and MetS (OR for DII Q4 compared to Q1 = 0.87, 95% CI = 0.46–1.63) [38]. They reported a more prevalent glucose intolerance component among police officers in DII Q4 compared

to Q1. Another study conducted on the Brazilian population (2017 adults) reported a mean DII score of 1.10, which indicates a pro-inflammatory diet, but no correlation between MetS and the DII score (men: prevalence ratio [PR], 0.98; 95% CI, 0.91–1.07; women: PR, 1.05; 95% CI, 0.91–1.20) [39].

In Asia, Ren et al. [40] reported a relatively limited association between the DII and the prevalence of MetS (with the exception of BP) among adults in eight cities in China. Similarly, in a study conducted among the Lebanese population (n = 336) [41] and in the Fasa Cohort Study (FACS) [42] conducted in Iran (n = 10,017), no significant association was reported between the DII and the prevalence of MetS.

However, there are a number of studies that have found a significant association between the DII score and MetS. In Europe, the authors of a French prospective study "the Supplémentation en Vitamines et Minéraux Antioxidants" (SU.VI.MAX, n = 3726) found an association between higher DII scores and a higher risk of developing MetS (OR for DII Q4 compared to Q1: 1.39; 95% CI = 1.01 to 1.92) [20]. In a 13-year follow-up, individuals in Q4 were more likely have higher systolic and diastolic BP, TG, and HDL-C [20]. A study conducted in the Irish population (Mitchelstown cohort, n = 3043) found an association of a pro-inflammatory diet with some MetS components, i.e., HDL-C, TG, FG, WC, and an overall association of MetS with higher DII scores (OR 1.37, 95% CI 1.01 to 1.88, $p < 0.05$) [22]. In the Croatian study, MetS prevalence of 25% was significantly associated with a pro-inflammatory diet as measured by DII [mean (SD) 3.28 (1.45); $p < 0.01$]. Multivariable logistic regression analysis showed a statistically positive association for a one-unit increase in the DII and MetS prevalence (OR = 2.31; 95% CI = 1.61–3.31), and elevated BP [21].

In America, the association between MetS and the DII was also observed in the cross-sectional US National Health and Nutrition Examination Survey (n = 17,689; OR for DII Q4 compared to Q1 = 1.65, 95% CI 1.44 to 1.89) whose authors found that the TG/HDL-C ratio, obesity, and high-sensitivity C-reactive protein (hsCRP) increased across DII quartiles [43]. The only exception was HDL-C levels, which decreased across DII quartiles. Two Mexican studies (n = 334 and n = 399) also confirmed the association of a pro-inflammatory diet with MetS [44,45]. Similarly, a study conducted in Latin America populations (n = 276) found a significant association between higher DII scores and MetS and/or cardiometabolic risk components: WC and diastolic BP [46].

In Asia, an association of pro-inflammatory outcomes evaluated by the DII score and MetS was observed in northern China [47], Iran [48,49], and Korea [50,51].

We observed a higher prevalence of increased TG across DII terciles (T1 vs. T3 OR 1.34 95% CI: 1.01–1.78), but after adjusting for confounding factors, this association was no longer statistically significant. Our logistic regression model was adjusted according to the criteria published by Qian Yi et al. [52] (BMI and physical activity, without the total energy intake). In addition, the model was adjusted for education, place of residence, smoking, and gender, which are important socioeconomic risk factors for CVD [53]. Increased risk of higher TG levels due to a more pro-inflammatory diet has also been shown in other studies [20,44,46–48]. In our study, a pro-inflammatory diet was characterized by a higher intake of red meat compared to the anti-inflammatory diet. Saturated fatty acids in processed red meat have been reported to activate a number of inflammatory pathways (mitogen-activated protein kinases (MAPK), nuclear factor kappa-B (NF-kB), and activator protein (AP)-1)), which may be associated with increased TG reserves in adipose tissue [54,55]. Similarly, the diets of participants in T3 had the highest intake of food products containing fructose, which is thought to induce lipid accumulation and hypertriglyceridemia, resulting in inflammation and hepatic steatosis [55,56]. Our study assessed the higher prevalence of abnormal FG in the anti-inflammatory diet (T1), which may be related to the cross-sectional nature of the study. Patients who were informed about their abnormal FG levels may have made some dietary changes before participating in the study, but the time was too short for these changes to be observed.

An anti-inflammatory diet (lower DII score) was characterized by a higher intake of vegetables, fruits, nuts, seeds, and fish. A pro-inflammatory diet, on the other hand,

contained a lot of whole-fat foods, refined cereals, fats, fruit juices, red meat, processed meat, sugar-sweetened beverages, sweets, sugar, and honey [15,16]. Similar findings have been observed by other researchers comparing MetS and DII [22,44]. A so-called Western diet causes chronic inflammation and increases CVDs markers. Therefore, it is important to provide patients with appropriate dietary counseling to change their eating habits [15,16].

The cross-sectional nature of the study did not allow us to assess the causal association between the DII and MetS, which needs to be further confirmed in prospective studies. In addition, study participants were recruited through radio and television announcements, making the study sample not representative of the target population. The fact that this study was carried out with standardized methods and a validated high-quality FFQ, which included 154 food products and dishes specific to the Lower Silesian region, is a definite strength of the study. However, the above method in this study is limited because some DII components were not included in the questionnaire (saffron, eugenol, ginger, turmeric, pepper, rosemary, and thyme). This is the first cross-sectional study to determine the inflammatory potential of the diets of Poland's Lower Silesia inhabitants, in which the DII was determined based on 37 food parameters. Also, due to the cross-sectional nature of the study design, study results corresponded to the actual dietary habits of study participants. No association between the DII and MetS reported in this study may be related to the fact that long-term risk factors for chronic diseases do not act until disease accumulates and manifests in the body. The real predictor is not the information whether disease occurs or not, but the exposure in a lifetime. Additionally, to get more accurate results, future studies should assess the role of inflammatory markers. The results of this study are only informative and provide an important basis for further research on the quality of diet and nutrition.

5. Conclusions

In conclusion, no association was found between the DII and MetS, except for increased TG concentrations in individuals in DII T3 compared to DII T1. However, this association was significant only in the crude model. Besides, our conclusion may be limited by the cross-sectional nature of the study. Therefore, more cohort studies are needed to fully understand whether diets with pro-inflammatory potential are associated with an increased risk of MetS and, possibly, with its specific components. Results of this study are informative and provide an important basis for further research on the quality of diet and nutrition.

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9. Omówienie wyników i podsumowanie

W pierwszej publikacji z cyklu, wskaźnik DII, został wykorzystany do określenia, które grupy produktów spożywczych i ich wartość odżywcza (tj.: wartość energetyczna, udział energii w diecie z węglowodanów, białek i tłuszczów, zawartość błonnika pokarmowego, cholesterolu) były związane z potencjałem pro- i antyzapalnym w kontekście ryzyka chorób sercowo-naczyniowych wśród badanych mieszkańców z Dolnego Śląska.

Większe spożycie produktów znajdujących się w T3, określającym dietę bardziej prozapalną tj.: rafinowanych produktów zbożowych, cukrów prostych, czerwonego i przetworzonego mięsa, jaj, wysokotłuszczowych produktów mlecznych przy mniejszym spożyciu owoców, warzyw, produktów pełnoziarnistych, orzechów, nasion roślin strączkowych jest charakterystyczne dla diety zachodniej [19]. Warto zaznaczyć, że zawartość jaj w diecie powinna być określana w zależności od wzoru żywieniowego w którym występują, ponieważ z obserwacji wynika, że spożycie jaj współwystępuje z innymi składnikami diety, często kojarzonymi z niezdrowymi wzorami żywienia [48,49]. Powyższa dieta przyczynia się do przyrostu masy ciała i proliferacji trzewnej tkanki tłuszczowej. Tkanka tłuszczowa jako narząd dokrewny znacząco przyczynia się do powstawania procesów zapalnych poprzez uwalnianie czynników prozapalnych, w tym leptyny, TNF-α, IL-6 [17]. Dodatkowo dieta zachodnia charakteryzuje się większą zawartością produktów będących źródłem końcowych produktów glikacji (ang. *Advanced glycationend-products,* AGE's), które mają właściwości prozapalne, tutaj warto zaznaczyć, że również sposób przyrządzania (tj. smażenie) ma istotny wpływ na tworzenie powyższych. Zatem przewlekłe zapalenie ogólnoustrojowe o niskim stopniu nasilenia i dieta charakteryzująca się potencjałem prozapalnym może zwiększać ryzyko wystąpienia i natężenia CVD [15]. Najnowsze dowody wysokiej jakości przemawiają za stosowaniem diety śródziemnomorskiej (bogatej w warzywa, owoce, produkty pełnoziarniste, rośliny strączkowe, orzechy i oliwę z oliwek) we wtórnej prewencji CVD

związanych z progresją miażdżycy. Może to być spowodowane zmniejszeniem ogólnoustrojowego stanu zapalnego i to niezależnie od zmian masy ciała czy stężenia cholesterolu. Dieta śródziemnomorska charakteryzuje się niską wartością DII, co świadczy o jej potencjale przeciwzapalnym [50].

W tym badaniu oceniono także związek wartości wskaźnika DII z czynnikami ryzyka chorób sercowo-naczyniowych wśród mieszkańców obszaru miejskiego i wiejskich Dolnego Śląska. Dieta przeciwzapalna uczestników badania PURE (charakteryzująca się większą zawartością owoców, warzyw, nasion roślin strączkowych, niskotłuszczowego drobiu, zup, orzechów, nasion, rodzynek i herbaty), określona na podstawie DII była związana z mniejszymi wartościami WHR i WC w grupie kobiet i niezależnie od płci z: TG, FG, i wskaźnikami aterogenności krwi (AIP i CRI), co potwierdza korzyści stosowania diety przeciwzapalnej w odniesieniu do parametrów związanych z CVD. Otyłość może być głównym wyznacznikiem przewlekłego zapalenia o niskim stopniu nasilenia i efektem braku równowagi między spożyciem i wydatkiem energetycznym. W badaniu własnym oraz innych, w których wykorzystano DII [51,52], dieta prozapalna była związana dodatnio z wyższą wartością energetyczną diety.

W badaniu drugim nie stwierdzono istotnego związku między potencjałem zapalnym diety ocenianej wartością wskaźnika DII a szansą wystąpienia MetS. Zaobserwowano większe szanse wystąpienia wysokiego stężenia TG wraz z wyższymi wynikami DII (T1 w porównaniu do T3 OR 1,34; 95% CI = 1,01-1,78), jednak po dostosowaniu czynników zakłócających, powyższa zależność nie była istotna statystycznie. W badaniu własnym dieta prozapalna charakteryzowała się większą zawartością mięsa czerwonego w porównaniu z dietą przeciwzapalną, a zawarte w przetworzonym mięsie czerwonym nasycone kwasy tłuszczowe aktywują wiele szlaków zapalnych (ang. *mitogen activated protein kinase* [MAPK], ang. *nuclear factor-kB* [NF-kB], białko aktywujące [AP]-1), co może się wiązać ze zwiększeniem

rezerw TG w tkance tłuszczowej [17,53]. Podobnie diety pacjentów w górnym tercylu charakteryzowały się największą zawartością produktów będących źródłem fruktozy, a uważa się, że ma to wpływ na kumulację lipidów i hipertriglicerydemię, co w konsekwencji powoduje stan zapalny i stłuszczenie wątroby [17,54]. Dodatkowo w tym badaniu oceniono większe szanse związane z wystąpieniem nieprawidłowej FG w diecie przeciwzapalnej (określonej w T1), co może być związane z przekrojowym charakterem badania. Pacjenci, którzy dowiedzieli się o nieprawidłowej glikemii mogli dokonać pewnych zmian w diecie przed udziałem w badaniu, jednak czas okazał się za krótki by te zmiany zostały zaobserwowane.

Prezentowane badania zostały wykonane przy użyciu wystandaryzowanych metod i walidowanego kwestionariusza FFQ dobrej jakości, w którego skład wchodziło 154 produkty i potrawy, charakterystyczne dla regionu dolnośląskiego, co jest zdecydowanie mocną stroną badania. Ograniczeniem powyższej metody jest brak możliwości włączenia niektórych składowych wskaźnika, ze względu na ich brak w kwestionariuszu (szafranu, eugenolu, imbiru, kurkumy, pieprzu, rozmarynu, tymianku). Nie mniej jednak są to pierwsze badania przekrojowe określające potencjał zapalny diet badanych z regionu dolnośląskiego w Polsce, w którym określono DII na podstawie 37 parametrów. Dodatkowo charakter przekrojowy jest także zaletą, ponieważ wyniki odpowiadają faktycznym nawykom żywieniowym. Powyższe wyniki mają charakter informacyjny i stanowią istotną podstawę dla dalszych badań nad jakością diety i żywienia. Zgodnie z naszą wiedzą, jest to pierwsze badanie w którym sprawdzono wartości wskaźników aterogenności krwi w zależności od wartości wskaźnika DII i określono poszczególne grupy produktów w tercylach DII przy uwzględnieniu czynników zakłócających w populacji polskiej.

10. Wnioski

1) Uczestnicy badania, których diety określono jako bardziej prozapalne, mieli wyższe średnie stężenie TG, FG, wyższe wartości wskaźników aterogennych krwi wśród wszystkich badanych oraz większy obwód pasa i wskaźnik WHR wśród kobiet. Ich diety były związane z wyższą zawartością: rafinowanych produktów zbożowych, słodyczy, soków, czerwonego mięsa, wysokotłuszczowych serów i śmietany, alkoholu, tłuszczów bez olejów roślinnych, ziemniaków, cukru i miodu, frytek, smażonych ryb oraz przetworzonego/wysokotłuszczowego drobiu.
2) Wśród tych uczestników pozostałe składniki diety tj. mleko i produkty mleczne niskotłuszczowe oraz jaja mogą być związane z ogólnie niezdrowymi nawykami/wzorami żywieniowymi, stąd ich wyższa zawartość występowała w diecie prozapalnej, jednak ich zawartość w diecie nie powinna być uznawana za niezależny czynnik ryzyka CVD.
3) Wyżej wymienione parametry antropometryczne i biochemiczne były korzystniejsze wśród uczestników, których diety charakteryzowały się większą zawartością warzyw, owoców, orzechów, nasion, rodzynek, nasion roślin strączkowych, niskotłuszczowego drobiu, herbaty. Spożycie napojów w odniesieniu do potencjału zapalnego diety wymaga dalszych badań.
4) Nie zaobserwowano zależności między DII a MetS, z wyjątkiem zwiększonego stężenia TG u badanych znajdujących się w T3 w porównaniu do T1 diety, jednak powyższa zależność była istotna w modelu surowym.
5) Brak powiązań między DII i Mets w niniejszym badaniu może być związany z faktem, że czynniki ryzyka rozwoju chorób przewlekłych działają przez długi czas, aż do kumulacji rozwoju choroby.

6) Wnioski mogą być ograniczone ze względu na przekrojowy charakter badania. Istnieje potrzeba kontynuacji badań kohortowych w celu wyjaśnienia czy diety o prozapalnym potencjale są związane z MetS i ewentualnie, z którymi jego składowymi.
7) Powyższe wyniki mają charakter informacyjny i stanowią istotną podstawę dla dalszych badań nad jakością diety i żywienia.

11. Piśmiennictwo

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12. Załączniki

12.1 Dorobek naukowy

Alicja Szypowska

Wykaz publikacji

1. Publikacje w czasopismach naukowych

1.1 Publikacje w czasopiśmie z IF

Lp	Opis bibliograficzny	IF	Punkty
1	Szypowska Alicja, Regulska-Ilow Bożena, Zatońska Katarzyna, Szuba Andrzej: Comparison of intake of food groups based on dietary inflammatory index (DII) and cardiovascular risk factors in the middle-age population of lower silesia: results of the PURE Poland study, Antioxidants, 2023, vol. 12, nr 2, art.285 [18 s.], DOI:10.3390/antiox12020285	7,675	100
2	Szypowska Alicja, Zatońska Katarzyna, Szuba Andrzej, Regulska-Ilow Bożena: Dietary Inflammatory Index (DII)® and metabolic syndrome in the selected population of Polish adults: results of the PURE Poland sub-study, International Journal of Environmental Research and Public Health, 2023, vol. 20, nr 2, art.1056 [14 s.], DOI:10.3390/ijerph20021056	4,614	140
	Podsumowanie	12,289	240

1.2 Publikacje w czasopiśmie bez IF

Lp	Opis bibliograficzny	Punkty
1	Szypowska Alicja, Regulska-Ilow Bożena: Możliwości zastosowania diety paleolitycznej w wybranych jednostkach chorobowych, Hygeia Public Health, 2019, vol. 54, nr 3, s. 144-152, [Publikacja w czasopiśmie spoza listy MNiSW]	5
2	Szypowska Alicja, Regulska-Ilow Bożena: Significance of low-carbohydrate diets and fasting in patients with cancer, Roczniki Państwowego Zakładu Higieny, 2019, vol. 70, nr 4, s. 325-336, DOI:10.32394/rpzh.2019.0083	20
3	Szypowska Alicja, Jeziorek Małgorzata, Regulska-Ilow Bożena: Assessment of eating and lifestyle habits among Polish cosmetology and physiotherapy students, Roczniki Państwowego Zakładu Higieny, 2020, vol. 71, nr 2, s. 157-163, DOI:10.32394/rpzh.2020.0111	20
4	Jeziorek Małgorzata, Szypowska Alicja, Regulska-Ilow Bożena: Mediterranean diet adherence among cosmetology students, Roczniki Państwowego Zakładu Higieny, 2021, vol. 72, nr 3, s. 301-307, DOI:10.32394/rpzh.2021.0172	20
5.	Wiśniewska A, Szypowska Alicja: The role of vitamin D in selected autoimmune diseases. Rocz Panstw Zakl Hig. 2021;72(2):111-121. doi: 10.32394/rpzh.2021.0156. PMID: 34114758.	20
	Podsumowanie	85

4. Abstrakty

Lp	Opis bibliograficzny
1	Szypowska Alicja, Jeziorek Małgorzata, Regulska-Ilow Bożena: Zastosowanie wskaźnika Mediterranean Diet Score (MDS) do oceny zgodności diet studentek kosmetologii z

Lp	Opis bibliograficzny
	zaleceniami diety śródziemnomorskiej, W: III Warszawski Dzień Dietetyki Klinicznej "Nowotwór - i co dalej?". On-line, Warszawa, 5 listopada 2020 2020, 33-34 poz.P5

Impact facor: 12,289
Punkty ministerialne: 325,0

31.03.23 r. Beata Mayerle

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tel. 71 784 19 25, faks 71 784 19 31

12.2 Zgoda Komisji Bioetycznej

KOMISJA BIOETYCZNA
przy
Akademii Medycznej
we Wrocławiu
ul. Pasteura 1; 50-367 WROCŁAW

OPINIA KOMISJI BIOETYCZNEJ Nr KB – 443/2006

Komisja Bioetyczna przy Akademii Medycznej we Wrocławiu, powołana zarządzeniem Rektora Akademii Medycznej we Wrocławiu nr 4XIII R/99 z dnia 27 września 1999 r., oraz działająca w trybie przewidzianym rozporządzeniem Ministra Zdrowia i Opieki Społecznej z dnia 12 maja 1999 r. (Dz. U. Nr 47, poz. 480) na podstawie ustawy o zawodzie lekarza z dnia 5 grudnia 1996 r. (Dz. U. Nr 28 z 1997 r. poz. 152 z późniejszymi zmianami) w składzie:

prof. dr hab. Karol BAL – filozof, profesor zwyczajny
Dyrektor Instytutu Filozofii Uniwersytetu Wrocławskiego,
prof. dr hab. Wiktor BEDNARZ – specjalista chirurg, profesor
i Katedra i Klinika Chirurgii Ogólnej, Gastroenterologicznej
i Endokrynologicznej Akademii Medycznej we Wrocławiu,
ks. dr Janusz CZARNY – teolog, adiunkt Papieskiego Fakultetu Teologicznego
we Wrocławiu,
dr Henryk KACZKOWSKI – chirurgia szczękowa, chirurgia stomatologiczna,
adiunkt Katedry i Kliniki Chirurgii Szczękowo-Twarzowej Akademii Medycznej
we Wrocławiu,
mgr Irena KNABEL-KRZYSZOWSKA – farmacja, przedstawiciel Dolnośląskiej
Izby Aptekarskiej,
prof. dr hab. Jan KOLASA - prawnik, profesor zwyczajny Uniwersytetu Wrocławskiego
prof. dr hab. Krystyna ORZECHOWSKA-JUZWENKO - farmakologia kliniczna,
choroby wewnętrzne, emerytowany profesor zwyczajny Akademii Medycznej,
prof. dr hab. Janusz PATKOWSKI – alergologia, choroby wewnętrzne, profesor
zwyczajny Katedra i Klinika Chorób Wewnętrznych i Alergologii Akademii
Medycznej,
prof. dr hab. Zbigniew RUDKOWSKI – pediatria, choroby zakaźne,
emerytowany profesor zwyczajny Akademii Medycznej we Wrocławiu,
dr hab. Sławomir SIDOROWICZ - specjalista psychiatra, Katedra Psychiatrii Akademii
Medycznej we Wrocławiu
Danuta TARKOWSKA – położna, emeryt,
dr Andrzej WOJNAR – patomorfologia, dermatologia, przedstawiciel Dolnośląskiej Izby
Lekarskiej.

pod przewodnictwem
prof. dr hab. Jana KORNAFELA – ginekologia i położnictwo, onkologia
profesor zwyczajny, Katedra Onkologii i Klinika Onkologii Ginekologicznej
Akademii Medycznej we Wrocławiu

Przestrzegając w działalności zasad Good Clinical Practice oraz zasad Deklaracji Helsińskiej, po zapoznaniu się z projektem badawczym pt.

„Epidemiologiczne badania prospektywne przeprowadzane wśród ludności miejskiej i wiejskiej (PURE)"

zgłoszonym przez prof. dr hab. Ryszarda Andrzejaka zatrudnionego w Katedrze i Klinice Chorób Wewnętrznych, Zawodowych i Nadciśnienia Tętniczego Akademii Medycznej we Wrocławiu oraz złożonymi wraz z wnioskiem dokumentami, w tajnym głosowaniu postanowiła wyrazić zgodę na przeprowadzenie badania w mieście Wrocławiu, gminach: Boguszyce, Żurawina i inne oraz w Katedrze i Klinice Chorób Wewnętrznych, Zawodowych i Nadciśnienia Tętniczego; Katedrze i Zakładzie Bromatologii; Katedrze i Zakładzie Medycyny Społecznej Akademii Medycznej we Wrocławiu oraz w Fundacji „Promocja Zdrowia".

Pouczenie: W ciągu 14 dni od otrzymania decyzji wnioskodawcy przysługuje prawo odwołania do Komisji Odwoławczej za pośrednictwem Komisji Bioetycznej AM we Wrocławiu
Opinia dotyczy: międzynarodowego badania epidemiologicznego

PRZEWODNICZĄCY KOMISJI
prof. dr hab. Jan Kornafel

Wrocław, dnia 6 października 2006 r.

12.3 Zgoda pacjentów

Prospektywne Epidemiologiczne Badanie Ludności Miejskiej i Wiejskiej

INFORMACJA O BADANIU

Cel badania:

Celem badania jest zbadanie wpływu uprzemysłowienia, mechanizacji, urbanizacji i rozwoju ekonomicznego na wzrost występowania: otyłości, cukrzycy i chorób sercowo-naczyniowych. Celem programu PURE jest także przeciwdziałanie występowaniu chorób sercowo-naczyniowych.

Charakter badania:

PURE jest badaniem obserwacyjnym epidemiologicznym.

Koordynatorzy badania:

Głównym koordynatorem badania PURE, które prowadzone jest w 15 krajach jest:
Profesor ***Salim Yusuf*** – dyrektor - Population Health Research Institute w Hamilton, Kanada

W Polsce badanie kierowane jest przez:

1. *Profesora* ***Adrzeja Szube***, Kierownika Katedry i Kliniki Agiologii, Diabiotelogii i Nadciśnienia Tętniczego, Uniwersytetu Medycznego we Wrocławiu

2. *Dr hab.* ***Katarzynę Zatonska,*** *prof. UMW,* Kierownika Katedry Zdrowia Populacyjnego Uniwersytetu medycznego we Wrocławiu

Przebieg badania:

W Polsce założono, że badaniem zostanie objęta grupa 2500 osób - mieszkańców Wrocławia oraz grupa 2500 osób – mieszkańców regionów wiejskich (gmina Żurawina). Do badania zostaną włączone osoby w wieku **od 35 do 70 lat**.

Pacjenci będą badani co trzy lata, program ma zakończyć się w roku 2030.

W trakcie badania, pacjenci będą proszeni o wypełnienie ankiet dotyczących: stanu zdrowia, aktywności fizycznej, warunków życia, zwyczajów żywieniowych. Ponadto zostanie pobrana krew (na badania biochemiczne), próbka moczu oraz będą wykonane badania antropometryczne, EKG i spirometria.
Pacjent otrzyma:

- wyniki badania wydolnościowego układu oddechowego (spirometrii), elektrokardiogram (EKG), pomiaru ciśnienia tętniczego krwi, wzrostu i masy ciała, obwodu: bioder, brzucha i ramienia oraz siły mięśniowej,
- wyniki poziomu cholesterolu z lipidogramem oraz poziom cukru.

Wyniki będą ocenione przez lekarza ze wskazówkami dalszego postępowania.

Osoby uczestniczące w badaniu będą na bieżąco informowane o wszelkich nowych ustaleniach czy informacjach dot. badania, mogących mieć wpływ na chęć dalszego uczestnictwa w badaniu. Na podstawie tych informacji można ponownie rozważyć decyzję dalszego udziału w badaniu.

Uczestnictwo w badaniu nie niesie ze sobą żadnego bądź minimalne ryzyko dla uczestników. Badanie nie jest eksperymentem medycznym i nie polega także na przyjmowaniu przez pacjentów jakichkolwiek produktów leczniczych (leków) w celu zbadania ich bezpieczeństwa czy skuteczności. Ewentualne niedogodności wynikające z udziału w badaniu mogą polegać na:

- w trakcie pobierania krwi może dojść do omdlenia i bólu, zasinienia, obrzęku lub w rzadkich przypadkach zakażenia w miejscu wkłucia igły,
- w trakcie wykonywania badania EKG możliwe jest podrażnienie skóry w wyniku przyłożenia elektrod EKG (samoprzylepne nakładki, do których podłączone są przewody) do skóry lub ból podczas ich usuwania.

Koordynator prowadzący badanie może zakończyć Pana/Pani udział w tym badaniu niezależnie od Pana/Pani woli, jeśli uzna, że takie rozwiązanie będzie dla Pana/Pani korzystniejsze, np. ze względu na Pana/Pani stan zdrowia powodujący, że wypełnianie obowiązków uczestnika badania mogłoby stanowić dla Pana/Pani nadmierną uciążliwość. Zakończenie uczestnictwa w badaniu może nastąpić także w przypadku wstrzymania lub wcześniejszego zakończenia badania.

Korzyści wynikające z uczestnictwa w badaniu:

Udział w badaniu nie wiąże się z jakimikolwiek bezpośrednimi korzyściami dla uczestników badania. Natomiast, Pana/Pani uczestnictwo w badaniu niewątpliwie przyczyni się do poszerzenia wiedzy medycznej, w szczególności służącej zapobieganiu występowania chorób sercowo-naczyniowych.

Dobrowolność uczestnictwa w badaniu:

Uczestnictwo w tym badaniu jest dobrowolne.
Może Pan/Pani odmówić lub zrezygnować z udziału w badaniu w dowolnym momencie, bez podania przyczyny i bez żadnych konsekwencji.

Zachowanie poufności danych osobowych uczestników badania:

Gromadzone w badaniu dane osobowe dot. zdrowia, które pozwoliłyby na identyfikację uczestników badania są poufne. Bezpieczeństwo danych jest zapewnione przez stosowanie odpowiednich środków technicznych i organizacyjnych, które chronią dane w szczególności przed przypadkowym lub niezgodnym z prawem zniszczeniem, utratą, zmianą, nieupoważnionym ujawnieniem lub dostępem. Zgromadzone w badaniu dane osobowe są zastępowane indywidualnym numerem uczestnika, co uniemożliwia jego bezpośrednią identyfikację.
Publikacja wyników badania nie będzie zawierała żadnych danych osobowych uczestników. Wszelkie informacje, które zostaną opublikowane będą anonimowe.

Uzyskanie dodatkowych informacji na temat badania:

Dalsze pytania na temat badania i praw osób uczestniczących w badania, a także zgłoszenia ewentualnych szkód powstałych w związku z uczestnictwem, należy kierować do Punktu przyjęć pacjentów, którego adres i numer telefonu znajdują się poniżej.

Punkt przyjęć pacjentów:

Uniwersytet Medyczny we Wrocławiu Katedra Zdrowia Populacyjnego, Wrocław, ul. Bujwida 44
Prosimy o kontakt pod numerem telefonu: (071)784 17 77; (071) 328 21 45, od poniedziałku do piątku od godz. 9.00 do 14.00

☐ Wyrażam zgodę na udostępnienie moich danych osobowych, w tym danych dotyczących zdrowia, osobom przeprowadzającym kontrolę (audyt), Niezależnej Komisji Bioetycznej czy innym uprawnionym podmiotom w celu weryfikacji sposobu prowadzenia badania i zgromadzonych w badaniu danych.

_____

Imię i nazwisko Uczestnika (drukowanymi literami) - wypełnia uczestnik badania

_____ _____

Podpis Uczestnika - wypełnia uczestnik badania

Data - wypełnia uczestnik badania (dd/mm/rrrr)

_____ _____

Podpis Koordynatora pozyskującego zgodę

Data (dd/mm/rrrr)

**Jeden podpisany egzemplarz otrzymuje Uczestnik badania, drugi pozostaje w dokumentacji badania.*

12.4 Kwestionariusz FFQ

PURE/Poland

We are very grateful to you for your participation in this study. All information given by you will be held in strict confidence, and will be used for the purpose of this study only after removing any personal identifying information.

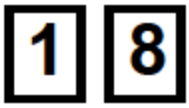
Adult Semi-Quantitative Food Frequency Questionnaire

INSTRUCTIONS

Please answer EACH question by marking an X in ONE BOX on each line: (unless otherwise instructed)

OR

By writing number(s) in the spaces provided:



OR

By specifying the answer on the line(s) provided

October 17, 2007

PURE/Poland **Food Frequency Questionnaire** **Page 1**

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During the past year, on average, how often have you consumed the following foods and drinks? (please check the appropriate box)

Milk and dairy Products	**Avg Serving**	**Never, less than once/month**	**1-3/mo**	**1/wk**	**2-4/wk**	**5-6/wk**	**1/day**	**2-3/day**	**4-5/day**	**>6/day**
1. Low fat milk (1-2% fat)	1 glass	☐	☐	☐	☐	☐	☐	☐	☐	☐
2. Milk (3.2% fat)	1 glass	☐	☐	☐	☐	☐	☐	☐	☐	☐
3. Buttermilk, 0.5% fat	1 glass	☐	☐	☐	☐	☐	☐	☐	☐	☐
4. Cocoa with milk	1 glass	☐	☐	☐	☐	☐	☐	☐	☐	☐
5. Feta cheese	1 slice	☐	☐	☐	☐	☐	☐	☐	☐	☐
6. Cottage cheese	1 small plate	☐	☐	☐	☐	☐	☐	☐	☐	☐
7. Hard cheese	1 slice	☐	☐	☐	☐	☐	☐	☐	☐	☐
8. Cheese "Fromage" naturel	1 slice	☐	☐	☐	☐	☐	☐	☐	☐	☐
9. Cheese, Edam type, fat	1 slice	☐	☐	☐	☐	☐	☐	☐	☐	☐
10. Quark, fresh cheese	1 slice	☐	☐	☐	☐	☐	☐	☐	☐	☐
11. Low fat yogurt	1 Tbs	☐	☐	☐	☐	☐	☐	☐	☐	☐
12. Yogurt, 2-8% fat	1 Tbs	☐	☐	☐	☐	☐	☐	☐	☐	☐
13. Kefir	1 glass	☐	☐	☐	☐	☐	☐	☐	☐	☐
14. Cream, 12% fat	1 Tbs	☐	☐	☐	☐	☐	☐	☐	☐	☐
15. Cream, 18% fat	1 Tbs	☐	☐	☐	☐	☐	☐	☐	☐	☐

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During the past year, on average, how often have you consumed the following foods and drinks? (please check the appropriate box)

Milk and dairy Products Cont'	**Avg Serving**	**Never, less than once/month**	**1-3/mo**	**1/wk**	**2-4/wk**	**5-6/wk**	**1/day**	**2-3/day**	**4-5/day**	**>6/day**
16. Margarine, soft	1 Tsp	☐	☐	☐	☐	☐	☐	☐	☐	☐
17. Ice cream	1 bowl	☐	☐	☐	☐	☐	☐	☐	☐	☐
18. Butter	1 heaped Tbs	☐	☐	☐	☐	☐	☐	☐	☐	☐
19. Lard	1 Tbs	☐	☐	☐	☐	☐	☐	☐	☐	☐
20. Finea/Masmix	1 Tsp	☐	☐	☐	☐	☐	☐	☐	☐	☐

During the past year, on average, how often have you consumed the following fruits? (please check the appropriate box)

Fruits	**Avg Serving**	**Never, less than once/month**	**1-3/mo**	**1/wk**	**2-4/wk**	**5-6/wk**	**1/day**	**2-3/day**	**4-5/day**	**>6/day**
21. Apple	1 medium	☐	☐	☐	☐	☐	☐	☐	☐	☐
22. Banana	1 medium	☐	☐	☐	☐	☐	☐	☐	☐	☐
23. Grapefruit	1 medium	☐	☐	☐	☐	☐	☐	☐	☐	☐
24. Grapes	1 medium bunch	☐	☐	☐	☐	☐	☐	☐	☐	☐
25. Tangerine	1 medium	☐	☐	☐	☐	☐	☐	☐	☐	☐
26. Strawberries	1/2 cup	☐	☐	☐	☐	☐	☐	☐	☐	☐
27. Kiwi fruit	1 medium	☐	☐	☐	☐	☐	☐	☐	☐	☐
28. Lemon	1 medium	☐	☐	☐	☐	☐	☐	☐	☐	☐
29. Orange	1 medium	☐	☐	☐	☐	☐	☐	☐	☐	☐
30. Peach	1 medium	☐	☐	☐	☐	☐	☐	☐	☐	☐
31. Pear	1 medium	☐	☐	☐	☐	☐	☐	☐	☐	☐
32. Plum	1 medium	☐	☐	☐	☐	☐	☐	☐	☐	☐
33. Raspberries	1 glass	☐	☐	☐	☐	☐	☐	☐	☐	☐

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During the past year, on average, how often have you consumed the following vegetables? (please check the appropriate box)

Vegetables	**Avg Serving**	**Never, less than once/month**	**1-3/mo**	**1/wk**	**2-4/wk**	**5-6/wk**	**1/day**	**2-3/day**	**4-5/day**	**>6/day**
34. Beans, white (boiled)	1 plate	☐	☐	☐	☐	☐	☐	☐	☐	☐
35. Beets, cooked	1 plate	☐	☐	☐	☐	☐	☐	☐	☐	☐
36. Broccoli, green	1 plate	☐	☐	☐	☐	☐	☐	☐	☐	☐
37. Cabbage, red (raw)	1 plate	☐	☐	☐	☐	☐	☐	☐	☐	☐
38. Cabbage, Shantung	1 plate	☐	☐	☐	☐	☐	☐	☐	☐	☐
39. Cabbage, white (raw)	1 plate	☐	☐	☐	☐	☐	☐	☐	☐	☐
40. Cabbage, white (boiled)	1 plate	☐	☐	☐	☐	☐	☐	☐	☐	☐
41. Carrot (fresh)	1 plate	☐	☐	☐	☐	☐	☐	☐	☐	☐
42. Carrot (boiled)	1 plate	☐	☐	☐	☐	☐	☐	☐	☐	☐
43. Cauliflower (raw)	1 plate	☐	☐	☐	☐	☐	☐	☐	☐	☐
44. Cauliflower (boiled with butter)	1 plate	☐	☐	☐	☐	☐	☐	☐	☐	☐
45. Chives	1 Tsp	☐	☐	☐	☐	☐	☐	☐	☐	☐
46. Cucumber (raw)	1 medium	☐	☐	☐	☐	☐	☐	☐	☐	☐
47. Garlic (raw)	1 clove	☐	☐	☐	☐	☐	☐	☐	☐	☐
48. Lettuce	5 leaves	☐	☐	☐	☐	☐	☐	☐	☐	☐
49. Mushroom (fried)	1/2 cup	☐	☐	☐	☐	☐	☐	☐	☐	☐
50. Onion (raw)	1 slice	☐	☐	☐	☐	☐	☐	☐	☐	☐
51. Parsley (leaves)	1 Tbs	☐	☐	☐	☐	☐	☐	☐	☐	☐
52. Horseradish	1 Tbs	☐	☐	☐	☐	☐	☐	☐	☐	☐
53. Pepper (cooked)	1 medium	☐	☐	☐	☐	☐	☐	☐	☐	☐
54. Pepper, red (raw)	1 medium	☐	☐	☐	☐	☐	☐	☐	☐	☐

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During the past year, on average, how often have you consumed the following vegetables? (please check the appropriate box)

Vegetables, Cont'	**Avg Serving**	**Never, less than once/month**	**1-3/mo**	**1/wk**	**2-4/wk**	**5-6/wk**	**1/day**	**2-3/day**	**4-5/day**	**>6/day**
55. Potato (french fried)	1 plate	☐	☐	☐	☐	☐	☐	☐	☐	☐
56. Potato (boiled)	2 medium/150 g	☐	☐	☐	☐	☐	☐	☐	☐	☐
57. Potato (mashed)	1 plate	☐	☐	☐	☐	☐	☐	☐	☐	☐
58. Radish	3 pieces	☐	☐	☐	☐	☐	☐	☐	☐	☐
59. Tomato (raw)	1 medium	☐	☐	☐	☐	☐	☐	☐	☐	☐
60. Tomato (cooked)	1 cup	☐	☐	☐	☐	☐	☐	☐	☐	☐
61. Tomato sauce	1 cup	☐	☐	☐	☐	☐	☐	☐	☐	☐
62. Spinach (cooked)	1 plate	☐	☐	☐	☐	☐	☐	☐	☐	☐
63. Squash, summer (cooked)	1 plate	☐	☐	☐	☐	☐	☐	☐	☐	☐
64. String beans (boiled)	1 plate	☐	☐	☐	☐	☐	☐	☐	☐	☐
65. Sweet corn, (canned, drained)	1 plate	☐	☐	☐	☐	☐	☐	☐	☐	☐
66. Peas, green, (canned, drained)	1 plate	☐	☐	☐	☐	☐	☐	☐	☐	☐

During the past year, on average, how often have you consumed the following meat, eggs, etc.? (please check the appropriate box)

Meat, Eggs, etc.										
67. Eggs (boiled, fried)	1	☐	☐	☐	☐	☐	☐	☐	☐	☐
68. Beef steaks	1 piece	☐	☐	☐	☐	☐	☐	☐	☐	☐
69. Beef, ham (cooked)	1piece	☐	☐	☐	☐	☐	☐	☐	☐	☐
70. Chicken fillets (breaded, fried)	1 piece	☐	☐	☐	☐	☐	☐	☐	☐	☐
71. Chicken ham	1 piece	☐	☐	☐	☐	☐	☐	☐	☐	☐
72. Chicken with skin (cooked/fried)	1 piece	☐	☐	☐	☐	☐	☐	☐	☐	☐
73. Chicken without skin (cooked/fried)	1 piece	☐	☐	☐	☐	☐	☐	☐	☐	☐

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During the past year, on average, how often have you consumed the following meat, eggs, etc.? (please check the appropriate box)

Meat, Eggs, etc. con't	**Avg Serving**	**Never, less than once/month**	**1-3/mo**	**1/wk**	**2-4/wk**	**5-6/wk**	**1/day**	**2-3/day**	**4-5/day**	**>6/day**
74. Cod fillets (breaded and fried)	1 piece	☐	☐	☐	☐	☐	☐	☐	☐	☐
75. Herring in cream	1 small plate	☐	☐	☐	☐	☐	☐	☐	☐	☐
76. Frankfurter/ Hotdog	1 medium	☐	☐	☐	☐	☐	☐	☐	☐	☐
77. Luncheon meat (pork)	1 slice	☐	☐	☐	☐	☐	☐	☐	☐	☐
78. Mackerel (smoked)	1 piece	☐	☐	☐	☐	☐	☐	☐	☐	☐
79. Pork, belly (no bone, boiled)	1 slice	☐	☐	☐	☐	☐	☐	☐	☐	☐
80. Pork ham	1 slice	☐	☐	☐	☐	☐	☐	☐	☐	☐
81. Pork cutlets (breaded, fried)	1 slice	☐	☐	☐	☐	☐	☐	☐	☐	☐
82. Sausage, Slaska (pork, cooked)	50g	☐	☐	☐	☐	☐	☐	☐	☐	☐
83. Sausage Krakowska (pork and beef)	50g	☐	☐	☐	☐	☐	☐	☐	☐	☐
84. Sausage (pork, biala)	50g	☐	☐	☐	☐	☐	☐	☐	☐	☐
85. Turkey, ham	1 slice	☐	☐	☐	☐	☐	☐	☐	☐	☐
86. Turkey (roasted)	1 slice	☐	☐	☐	☐	☐	☐	☐	☐	☐
87. Turkey, sausage (Szynkowa)	50g	☐	☐	☐	☐	☐	☐	☐	☐	☐
88. Head Cheese, white and black	50g	☐	☐	☐	☐	☐	☐	☐	☐	☐
89. Organ meat (liver,tounge,heart)	1 piece	☐ **Never**	☐ **less than 1/month**	☐ **1/month**	☐ **2-3/month**	☐ **1/wk or more**				

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During the past year, on average, how often have you consumed the following breads and cereals? (please check the appropriate box)

Breads, Cereals	Avg Serving	Never, less than once/month	1-3/mo	1/wk	2-4/wk	5-6/wk	1/day	2-3/day	4-5/day	>6/day
90. Wheat bread	1 slice	☐	☐	☐	☐	☐	☐	☐	☐	☐
91. Rice (boiled)	2 Tbs	☐	☐	☐	☐	☐	☐	☐	☐	☐
92. Rye, brown bread	1 slice	☐	☐	☐	☐	☐	☐	☐	☐	☐
93. Wheat rolls (Kajzerki)	1	☐	☐	☐	☐	☐	☐	☐	☐	☐
94. Wheat rolls (Wroclawskie)	1 slice	☐	☐	☐	☐	☐	☐	☐	☐	☐
95. Wheat-rye bread/ White bread	1 slice	☐	☐	☐	☐	☐	☐	☐	☐	☐
96. Wheat-rye bread with sunflower seeds	1 plate	☐	☐	☐	☐	☐	☐	☐	☐	☐
97. Cold Cereal (Cornflakes)	25g	☐	☐	☐	☐	☐	☐	☐	☐	☐
98. Pasta (cooked)	1 plate	☐	☐	☐	☐	☐	☐	☐	☐	☐

During the past year, on average, how often have you consumed the following mixed dishes? (please check the appropriate box)

Mixed Dishes	Avg Serving	Never, less than once/month	1-3/mo	1/wk	2-4/wk	5-6/wk	1/day	2-3/day	4-5/day	>6/day
99. Baked beans with meat	1 plate	☐	☐	☐	☐	☐	☐	☐	☐	☐
100. Beef and pork minced cutlets, fried	1 medium	☐	☐	☐	☐	☐	☐	☐	☐	☐
101. Broth	1 plate/400 g	☐	☐	☐	☐	☐	☐	☐	☐	☐
102. Buckwheat groats (boiled)	1 plate	☐	☐	☐	☐	☐	☐	☐	☐	☐
103. Cabbage leaves, stuffed	1 plate	☐	☐	☐	☐	☐	☐	☐	☐	☐
104. Chicken pate (canned)	1 slice	☐	☐	☐	☐	☐	☐	☐	☐	☐
105. Pearl barley groats, boiled	1 plate	☐	☐	☐	☐	☐	☐	☐	☐	☐
106. Soup with vegetables	1 plate/400 g	☐	☐	☐	☐	☐	☐	☐	☐	☐

Subject ID

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Centre # Community # Household # Subject #

Subject Initials ☐☐☐

During the past year, on average, how often have you consumed the following mixed dishes? (please check the appropriate box)

Mixed Dishes con't	**Avg Serving**	**Never, less than once/month**	**1-3/mo**	**1/wk**	**2-4/wk**	**5-6/wk**	**1/day**	**2-3/day**	**4-5/day**	**>6/day**
107. Soup, Krupnik with pearl barley groats	1 plate/400 g	☐	☐	☐	☐	☐	☐	☐	☐	☐
108. Soup, Zurek sour rye	1 plate/400 g	☐	☐	☐	☐	☐	☐	☐	☐	☐
109. Soup, milk with rolled oats	1 plate/400 g	☐	☐	☐	☐	☐	☐	☐	☐	☐
110. Soup, tomato	1 plate/400 g	☐	☐	☐	☐	☐	☐	☐	☐	☐
111. Soup, sauerkraut	1 plate/400 g	☐	☐	☐	☐	☐	☐	☐	☐	☐
112 Soup, white bean	1 plate/400 g	☐	☐	☐	☐	☐	☐	☐	☐	☐
113. Polish dumplings with meat	1 plate	☐	☐	☐	☐	☐	☐	☐	☐	☐
114. Sauerkraut with sausage and meat, (Bigos, stewed)	1 plate	☐	☐	☐	☐	☐	☐	☐	☐	☐
115. Shantung cabbage, salad with mayonnaise	1 small plate	☐	☐	☐	☐	☐	☐	☐	☐	☐
116. Sauerkraut salad	1 plate	☐	☐	☐	☐	☐	☐	☐	☐	☐
117. Dumplings with potato filling (Ruskie, boiled)	1 plate	☐	☐	☐	☐	☐	☐	☐	☐	☐
118. Lettuce with sour cream salad	1 plate	☐	☐	☐	☐	☐	☐	☐	☐	☐
119. Vegetable salad, cooked with mayonnaise	1 plate	☐	☐	☐	☐	☐	☐	☐	☐	☐

During the past year, on average, how often have you consumed the following beverages? (please check the appropriate box)

Beverages	**Avg Serving**	**Never, less than once/month**	**1-3/mo**	**1/wk**	**2-4/wk**	**5-6/wk**	**1/day**	**2-3/day**	**4-5/day**	**>6/day**
120. Orange juice	1 glass	☐	☐	☐	☐	☐	☐	☐	☐	☐
121. Raspberry juice	1 glass	☐	☐	☐	☐	☐	☐	☐	☐	☐

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Centre # Community # Household # Subject #

Subject Initials ☐☐☐

During the past year, on average, how often have you consumed the following beverages? (please check the appropriate box)

Beverages, con't	**Avg Serving**	**Never, less than once/month**	**1-3/mo**	**1/wk**	**2-4/wk**	**5-6/wk**	**1/day**	**2-3/day**	**4-5/day**	**>6/day**
122. Carrot juice	1 glass	☐	☐	☐	☐	☐	☐	☐	☐	☐
123. Apple juice	1 glass	☐	☐	☐	☐	☐	☐	☐	☐	☐
124. Grapefruit juice	1 glass	☐	☐	☐	☐	☐	☐	☐	☐	☐
125. Blackcurrent juice	1 glass	☐	☐	☐	☐	☐	☐	☐	☐	☐
126. Multifruit juice from Polish fruits	1 glass	☐	☐	☐	☐	☐	☐	☐	☐	☐
127. Multifruit juice from exotic fruits	1 glass	☐	☐	☐	☐	☐	☐	☐	☐	☐
128. Fruits drink	1 glass	☐	☐	☐	☐	☐	☐	☐	☐	☐
129. Soft drink (regular)	1 glass	☐	☐	☐	☐	☐	☐	☐	☐	☐
130. Soft drink (low calorie)	1 glass	☐	☐	☐	☐	☐	☐	☐	☐	☐
131. Coffee	1 glass	☐	☐	☐	☐	☐	☐	☐	☐	☐
132. Black tea	1 glass	☐	☐	☐	☐	☐	☐	☐	☐	☐
133. Herbal/green	1 glass	☐	☐	☐	☐	☐	☐	☐	☐	☐
134. Beer	1 bottle/330 mL	☐	☐	☐	☐	☐	☐	☐	☐	☐
135. Wine, red	1 glass	☐	☐	☐	☐	☐	☐	☐	☐	☐
136. Vodka	1 glass	☐	☐	☐	☐	☐	☐	☐	☐	☐

During the past year, on average, how often have you consumed the following snacks? (please check the appropriate box)

Snacks	**Avg Serving**	**Never, less than once/month**	**1-3/mo**	**1/wk**	**2-4/wk**	**5-6/wk**	**1/day**	**2-3/day**	**4-5/day**	**>6/day**
137. Milk chocolate	1 bar	☐	☐	☐	☐	☐	☐	☐	☐	☐
138. Bitter chocolate	1 bar	☐	☐	☐	☐	☐	☐	☐	☐	☐

Subject ID

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Centre # Community # Household # Subject #

Subject Initials ☐☐☐

During the past year, on average, how often have you consumed the following snacks? (please check the appropriate box)

Snacks, con't	**Avg Serving**	**Never, less than once/month**	**1-3/mo**	**1/wk**	**2-4/wk**	**5-6/wk**	**1/day**	**2-3/day**	**4-5/day**	**>6/day**
139. Biscuits	small pack/50 g	☐	☐	☐	☐	☐	☐	☐	☐	☐
140. Yeast cake	1 slice	☐	☐	☐	☐	☐	☐	☐	☐	☐
141. Short-cake	1 slice	☐	☐	☐	☐	☐	☐	☐	☐	☐
142. Gingerbread cake	1 slice	☐	☐	☐	☐	☐	☐	☐	☐	☐
143. Sponge cake	1 slice	☐	☐	☐	☐	☐	☐	☐	☐	☐
144. Cheesecake (Krakowski)	1 slice	☐	☐	☐	☐	☐	☐	☐	☐	☐
145. Honey	1 Tbs	☐	☐	☐	☐	☐	☐	☐	☐	☐
146. Halva with vanilla	1 piece	☐	☐	☐	☐	☐	☐	☐	☐	☐
147. Drops	6	☐	☐	☐	☐	☐	☐	☐	☐	☐
148. Mayonnaise	1 Tbs	☐	☐	☐	☐	☐	☐	☐	☐	☐
149. Nuts	1/2 cup	☐	☐	☐	☐	☐	☐	☐	☐	☐
150. Raisins, dried	1/2 cup	☐	☐	☐	☐	☐	☐	☐	☐	☐
151. Sweets	1 Tbs	☐	☐	☐	☐	☐	☐	☐	☐	☐
152. Sugar	2 Tbs	☐	☐	☐	☐	☐	☐	☐	☐	☐
153. Seeds	1 Tbs	☐	☐	☐	☐	☐	☐	☐	☐	☐
154. Walnuts	1 Tbs	☐	☐	☐	☐	☐	☐	☐	☐	☐

Subject ID

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Centre # Community # Household # Subject #

Subject Initials ☐☐☐

Vitamins

155. Do you regularly take vitamin pills? ☐ No ☐ Yes

156. Do you regularly take mineral pills? ☐ No ☐ Yes

If yes for how many years and how often have you taken?

	≤ 1 year		1-3 years		4-6 years		> 6 years	
	mostly	occasionaly	mostly	occasionaly	mostly	occasionaly	mostly	occasionaly
157. Vitamin A	☐	☐	☐	☐	☐	☐	☐	☐
158. Vitamin D	☐	☐	☐	☐	☐	☐	☐	☐
159. Vitamin E	☐	☐	☐	☐	☐	☐	☐	☐
160. Vitamin B complex	☐	☐	☐	☐	☐	☐	☐	☐
161. Vitamin C	☐	☐	☐	☐	☐	☐	☐	☐
162. Calcium	☐	☐	☐	☐	☐	☐	☐	☐
163. Iron	☐	☐	☐	☐	☐	☐	☐	☐
164. Zinc	☐	☐	☐	☐	☐	☐	☐	☐
165. Multiviamin /Mineral supplement	☐	☐	☐	☐	☐	☐	☐	☐

What type of cooking oil is usually used at home and what is the frequency of consumption?

	Avg Serving	Never, less than	1-3/mo	1/wk	2-4/wk	5-6/wk	1/day	2-3/day	4-5/day	>6/day
166. Soybean	1/2 cup	☐	☐	☐	☐	☐	☐	☐	☐	☐
167. Corn	1/2 cup	☐	☐	☐	☐	☐	☐	☐	☐	☐
168. Vegetable	1/2 cup	☐	☐	☐	☐	☐	☐	☐	☐	☐
169. Sunflower	1/2 cup	☐	☐	☐	☐	☐	☐	☐	☐	☐
170. Canola	1/2 cup	☐	☐	☐	☐	☐	☐	☐	☐	☐
171. Cottonseed	1/2 cup	☐	☐	☐	☐	☐	☐	☐	☐	☐
172. Olive	1/2 cup	☐	☐	☐	☐	☐	☐	☐	☐	☐

173. Name of Interviewer: ***(please print)*** _____ *First Initial* _____ *Last Name* **Interviewer Code:** ☐☐☐

12.5 Oświadczenia współautorów

mgr Alicja Szypowska
Zakład Dietetyki*
Uniwersytet Medyczny im. Piastów Śląskich we Wrocławiu

Wrocław, 29.06.2023

OŚWIADCZENIE

Oświadczam, że w pracach

1) **Comparison of intake of food groups based on dietary inflam-matory index (DII) and cardiovascular risk factors in the mid-dle-age population of Lower Silesia: results of the PURE Poland Study.** Alicja Szypowska, Bożena Regulska-Ilow, Katarzyna Zatońska, Andrzej Szuba, 2023, Antioxidants, vol. 12, nr 2, art. 285 [18 s.]
2) **Dietary Inflammatory Index (DII)® and Metabolic Syndrome in the Selected Population of Polish Adults: Results of the PURE Poland Sub-Study,** Alicja Szypowska, Katarzyna Zatońska, Andrzej Szuba, Bożena Regulska-Ilow, International Journal of Environmental Research and Public Health, 2023, vol. 20, nr 2, art. 1056 [14s.]

mój udział polegał na opracowaniu koncepcji i metodologii manuskryptów, gromadzeniu i analizie danych dotyczących publikacji, zebraniu piśmiennictwa, pisaniu treści manuskryptów oraz korekcie prac przed złożeniem do druku.

*zatrudniona do 06.2021

Alicja Szypowska

Podpis

dr hab. Bożena Regulska-Ilow, prof. UMW
Katedra i Zakład Dietetyki i Bromatologii
Uniwersytet Medyczny im. Piastów Śląskich we Wrocławiu

Wrocław, 29.06.2023

OŚWIADCZENIE

Oświadczam, że w pracach:

1) **Comparison of intake of food groups based on dietary inflam-matory index (DII) and cardiovascular risk factors in the middle-age population of Lower Silesia: results of the PURE Poland Study,** Alicja Szypowska, Bożena Regulska-Ilow, Katarzyna Zatońska, Andrzej Szuba, 2023, Antioxidants, vol. 12, nr 2, art. 285 [18 s.]
2) **Dietary Inflammatory Index (DII)® and Metabolic Syndrome in the Selected Population of Polish Adults: Results of the PURE Poland Sub-Study,** Alicja Szypowska, Katarzyna Zatońska, Andrzej Szuba, Bożena Regulska-Ilow, International Journal of Environmental Research and Public Health, 2023, vol. 20, nr 2, art. 1056 [14s.]

mój udział polegał na opiece promotorskiej, nadzorze merytorycznym nad realizacją projektu badawczego i ostatecznej akceptacji artykułu.

Bożena Regulska-Ilow

Podpis

dr hab. Katarzyna Zatońska, profesor UMW
Katedra Zdrowia Populacyjnego
Uniwersytet Medyczny im. Piastów Śląskich we Wrocławiu

Wrocław, 29.06.2023

OŚWIADCZENIE

Oświadczam, że w pracach

1) **Comparison of intake of food groups based on dietary inflam-matory index (DII) and cardiovascular risk factors in the middle-age population of Lower Silesia: results of the PURE Poland Study,** Alicja Szypowska, Bożena Regulska-Ilow, Katarzyna Zatońska, Andrzej Szuba, 2023, Antioxidants, vol. 12, nr 2, art. 285 [18 s.]
2) **Dietary Inflammatory Index (DII)® and Metabolic Syndrome in the Selected Population of Polish Adults: Results of the PURE Poland Sub-Study,** Alicja Szypowska, Katarzyna Zatońska, Andrzej Szuba, Bożena Regulska-Ilow, International Journal of Environmental Research and Public Health, 2023, vol. 20, nr 2, art. 1056 [14s.]

mój udział polegał na gromadzeniu danych biochemicznych i antropometrycznych oraz ostatecznej akceptacji artykułu.

Podpis

prof. dr hab. Andrzej Szuba
Katedra i Klinika Angiologii, Nadciśnienia Tętniczego i Diabetologii
Uniwersytet Medyczny im. Piastów Śląskich we Wrocławiu

Wrocław, 29.06.2023

OŚWIADCZENIE

Oświadczam, że w pracach

1) **Comparison of intake of food groups based on dietary inflammatory index (DII) and cardiovascular risk factors in the middle-age population of Lower Silesia: results of the PURE Poland Study,** Alicja Szypowska, Bożena Regulska-Ilow, Katarzyna Zatońska, Andrzej Szuba, 2023, Antioxidants, vol. 12, nr 2, art. 285 [18 s.]
2) **Dietary Inflammatory Index (DII)® and Metabolic Syndrome in the Selected Population of Polish Adults: Results of the PURE Poland Sub-Study,** Alicja Szypowska, Katarzyna Zatońska, Andrzej Szuba, Bożena Regulska-Ilow, International Journal of Environmental Research and Public Health, 2023, vol. 20, nr 2, art. 1056 [14s.]

mój udział polegał na nadzorze nad projektem PURE Poland, w tym gromadzeniem danych biochemicznych i antropometrycznych oraz ostatecznej akceptacji artykułu.

prof. dr hab. n. med. Andrzej Szuba
specjalista chorób wewnętrznych
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Podpis