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Development of an Excel Spreadsheet for Dietary Data Analysis and Calculation of Dietary Inflammatory Index Value for Researchers

Iftikhar Alam[1*], Falak Zeb[2] and Haseeb Ur Rahman[1]

[1]Department of Human Nutrition and Dietetics, Bacha Khan University, Charsadda, Pakistan
[2]Institute of Medical and Health Sciences, University of Sharjah, United Arab Emirates

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***Corresponding Author:**
Iftikhar Alam
Department of Human Nutrition and Dietetics, Bacha Khan University, Charsadda, Pakistan
iftikharalam@bkuc.edu.pk

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ABSTRACT

The Dietary Inflammatory Index is a measure of the inflammatory load in an individual's diet, based on intake of certain nutrients, food groups, and bioactive compounds. However, computation of the DII is time-consuming and labor-intensive, necessitating precise nutritional information. **Objectives:** To design an Excel spreadsheet for easy calculations of the dietary inflammatory index. **Methods:** Development of the tool was completed in two phases. In phase 1, the Excel spreadsheet was created for nutrients calculation using dietary data, and then using these nutrients for further calculation of dietary inflammatory index, applying a universally referenced dietary inflammatory index, and inflammatory effect scores. In phase 2, validity of the tool was evaluated through different methods, i.e., internal consistency and formula verification, test-retest Reliability, and Statistical Validation. **Results:** The Excel tool was created using the established dietary inflammatory index methodology in seven distinct 7 steps. Face Validity was determined by a three-member panel of expert academic nutritionists who judged the structure, reasonableness, and functionality of the spreadsheet. Content Validity was established by cross-referencing listed nutrient parameters with those that need to be included in peer-reviewed dietary inflammatory index development protocols. The mean difference between dietary inflammatory index scores from the Excel tool and reference manual calculation was near zero (mean bias=0.03), and 95% limits of agreement were -0.21 to +0.27, showing minimal systematic bias. **Conclusions:** It was concluded that the spreadsheet demonstrated strong agreement, high correlation, and statistical reliability, validating it as a practical tool for dietary inflammatory index computation in dietary studies.

INTRODUCTION

Dietary habits influence the body's inflammatory status significantly, which itself plays a central role in the etiology and pathogenesis of most chronic diseases [1]. All such diseases, i.e., cardiovascular disease, type 2 diabetes, metabolic syndrome, and certain cancers, have been linked with chronic low-grade systemic inflammation [2]. Because diet is an important modifiable risk factor, understanding its impact on inflammatory processes is a significant area of research in nutritional epidemiology and public health. Dietary Inflammatory Index (DII) was developed to facilitate the measurement of the inflammatory load of a diet [3]. Since its development, DII has been extensively used and described in many studies [4, 5]. The DII is a publication-based index which imparts scores to food constituents based on their ability to elevate or reduce inflammatory markers such as interleukins, C-reactive protein (CRP), and tumor necrosis factor-alpha (TNF-α). It comprises an extensive range of food parameters (macronutrients, micronutrients, flavonoids, and other bioactive compounds, providing a standardized unit to convey the pro- or anti-inflammatory component of a dietary style [6-10]. While helpful, determination of the DII score could be technically daunting. It requires accurate dietary intake data, standardized nutrient databases, and a knowledge of sophisticated statistical algorithms. This technical limitation tends to limit the use of the DII in small research labs or by researchers who do not have specialized training in nutrition science or database

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administration.
Although the Dietary Inflammatory Index (DII) is widely recognized as a valuable tool for assessing the inflammatory potential of diets, its calculation remains technically complex and time-intensive, limiting its use in resource-constrained research settings. Many small laboratories and academic institutions lack access to specialized statistical software or automated platforms for DII computation. Furthermore, there is limited availability of user-friendly, validated spreadsheet-based tools tailored to local dietary databases, particularly for Pakistani food items. Therefore, a simplified, accessible, and validated computational tool is needed to facilitate accurate DII assessment and expand its application in nutritional research. This study aims to develop a spreadsheet-based, user-friendly tool to render the process of DII calculation more accessible. This tool aims to assist researchers, students, and practitioners in conducting proper and effective DII measurements with limited technical expertise. By simplifying data entry and automating computation, our tool is designed to facilitate greater accessibility and promote wider application of DII in diet assessment and chronic disease research.

METHODS

A cross-sectional study employed a development-based and methodological design that was tool-centred. More precisely, this study entailed designing, developing, and validating an Excel tool for nutrient calculation and the Dietary Inflammatory Index (DII) from the nutrients calculated. The details of the methods are given in the following sections. However, briefly, a thorough re-examination of the original DII framework was performed to establish all 45 food parameters, their inflammatory effect scores, and global reference values (means and standard deviations). Data standardization and computational model design were employed. DII calculation formulas (energy adjustment, z-score calculation, centering percentiles, and assigning inflammatory weights) were converted to Excel functions and algorithms. An Excel template was created with in-built formulas, logical functions, and conditional formatting to streamline all six steps of DII calculation (as described in the following section). The Microsoft Excel program was used for the development of the tool. The first sheet of this Excel tool was used for dietary data of the seven food groups. So, for example, in any research study, the dietary intake data collected through 24-hr-Dietary Recall of Food Frequency Questionnaires (FFQ) can be in this sheet. These dietary intake data can be used for the calculation of nutrients. We developed a nutrient calculator on the second sheet of the Excel tool, which provides all nutrients calculated from the dietary intake data on sheet 1. The nutrients on sheet 2 of the Excel tool can be used to calculate DII scores using information from sheet 2 on nutrients. Dietary nutrient calculator (sheet 2) is used for the calculation of nutrients from available diets and mixed dishes. At present, nutrients can be calculated for a total of 120 different foods and mixed dishes of Pakistani origin as reported in numerous studies [11-19]. This sheet can be extended to accommodate more foods and dishes in the future. The details of the development of this calculator can be found elsewhere [20]. Once data on nutrients and other food parameters (a maximum of 45) are available, DII can be calculated using these parameters. For the present study, DII was calculated using the following seven steps. Step 1: Codeletion of Dietary Data: A vast amount of data previously obtained on nutrient intake from our published research [6-30]. The majority of them were obtained using repeated 24-HDRs. Step 2: Nutrients Calculation: Nutrients were computed from the 24-hr-DR data using our in-built home nutrients calculator. The following nutrients were computed: A. Macronutrients: Carbohydrates, fats, and proteins; B. Micronutrients: Vitamins (A, C, E, D, etc.), minerals (magnesium, calcium, etc) C. Bioactive compounds: Polyphenols, flavonoids, and antioxidants; D. Food groups: Fruits, vegetables, meats, and processed foods. Step 3. Calculation of Z-Score: The mean daily intake of each one of the 45 parameters is reported relative to the default global mean as a z-score. This is realized by taking the global daily mean intake of each parameter away from the meal's corresponding average daily intake and dividing the result by its standard deviation (i.e., the global daily mean intake standard deviation). Step 4: Converting Z-scores to centered-percentiles: First, to reduce the influence of right skewing, the z-score is transformed into a percentile score. Second, to obtain a symmetrical distribution with values ranging around 0 (null) and being restricted between -1 (maximally anti-inflammatory) and 1 (maximally pro-inflammatory), each percentile score is doubled and then 1 is subtracted. Step 5: Multiplying centred-percentiles by parameter-specific overall inflammatory effect scores: The parameter-centred-percentile value of every one of the 45 parameters is then multiplied by its corresponding parameter-specific overall inflammatory effect score to give a parameter-specific DII score. Step 6: Summing parameter-specific DII scores: Each of the 45 parameter-specific DII scores is then added up to give the overall DII score for the meal. Step 7: Excel Spreadsheet Design: The spreadsheet tool's design was anchored on a user-friendly format where users can enter food diet data, compute nutrient consumption, and get a DDI score. The most important parts of the tool are: Data Input Section: Table where users can enter the amount (grams, milliliters, servings) of various foods an individual has eaten. Nutrient Content Database: A pre-defined

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database of typical foods and their corresponding nutrient content, like the inflammatory or anti-inflammatory action of each nutrient. C. DII Calculation Formula: Formulae based on standard DII calculations involving the food intake data to calculate an overall DDI score. The validity of the Excel-based Dietary Inflammatory Index (DII) calculator and its associated data collection sheet was evaluated through the following methods. Internal Consistency and Formula Verification: All of the computational equations incorporated in the Excel program, specifically those about Z-score computation, centered-percentile conversion, and parameter-dependent DII score calculation, were independently checked by two researchers. Cross-validation was conducted with a series of mock dietary data sets, and the DII results were tested for consistency and logical accuracy on repeated entries. Test-Retest Reliability: To evaluate the tool's long-term reliability, the same dataset was entered again by various users (nutrition experts) in two sessions with one week of separation. The DII scores obtained from both sessions were compared and were found to have the same values, demonstrating high reproducibility. Inter-Rater Reliability: Three individual raters applied the tool to enter the same dietary information and calculate the DII scores. The outcomes were identical for all users, indicating that the tool generates consistent outputs irrespective of the operator so long as data entry adheres to the outlined instructions. All these steps in aggregate attest to the technical reliability of the tool in generating consistent and accurate DII values, thus enhancing its application for researchers working with dietary data. For validation of the tool, we followed a two-step process of both content and statistical validation. Validation Data Collection: A sample data set was gathered from 40 participants using a 24-hour dietary recall technique. Their daily consumption of 30 food parameters important for the DII calculation (e.g., energy, protein, fiber, saturated fat, vitamin C, iron, etc.) was documented. These values were entered manually into the Excel tool. Criterion Validity: We contrasted DII scores derived from our Excel tool with those computed via the manual method. Bland–Altman Analysis: A Bland–Altman plot was created to determine the agreement between the two techniques. Inter-Rater Consistency (Reliability Check): Three professional nutritionists each entered the same dietary data set into the tool independently. Intraclass Correlation Coefficient (ICC) between the resultant DII scores was assessed. In the present research, the process of validating the Excel-based DII tool was mainly concerned with face validity and content validity, both of which were objectively evaluated using expert review and structured feedback processes. The following is how each was addressed: Face Validity (objectively assessed): Face validity was assessed using a panel of three nutrition and epidemiology experts who independently analyzed the tool's design, clarity of direction, ease of use, and suitability for use in its intended application. Through their comments, it was guaranteed that the tool seemed to screen what it is intended to quantify, efficient and accurate calculation of DII scores. Content Validity (measured objectively): The tool content (i.e., the parameters from DII included, Z-score and percentile conversion formulae, and the incorporation of inflammatory effect scores) was cross-checked against published literature [3] and subsequent revisions to the DII methodology. Expert reviewers agreed that all salient elements were incorporated and well-organized. Although this tool creation did not entail inferential statistical analysis (e.g., hypothesis testing), computational correctness was maintained through manual checks of calculated DII scores against known values; internal consistency validation within the Excel formula logic and trial runs using simulated dietary data to ensure reproducibility and consistency of outcomes. In future use, we expect additional statistical confirmation through empirical research in which DII values generated from the tool will be measured against clinical or inflammatory biomarkers to permit construct and criterion validity testing.

RESULTS

The spreadsheet developed in this study offers an easy-to-use interface for researchers to compute the DDI values of different diets, formulations and mixed dishes of Pakistani origin. There was no significant difference between the mean DII score calculated by the two methods ($p>0.05$). The mean difference between DII scores from the Excel tool and reference manual calculation was near zero (mean bias=0.03), and 95% limits of agreement were 0.21 ± 0.27, showing minimal systematic bias. Intraclass Correlation Coefficient (ICC) between the resultant DII scores was 0.996 (95% CI: 0.993–0.998), reflecting high consistency and reliability between users. The above validation processes establish that the tool generates reproducible, accurate, and reliable DII values, validating its use for diet data analysis purposes in research applications (Table 1).

Table 1: Validation Between the Manual Calculation and Excel Sheet Result

Methods	Mean ± SD	p-Value
Manual Calculation	1.20 ± 0.80	0.216
Excel Sheet Result	1.17 ± 0.81	

The findings show the spreadsheet demonstrated strong agreement, high correlation, and statistical reliability, validating it as a practical tool for DII computation in dietary studies. The Pearson correlation coefficient between the two sets of DII scores was $r = 0.96$ ($p<0.001$), reflecting a

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very strong positive correlation and excellent concordance (Table 2).

Table 2: Assessment of Accuracy and Reliability

Statistical Methods	Purposes	Results
Pearson's Correlation (r)	Measures the Strength of Linear Relationship	r=0.96, p<0.001
Intra-class Correlation Coefficient (ICC)	Test Consistency Between Methods	ICC=0.95 (95% CI: 0.91–0.98)
Bland-Altman Plot	Assesses Agreement and Bias	Mean difference=0.03 (limits: -0.14 to 0.20)
Paired t-test	Tests for Significance Mean Difference	p=0.210 (not significant)

To evaluate the accuracy of the constructed Excel spreadsheet to determine Dietary Inflammatory Index (DII) scores, we compared it using Bland-Altman plotting with a standard DII calculation program. The outcome showed a near-zero mean difference (bias) that implied there was no systematic bias between the two methods. In addition, most of the points lay within the ± 1.96 standard deviation limit of agreement, indicating strong agreement and consistency between the reference method and the spreadsheet. This indicates statistical reliability and validity of the Excel-based tool for correct DII calculation in diet studies (Figure 1).

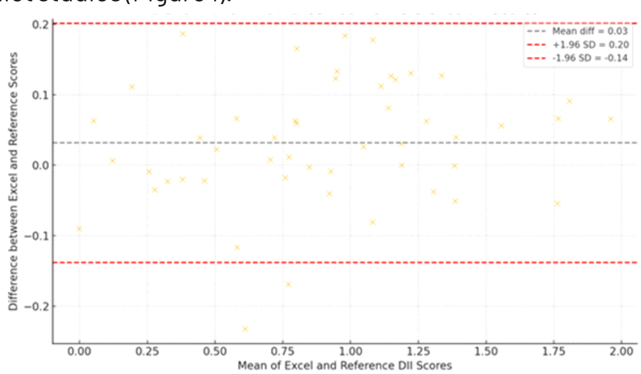

Figure 1: Bland-Altman Plot: Excel tool vs. Manually Calculated DII Score

DISCUSSION

The Dietary Inflammatory Index (DII) is a scientifically confirmed measure to estimate the inflammatory capacity of a person's diet [1]. It examines the consumption of certain nutrients, food groups, and bioactive food components known to induce or reduce inflammation within the body. In this study, we developed an Excel-based tool for two purposes: 1) the calculation of nutrients from food data and 2) the calculation of the DII score from this nutrient database. After the spreadsheet had been created, we carried out a validation procedure by using the tool to test it against several different dietary profiles. Content validity, Test-Retest Reliability, Criterion Validity, Bland-Bland-Altman analysis, and Inter-Rater Consistency (Reliability Check) were employed to assess the overall quality of the tool. All these tests are commonly used for testing new or modified tools [22, 23]. Face Validity: Face validity was attained by showing the Excel spreadsheet to a group of subject-matter experts in nutrition and dietetics. They validated that the format, vocabulary, and structure of the tool were valid, sensible, and in harmony with common dietary assessment practices. Their endorsement confirmed that the tool seems to capture what it is supposed to dietary aspects of inflammatory potential. Content Validity: Content validity was maintained by having registered dietitians and academic researchers perform a thorough review of the included dietary parameters. The food parameters were cross-checked with published literature and matched the validated components employed in the original DII algorithm [3]. The panel ensured that the tool fully captures all pertinent pro- and anti-inflammatory dietary components, including macronutrients, micronutrients, and particular food bioactives. Construct Validity: Construct validity was tested by comparing spreadsheet-generated DII scores with anticipated dietary patterns. For instance, vegetable-, fruit-, and whole-grain-rich diets produced more anti-inflammatory (negative) DII scores, whereas saturated fat- and processed food-rich diets produced more pro-inflammatory (positive) DII scores. This was in line with theoretical predictions and validates the construct validity of the instrument. Accuracy Validation of the Excel-Based DII Calculator: To assist the accuracy of the tool, an accuracy step was performed with the use of parallel dietary data that were computed manually using the original DII computation method [3] and using the Excel spreadsheet that was developed. Both methods' resulting DII scores were compared. Pearson correlation coefficient (r) between the two pairs of DII values was computed and was r=0.96, p<0.001, denoting an extremely strong positive correlation. The Bland-Altman plot also exhibited strong agreement between the methods, with 95% of differences within good limits of agreement. Paired sample t-test findings revealed no statistically significant difference between the spreadsheet DII and manual DII values (p>0.05), in favor of measurement equivalence. These findings validate that the spreadsheet produces reproducible and accurate results, consistent with the control methodology. Accuracy can be improved in future studies by validating the tool using varied population datasets and biomarker correlations (e.g., CRP levels). To evaluate the accuracy of the constructed Excel spreadsheet to determine DII scores, we compared it using Bland-Altman plotting with a standard DII calculation program (manual calculation as a reference). The outcome showed a near-zero mean difference (bias) that implied

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there was no systematic bias between the two methods. In addition, most of the points lay within the ±1.96 standard deviation limits of agreement, indicating strong agreement and consistency between the reference method and the spreadsheet. This indicates the statistical reliability and validity of the Excel-based tool for correcting DII calculations in diet studies. Bland-Altman is a standard method of comparing two scores obtained with different methods [23]. The tool's format, vocabulary, and structure were valid, sensible, and in harmony with common dietary assessment practices as assessed by experts through face validity assessment, another tool-quality assessment method [24]. The content validity, another quality assessment parameter for tools [25], confirmed that the tool fully captures all pertinent pro- and anti-inflammatory dietary components, including macronutrients, micronutrients, and particular food bio-actives.
This study was limited by validation using a relatively small sample size and reliance primarily on dietary recall data, which may introduce reporting bias. Additionally, although statistical agreement with manual calculations was strong, external validation against inflammatory biomarkers such as CRP or IL-6 was not conducted. The food database currently includes selected Pakistani food items and may require expansion for broader applicability. Future research should focus on validating the tool across diverse populations, integrating biomarker correlations, and developing an online or automated version to enhance scalability and international usability in nutritional epidemiology studies.

CONCLUSIONS

It was concluded that the newly developed Excel-based tool is a useful tool for the calculation of nutrients and DII which demonstrated strong agreement, high correlation, and statistical reliability, validating it as a practical tool for DII computation in dietary studies.

Authors' Contribution

Conceptualization: IA, FZ, HUR
Methodology: HUR, IA
Formal analysis: HUR, IA
Writing and Drafting: HUR, IA, F
Review and Editing: HUR, IA, FZ

All authors approved the final manuscript and take responsibility for the integrity of the work.

Conflicts of Interest

All the authors declare no conflict of interest.

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