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ROCZNIKI PAŃSTWOWEGO ZAKŁADU HIGIENY
[ANNALS OF THE NATIONAL INSTITUTE OF HYGIENE]

Volume 76 **2025** **Number 3**

OD REDAKTORA NACZELNEGO

Szanowni Państwo,

W bieżącym numerze Roczników Państwowego Zakładu Higieny pragnę zwrócić Państwa uwagę na dwa artykuły prezentujące aktualną i ważną tematykę wpływu mediów społecznościowych na zachowania żywieniowe i kształtowanie nawyków żywieniowych. W pierwszym z nich Z. Meskini i wsp. opisali sposób przeprowadzenia walidacji kwestionariusza oceny wpływu mediów społecznościowych na zachowania żywieniowe (SESMEB) wśród studentów w Algierii. Z kolei M. Mohr i M. Törőcsik zaprezentowały różnice w reakcjach obserwatorów blogów internetowych na temat żywności i żywienia, z uwzględnieniem tradycyjnych podziałów wyznaniowych w Europie. Ponadto w bieżącym numerze znajdują się dwa artykuły dotyczące wpływu różnych czynników, w tym żywieniowych, na występowanie nadwagi i otyłości wśród kobiet (H. Kachache i wsp.), także otyłości ukrytej (L. Hačková i wsp.). Żywienie kobiet jest również tematem artykułu M.K. Szmidt i D. Grandy, w którym przedstawione są wyniki przeglądu badań nad możliwością zastosowania modelu diety opartej o produkty zawierające składniki o działaniu przeciwzapalnym w łagodzeniu nasilenia bólu menstruacyjnego. Kwestii żywienia we wczesnym okresie życia poświęcony jest artykuł N. Bouali i wsp., w którym autorzy przedstawili porównanie zmian w pierwszych dwóch latach życia, parametrów antropometrycznych niemowląt urodzonych przedwcześnie, z hipotrofią wewnątrzmaciczną (IURG) i bez niej, wraz z oceną wpływu sposobu żywienia niemowląt na te zmiany. W artykule M. Andrulewicza została z kolei przedstawiona ocena stanu wiedzy studentów medycyny i dietetyki Uniwersytetu Medycznego w Białymstoku, na temat probiotyków oraz ich zastosowania w żywieniu w kontekście profilaktyki i wspomagania leczenia.

W bieżącym numerze znajduje się również informacja nt. elektronicznej Bazy danych o zawartości izomerów trans kwasów tłuszczowych w żywności w Polsce (e-Baza TFA), która w 2025 r. została zmodernizowana. Zachęcam Państwa do zapoznania się z danymi zawartymi w e-Bazie TFA i korzystania z nich zarówno w pracach badawczych, jak i w tworzeniu własnego modelu żywienia w profilaktyce chorób dietozależnych, których przyczyną może być nadmierne pobranie TFA z dietą.

Zapraszam do czytania i publikowania w Rocznikach PZH. Jednocześnie uprzejmie informuję, że od 2026 roku Roczniki PZH nie będą się już ukazywały w formie papierowej.

Z poważaniem,

Prof. dr hab. Hanna Mojska
Redaktor naczelna
Roczników Państwowego Zakładu Higieny

EDITORIAL INTRODUCTION

Ladies and Gentlemen,

In the current issue of the journal 'Roczniki Państwowego Zakładu Higieny', I would like to draw your attention to two articles presenting the current and important topic of the influence of social media on nutritional behaviors and the formation of eating habits. In the first article, Z. Meskini et al. described the method of validation of the questionnaire assessing the impact of social media on eating behavior (SESMEB) among students in Algeria. In turn, M. Mohr and M. Törőcsik presented differences in the reactions of internet about food and nutrition blogs followers, taking into account traditional religious divisions in Europe. In addition, the current issue includes two articles on the influence of various factors, among others nutritional ones, on the occurrence of overweight and obesity among women (H. Kachache et al.), including hidden obesity (L. Hačková et al.). Women's nutrition is also the subject of the article by M.K. Szmidt and D. Grandy, which presents the results of a review of research on the possibility of using a dietary model based on products containing anti-inflammatory ingredients in relieving the severity of menstrual pain. The issue of nutrition in early life is discussed in the article by N. Bouali et al., in which the authors presented a comparison of changes in anthropometric parameters of infants born prematurely, with and without intrauterine growth restriction (IURG), in the first two years of life, together with an assessment of the impact of infant feeding methods. The article by M. Andrulewicz presents the assessment of the state of knowledge of medical and dietetics students at the Medical University of Białystok on probiotics and their use in nutrition in the context of prevention and treatment support.

This issue also includes information on the electronic Database containing trans fatty acids in food in Poland data (TFA e-Database), which was modernized in 2025.

I encourage you to familiarize yourself with the data aggregated in the TFA e-Database and use it both in your research and in creating your own nutritional model to prevent diet-related diseases that may be caused by excessive TFA intake.

I invite you to read and publish in the journal 'Roczniki Państwowego Zakładu Higieny'. I also kindly inform you that, starting in 2026, the journal will no longer be published in print.

Kind regards,

Prof. Hanna Mojska, PhD
Editor-in-Chief
Roczniki Państwowego Zakładu Higieny

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REVIEW ARTICLE

ANTI-INFLAMMATORY FOOD PRODUCTS AND THE SEVERITY OF MENSTRUAL PAIN: A NARRATIVE REVIEW

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ABSTRACT

Menstruation is a natural physiological process in healthy women of reproductive age, often accompanied by physical and psychological symptoms that can impair daily functioning and quality of life. Given the established role of oxidative imbalance in menstrual discomfort, dietary products rich in anti-inflammatory and antioxidant compounds may offer a non-pharmacological approach to symptom management. However, to date, this area remains insufficiently explored in the literature. The aim of this narrative review was to assess the relationship between the consumption of foods with anti-inflammatory potential and the severity of menstrual pain. PubMed, ScienceDirect, and Web of Science were searched from inception to May 2025 using following keywords: "anti-inflammatory products", "whole grains", "fish", "seafood", "vegetables", "fruits", "legumes", "nuts", "seeds", "olive oil", "fats", "menstruation", "primary dysmenorrhea". Reference lists of included studies were also reviewed manually. Nine relevant studies were identified in the literature review (1 meta-analysis, 2 case-control, and 6 cross-sectional studies). The results showed that whole grains and fish consumption may be inversely associated with menstrual pain, though findings were inconsistent. While one meta-analysis on fruit and vegetable consumption and severity of menstrual pain found no significant association, several other studies reported a protective association with higher/more frequent intake. Evidence on legumes was inconclusive. No studies to date assessed the association between olive oil, nuts, and seeds and menstrual symptoms. Interpretation of findings was limited by methodological heterogeneity, including differences in dietary assessment, symptom measurement tools, and participant characteristics. Preliminary evidence suggests that the anti-inflammatory foods, such as whole grain, vegetables, and fish may help alleviate the severity of menstrual pain, but the current evidence is inconsistent. However, the number of studies published in this area to date is limited and generally of low quality. Therefore, further high-quality research is needed to clarify these associations.

Keywords: *anti-inflammatory products, diet, menstruation, primary dysmenorrhea, women*

INTRODUCTION

Menstruation is a natural physiological process that occurs in healthy women of reproductive age. In many cases, hormonal and physiological changes during the menstrual cycle are accompanied by various symptoms, which can be categorized as either physical or psychological. The most reported complaint is cramping pain in the lower abdomen. Other frequent symptoms include back pain, headaches, nausea, diarrhea, and general malaise [1]. The intensity and duration of menstrual symptoms can vary greatly among individuals, depending on factors such as individual sensitivity, hormonal balance, and overall health status. These symptoms may last from a few hours to several days [2-4]. Depending on their severity, menstrual symptoms may negatively affect daily functioning and quality of life [3, 5].

The pathophysiology of menstrual pain and related symptoms is not yet fully understood. However, recent theories emphasize that the severity of menstrual symptoms may be linked to inflammatory processes and oxidative stress that occur as part of the normal menstrual cycle in the endometrium. In the luteal phase, the decline in progesterone levels initiates the release of arachidonic acid and its pro-inflammatory metabolites (such as prostaglandins and leukotrienes), which contribute to vasoconstriction, uterine contractions, and ischemia. This cascade not only induces menstrual pain but is also associated with the generation of reactive oxygen species (ROS) and subsequent oxidative stress, which may amplify

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inflammatory responses and discomfort [6, 7]. Primary dysmenorrhea, which is defined as painful, spasmodic cramps in the lower abdomen occurring during and/or before menstruation, in the absence of detectable macroscopic pelvic pathology [1], is one of the most common manifestations of these mechanisms. Szmidt et al. [8], in a systematic literature review that included six case-control studies (175 women with dysmenorrhea and 161 women in the control group), found that women with dysmenorrhea compared to the control group had higher levels of oxidative stress markers, such as 3-nitrotyrosine, protein carbonylation, 8-hydroxy-2'-deoxyguanosine, nitric oxide, and asymmetric dimethylarginine. Moreover, the authors noted limited evidence suggesting lower antioxidant status in women with dysmenorrhea compared to those without such symptoms. Only one study [9] assessed high-sensitivity C-reactive protein, making it impossible to draw conclusions about systemic inflammation in women with dysmenorrhea.

Given the established role of oxidative imbalance in menstrual discomfort, dietary strategies rich in anti-inflammatory and antioxidant compounds may offer a supportive, non-pharmacological approach to symptom management. However, to date, this area remains insufficiently explored in the literature. Thus, the aim of this narrative review was to assess the relationship between the consumption of foods with anti-inflammatory potential and the severity of menstrual symptoms.

METHODS

Review methodology was based on Academy of Nutrition and Dietetics checklist for narrative review [10]. A comprehensive search of the PubMed, ScienceDirect, and Web of Science databases was performed, covering all records available from inception of each database until May 2025. The keywords used to identify relevant studies included: "anti-inflammatory products", "whole grains", "fish", "seafood", "vegetables", "fruits", "legumes", "nuts", "seeds", "olive oil", "fats", "menstruation", and "primary dysmenorrhea". Additionally, to identify studies that may have been missed during the database search, the reference lists of selected publications were manually reviewed.

Inclusion criteria and data extraction

The following inclusion criteria were adopted for this review: (1) type of study: case-control, cross-sectional, interventional studies, or meta-analyses; (2) participants were women of reproductive age; (3) the authors of the study specified a method for assessing the severity and/or pain associated with menstruation; (4) the publication was written in either Polish or English. From the eligible studies, the following data were extracted and presented in tables: type of study, characteristics of the study population, method of assessing menstrual pain and/or severity, method of dietary assessment, and selected results. Additionally, for the purposes of this review, methodological issues identified in the reviewed publications were included in the tables under the column labelled "Notes".

Quality assessment

The quality of the studies was assessed using the Newcastle-Ottawa Quality Assessment Scale (NOS) accordingly for case-control studies [11] and for cross-sectional studies [12], as presented in Table 1. The NOS rates studies according to three pre-defined criteria: selection, comparability, and exposure, where nine points reflect the highest quality of case-control studies.

NARRATIVE REVIEW

Based on the premise that the pathophysiology of menstrual symptoms is likely driven by oxidative stress and oxidative imbalance in the female body, this literature review concentrates on the intake of foods with potential anti-inflammatory properties and their potential association with the mitigation of menstrual symptom severity.

The concept of an "anti-inflammatory diet" remains inadequately defined in the existing literature, though common examples include the Mediterranean diet and the Dietary Approaches to Stop Hypertension (DASH) diet [13]. The Mediterranean diet is typically characterized by a high consumption of whole grains, fruits, vegetables, legumes, and nuts; moderate intake of poultry, fish, and red wine; limited consumption of red and processed meats; and the use of olive oil as the primary source of dietary fat. Similarly, the DASH diet emphasizes high intakes of whole grains, fruits, vegetables, and nuts, sharing many nutrient-rich, anti-inflammatory elements with the Mediterranean diet. The rationale behind anti-inflammatory diets lies in their rich content of dietary fiber, unsaturated fatty acids, antioxidants, and polyphenols, which have the capacity to positively influence the inflammatory cascade by inhibiting the production of cytokines, reducing oxidative stress, and modulating the gut microbiota.

Whole grains

Whole grains exhibit anti-inflammatory properties due to their high content of dietary fiber (particularly soluble fiber and resistant starch), and bioactive compounds (such as phenolic acids, flavonoids, lignans, and quercetin). This components promote beneficial gut microbiota, reduce oxidative stress, decrease levels

Table 1. Quality assessment of studies

Case-control studies					
Authors	Selection (max. 4 points)	Comparability (max. 2 points)	Exposure (max. 3 points)	Total points (max. 9 points)	Quality assessment[a]
Di Cintio et al., 1997 [22]	2	1	3	6	Medium
Zeru and Muluneh, 2020 [27]	1	2	2	5	Medium
Cross-sectional studies					
Authors	Selection (max. 5 points)	Comparability (max. 2 points)	Exposure (max. 3 points)	Total points (max. 10 points)	Quality assessment[a]
Balbi et al., 2000 [21]	0	0	2	2	Low
Nagata et al., 2005 [30]	4	2	3	9	High
Tavallaee et al., 2011 [26]	2	0	3	5	Medium
Grandi et al., 2012 [23]	2	2	3	7	High
Onieva-Zafra et al., 2020 [29]	3	0	3	6	Medium
Al-Husban et al., 2022 [19]	2	2	2	6	Medium

[a]Case-control studies (range of total points 0-9): 0 to 3 points – low-quality study, 4 to 6 points – medium-quality study, and 7 to 9 points – high-quality study. Cross-sectional studies (range of total points 0-10): 0 to 3 points – low-quality study, 4 to 6 points – medium-quality study, and 7 to 10 points – high-quality study.

of systemic inflammatory markers such as CRP, IL-6, and TNF-α, and have been shown to decrease the risk of female reproductive conditions [14-18].

The relationship between the consumption of whole grain products and the severity of menstrual pain was analyzed in two studies of medium quality, including one case-control study and one cross-sectional study – Table 2. A significant association was found only in the study by Al-Husban et al. [19], which examined 660 women aged 18 to 25. The findings revealed that women who experienced severe menstrual pain were significantly more likely to report not consuming whole grain products compared to those with moderate pain (57.9% vs. 42.1%, p = 0.021).

Fish

Fatty fish are rich in omega-3 fatty acids, which help reduce inflammation by modulating immune responses and inhibiting pro-inflammatory mediators like cytokines and eicosanoids [20]. Findings on the relationship between fish consumption and menstrual pain are also inconclusive (Table 3). Balbi et al. [21] in a study of low quality reported that women experiencing menstrual pain consumed fish significantly less frequently per week compared to women without such symptoms (1.6 ± 1.3 vs. 2.3 ± 1.5 times/week, p = 0.010). Similarly, Al-Husban et al. [19] in a study of medium quality found that a significantly higher proportion of women with severe menstrual pain, compared to those with moderate pain, did not consume fish (57.5% vs. 42.5%, p = 0.004).

In contrast, both Di Cintio et al. [22] in a case-control study of medium quality and Grandi et al. [23] in a cross-sectional study of high quality reported no significant associations between fish consumption (including frequency) and the severity or intensity of menstrual pain. It is important to note that in both studies, the authors did not specify the portion size corresponding to a single serving**.**

Vegetables and fruits

Fruits and vegetables are rich in phenolics, flavonoids, carotenoids, vitamins, and minerals, which modulate inflammation by regulating inflammatory cytokines (e.g., interleukins) and inhibiting key signalling pathways such as NFκB. These compounds act as natural antiinflammatory agents, reducing proinflammatory gene expression and oxidative stress to support overall immune health [24]. However, results from a meta-analysis published in 2022, which included four cross-sectional studies examining fruit and vegetable intake, indicated no significant association between the consumption of these foods and menstrual pain (OR = 0.98, 95% CI: 0.76-1.25, p > 0.05) [25] – Table 3. Di Cintio et al. [22], in a medium quality study not included in the meta-analysis, also did not found significant association between the frequency of fruit and vegetable consumption and the occurrence of bothersome menstruation.

In contrast, four other studies not included in the meta-analysis reported differing results [19, 21, 26-27] – Table 4. In a medium quality case-control

Table 2. Research findings on the impact of frequency and quantity of whole grain products consumption on the severity of menstrual pain

Authors (country)	Type of study	Study groups (age, BMI)	Assessment of menstrual pain	Dietary assessment	Results	Notes
Di Cintio et al., 1997 [22] (Italy)	Case-control	Study group: moderate or severe menstrual pain n = 106 (median age: 27 years; BMI: < 20 kg/m^2 – 45%, > 20 kg/m^2 – 55%) Control group: no menstrual pain n = 145 (median age: 26 years; BMI: < 20 kg/m^2 – 45%, > 20 kg/m^2 – 55%)	Andersch and Milsom Scale	Scale of whole grain bread consumption (from occasional to high)	High vs. low whole grain product consumption: RR = 1.8 (95% CI: not reported), p > 0.05	- Portion size not specified. - RR adjusted for age, education, smoking, and selected menstruation-reyearsed characteristics.
Al-Husban et al., 2022 [19] (Jordan)	Cross-sectional	n = 660 (age range: 18-25 years, BMI: 22.4 ± 3.6 kg/m^2 for moderate pain group, BMI: 22.1 ± 3.6 kg/m^2 for severe pain group)	Menstrual pain: moderate, severe	Frequency of whole grain product consumption (from never to > 4 times per week)	Moderate vs. severe menstrual pain: (% women non-consuming): 42.1 vs. 57.9%, p = 0.021	-

RR – risk ratio

Table 3. Summary of research findings on the impact of frequency and quantity of fish consumption on the severity of menstrual pain

Authors (country)	Type of study	Study groups (age, BMI)	Assessment of menstrual pain	Dietary assessment	Results	Notes
Di Cintio et al., 1997 [22] (Italy)	Case-control	Study group: moderate or severe menstrual pain n = 106 (median age: 27 years; BMI: < 20 kg/m^2 – 45%, > 20 kg/m^2 – 55%) Control group: no menstrual pain n = 145 (median age: 26 years; BMI: < 20 kg/m^2 – 45%, > 20 kg/m^2 – 55%)	Andersch and Milsom Score	Frequency of fish consumption (times/week)	Study vs. control group (median): 1 vs. 1 time/week, p = 0.92	-
Balbi et al., 2000 [21] (Nepal)	Cross-sectional	n = 356 (age range: 14-21 years; BMI: not provided)	Menstrual pain: VAS (mild, moderate, severe)	Frequency of fish consumption (times/week)	Painful menstruation vs. no symptoms (mean ± SD): 1.6 ± 1.3 vs. 2.3 ± 1.5 times/week, p = 0.010	-
Grandi et al., 2012 [23] (Italy)	Cross-sectional	n = 408 women (mean age: 22.9 ± 3.0 years; BMI: 20.9 ± 2.8 kg/m^2)	Menstrual pain: VAS (mild, moderate, severe)	Fish consumption (no specification provided)	Painful menstruation vs. no symptoms (% consumers) 95.0% vs. 95.4%, p = 0.907	-
Al-Husban et al., 2022 [19] (Jordan)	Cross-sectional	n = 660 (age range: 18-25 years; BMI: 22.4 ± 3.6 kg/m^2 for moderate pain group, BMI: 22.1 ± 3.6 kg/m^2 for severe pain group)	Menstrual pain: moderate, severe	Frequency of fish consumption (from never to > 4 times/week)	Moderate vs. severe menstrual pain (% of non-consuming women): 42.5 vs. 57.5%, p = 0.004	-

SD – standard deviation; VAS – Visual Analogue Scale

study conducted among 86 Ethiopian adolescents experiencing severe menstrual pain and 166 girls without menstrual pain, Zeru and Muluneh [27] found that those who consumed fruits and vegetables at least once daily had a 68% lower risk of experiencing menstrual pain compared to those who did not consume these foods (95% CI: 2-89%, p < 0.05).

Tavallaee et al. [26], in a medium quality cross-sectional study involving 276 women, found a significant negative correlation between fruit and vegetable intake and the severity of menstruation

Table 4. Summary of research findings on the impact of frequency and quantity of vegetable and fruit consumption on the severity of menstrual pain

Authors (country)	Type of study	Study groups (age, BMI)	Assessment of menstrual pain	Dietary assessment	Results	Notes
Di Cintio et al., 1997 [22] (Italy)	Case-control	Study group: moderate or severe menstrual pain n = 106 (median age: 27 years; BMI: < 20 kg/m^2 – 45%, > 20 kg/m^2 – 55%) Control group: no menstrual pain n = 145 (median age: 26 years; BMI: < 20 kg/m^2 – 45%, > 20 kg/m^2 – 55%)	Andersch and Milsom Score	Frequency of vegetable and fruit consumption (times/week)	Study vs. control group (median): - green vegetables (overall): 7 vs. 7 times/week, p = 0.62 - fruits: 8 vs. 10 times/week, p = 0.18 - potatoes: 1 vs. 1 time/ week, p = 0.38	-
Balbi et al., 2000 [21] (Nepal)	Cross-sectional	n = 356 (age range: 14-21 years, BMI: not provided)	Menstrual pain: VAS (mild, moderate, severe)	Frequency of fruit consumption (times/week)	Painful menstruation vs. no symptoms (mean ± SD): 4.7 ± 4.1 vs. 6.5 ± 3.7 times/ week, p = 0.037	-
Tavallaee et al., 2011 [26] (Iran)	Cross-sectional	n = 276 (age range: 16-56 years; mean age: 29.5 ± 6.0 years; BMI: mean 21.6 ± 3.0, 18.5-24.99 kg/m^2 – 70.7%, ≥ 25.0 kg/m^2 – 13.4%)	Andersch and Milsom Score	Fruit and vegetable consumption (from never to very high)	Severity vs. consumption: R_S: -0.27, p < 0.01 Very high vs. never/low consumption: OR = 0.20 (95% CI: 0.08-0.50), p < 0.01	-
Zeru and Muluneh, 2020 [27] (Ethiopia)	Case-control	Study group: severe menstrual pain preventing participation in school activities n = 86 (age range: 13-19 years; BMI: < 18.5 kg/m^2 – 27,9%; 18.5-24.99 kg/m^2 – 72.1%) Control group: no menstrual pain n = 166 (age range: 13-19 years; BMI: < 18.5 kg/m^2 – 34.9%; 18.5-24.99 kg/m^2 – 65.2%)	Menstrual pain: author's definition*	Frequency of fruit and vegetable consumption (never; < 1 time/day; ≥ 1 time/day)	< 1 time/day vs. never: OR = 0.92 (95% CI: 0.37-2.31), p > 0.05 ≥ 1 time/day vs. never: OR = 0.32 (95% CI: 0.11-0.98), p < 0.05	No information provided on what the model was adjusted for.
Al-Husban et al., 2022 [19] (Jordan)	Cross-sectional	n = 660 (age range: 18-25 years; BMI: 22.4 ± 3.6 kg/m^2 for moderate pain group, BMI: 22.1 ± 3.6 kg/m^2 for severe pain group)	Menstrual pain: moderate, severe	Frequency of fruit consumption (at least 3 servings/ day – yes/no response)	Moderate vs. severe menstrual pain (% of women not consuming at least 3 servings/day): 43.8 vs. 56.2%, p = 0.006	-
Wang et al., 2022 [25] (China)	Meta-analysis (4 cross-sectional studies)	Study group: n = 884 (age: not provided, BMI: not provided) Control group: n = 632 (age: not provided, BMI: not provided)	Menstrual pain: no specification provided	-	Study vs. control group: OR: 0.98 (95% CI: 0.76-1.25), p > 0.05	-

OR – odds ratio; CI – confidence interval; R_s – Spearman's correlation coefficient; SD – standard deviation; VAS – Visual Analogue Scale; *Primary dysmenorrhea was defined as crampy menstrual abdominal pain that begins shortly before or after the onset of menstruation and lasts from 12 hours to 3 days. School absenteeism among young female students due to painful menstruation was used as a criterion for classifying severe menstrual pain

(RS = -0.27, p < 0.01). Women with very high fruit and vegetable consumption (portion size not specified by the authors) had an 80% lower risk of experiencing bothersome menstruation compared to women with low or no consumption (95% CI: 50-92%, p < 0.01).

In a cross-sectional study of medium quality, Al-Husban et al. [19] observed that a greater proportion of women with severe menstrual pain, compared to those with moderate pain, did not consume at least three servings of fruit per day (56.2% vs. 43.8%, p = 0.006). These findings are consistent with those reported by Balbi et al. [21], who found that women experiencing menstrual pain had a 25% lower average weekly fruit intake compared to women without pain (4.7 ± 4.1 vs. 6.5 ± 3.7 times/week, p = 0.037).

Table 5. Summary of research findings on the impact of frequency and quantity of dry legume seeds consumption on the severity of menstrual pain

Authors (country)	Type of study	Study groups (age, BMI)	Assessment of menstrual pain	Dietary assessment	Results	Notes
Nagata et al., 2005 [30] (Japan)	Cross-sectional	n = 276 (age range: 19-24 years; BMI mean: 20.3 ± 2.2 kg/m^2)	Andersch and Milsom Score	Total consumption amount: miso soup, tofu, fried tofu, fried bean paste, dry bean paste, fermented soybeans, houba-miso, soy drink, cooked soybeans (g/day)	Consumption vs. menstrual severity: R_S = -0.05, p = 0.39	R_S adjusted for dietary energy intake, age, smoking status, and age at menarche.
Onieva-Zafra et al., 2020 [29] (Spain)	Cross-sectional	n = 311 (mean age: 21.2 ± 2.6 years; BMI: 22.4 ± 3.2 kg/m^2, 18.5-24.99 kg/m^2 – 78.8%, ≥ 25.0 kg/m^2 – 15.7%)	Presence of menstrual pain: yes/no VAS (mild, moderate, severe)	Likes dry legume seeds and consumes them more than once a week.	Women with menstrual pain vs. women without pain: > 1 times/week vs. < 1 time/week ↑OR = 2.32 (95% CI: 1.01-5.35), p < 0.05	OR adjusted for age, BMI, and use of hormonal contraceptives.

BMI – body mass index; OR – odds ratio; CI – confidence interval; R_S – Spearman's correlation coefficient; VAS – Visual Analogue Scale

Legumes

Legumes are a source of different types of phytochemicals. For example, contain saponins, which exhibit anti-inflammatory effects by suppressing the transcription of inflammatory cytokine genes [28]. To date, two cross-sectional studies have been published that examined the association between the consumption of dried legumes and the occurrence of bothersome or painful menstruation (Table 5). Onieva-Zafra et al. [29], in a medium quality study conducted among 311 Spanish women (mean age: 21.2 ± 2.6 years), found that consuming dried legumes at least once per week, compared to less frequent consumption, was associated with more than a twofold increased risk of experiencing menstrual pain (OR = 2.32, 95% CI: 1.01-5.35; p < 0.05). In contrast, Nagata et al. [30], in a high-quality study involving 276 Japanese women aged 19 to 24, found no significant correlations between the consumption of foods made from dried legumes and the severity of menstruation.

Other food products

Olive oil is considered one of the key nutritional components responsible for the beneficial effects of the Mediterranean diet, especially by reducing levels of inflammation markers as IL-6 [31]. Nuts and seeds, similarly to olive oil have high content of unsaturated fatty acids and phenolic compounds with antioxidant and anti-inflammatory properties [32]. However, despite their well-documented role in supporting anti-inflammatory processes, there is currently a lack of studies specifically investigating the relationship between the intake of olive oil, nuts, seeds and the severity of menstrual symptoms. Therefore, their potential role in modulating menstrual symptoms remains unclear and warrants further research.

It should be noted that, apart from the potential impact of selected anti-inflammatory foods, the overall quality of the diet may also contribute to menstrual health and pain perception. This factor, although important, was beyond the scope of our review and thus was not analyzed in detail.

RESEARCH GAPS AND FUTURE DIRECTIONS

This review aimed to present the current state of knowledge as well as highlight methodological issues identified in available literature. To date, only a very limited number of studies have examined the association between the consumption of foods with anti-inflammatory potential and menstrual symptoms (eight original studies and one meta-analysis). Specifically, two studies investigated whole grains [19, 22], four studies fish [19, 21-23], six studies fruits and vegetables (including one meta-analysis) [19, 21, 22, 25-27], and two studies legumes [29-30]. Importantly, no studies were identified on olive oil, nuts, or seeds. The existing publications were further limited to the assessment of menstrual pain only, without addressing other symptoms that contribute to the overall burden of menstruation, such as back pain, headache, nausea, diarrhea, or general malaise [1, 4-5].

Several methodological concerns hinder the comparability of available findings. Even when limited to menstrual pain, studies applied different measurement tools, not all of which were validated. Some authors used their own definitions of menstrual pain [27], while others did not clearly specify the criteria for categorizing mild versus severe pain [19]. Additional limitations include the wide age range of

participants (from adolescents to adult women), which may affect symptom severity and food consumption, and the heterogeneous reporting of BMI. In most studies, BMI was presented in different formats (mean values, subgroup means, or proportions of underweight participants) and was not always included as a covariate. This is important limitation, as obesity is a pro-inflammatory condition that increases the risk of comorbidities associated with oxidative stress and systemic inflammation [33], while underweight, on the other hand, is linked to reduced hormone secretion due to insufficient body fat stores [34]. Other methodological issues include inconsistent classification of food items into food groups, insufficiently described statistical analyses, partial presentation of results, and relatively small sample sizes.

Future studies should address the identified research gaps. First and foremost, there is a need for more research in this area, not only because existing evidence is very limited, but also because women remain consistently underrepresented in clinical and nutritional studies [35]. In particular, there is no research on the effects of olive oil, nuts, and seeds on menstrual symptoms, despite the fact that these foods are well-known for their anti-inflammatory potential [32]. Studies, should also account for diet quality indices and dietary patterns rather than single food groups in their analyses to better capture the complexity of diet–health interactions. Moreover, future research should expand beyond menstrual pain to investigate the impact of diet on the broader spectrum of menstrual symptoms and overall menstrual burden. Importantly, well-designed interventional studies with standardized and validated outcome measures are needed to provide stronger evidence and to evaluate causal relationships between anti-inflammatory foods and menstrual symptoms. Furthermore, interactions with other lifestyle factors (physical activity, stress, sleep quality) and individual differences (hormonal status, genetic factors, gut microbiota) should also be considered in order to better understand the complexity of diet–menstrual health relationships.

CONCLUSIONS

The current evidence on the relationship between anti-inflammatory foods and the severity of menstrual pain is inconsistent. Some studies suggest that higher intake of whole grains, fish, fruits, and vegetables may be associated with reduced pain, while others report no significant associations. However, it should be noted that the number of studies published in this area to date is limited and generally of low quality. Therefore, further high-quality research using standardized methods is needed to clarify these associations and support evidence-based dietary recommendations for menstrual health.

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Conflict of interest

The authors declare no conflict of interest.

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ORIGINAL ARTICLE

ASSESSING THE EFFECTS OF SOCIAL MEDIA ON EATING BEHAVIOR IN ALGERIAN UNIVERSITY STUDENTS

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ABSTRACT

Background. Social media plays a central role in the daily lives of university students, influencing various aspects of behavior, especially their eating habits. The goal of this study was to adapt and validate the scale of effects of social media on eating behavior (SESMEB), which was initially established in Turkish, for use by Algerian university students.

Methods. A cross-sectional study was conducted between March 2025 and May 2025. Participants filled out an online questionnaire covering socio-demographic data, social media usage patterns, and the SESMEB. Internal consistency was assessed using Cronbach's alpha and the Spearman-Brown coefficient was used to measure reliability. Confirmatory Factor Analysis (CFA) was used to assess construct validity, and independent t-tests were used to investigate item discrimination across extreme groups.

Results. The Algerian version of SESMEB demonstrated excellent internal consistency (Cronbach's alpha = 0.930). CFA confirmed a strong unidimensional structure, with factor loadings ranging from 0.49 to 0.75 and high model fit indices. SESMEB scores were significantly correlated with daily social media time ($p < 0.001$), indicating that higher social media engagement corresponded to a greater influence on eating behavior.

Conclusion. The adapted SESMEB is a valid and reliable instrument for assessing the influence of social media on eating habits among Algerian university students. These findings provide a foundation for future study focused at encouraging healthy digital and nutritional behaviors among young people.

Keywords: *Algerian students, eating behavior, social media, reliability, validity*

INTRODUCTION

As information and communication technologies have advanced, digital technology has become firmly integrated in daily life. This has resulted in a surge in social media. According to the most recent figures, there are 5.24 billion active social media user identities worldwide, up 4.1 percent in the last year [1]. University students, in particular, spend a significant amount of time on social media during the day and night, and it can be argued that such technologies play a vital role in their everyday life [2]. Individuals may freely communicate, exchange material, and express themselves through social media, as well as engage with people in their own nation and throughout the world [3]. Students use social networking platforms and applications extensively, making them an integral part of their everyday lives. According to research, university students are the most regular users of these platforms across all age categories [2, 4]. Highlighting the potential for social media to have a profound impact on young adults.

Technology is continuously changing to satisfy users' increasing demands. Digital literacy is required to engage in society and the economy [5]. However, psychological, social, and health issues might be linked to social media abuse or overexposure [6].

The rising popularity of online healthy eating groups has resulted in consumers being regularly exposed to diet and health advice via social media [7].

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Furthermore, internet and social media use has been found to raise knowledge of nutrition, dietary choices, and healthy lifestyles [8].

Social media platforms are frequently overloaded with food-related material. This might increase the impulse to eat harmful or irrelevant meals. Furthermore, ads for unhealthy food products tend to target young individuals [9, 10]. On the other hand, healthcare practitioners and organizations are increasingly using social media to provide information about healthy lifestyles and illness prevention. Providing a unique chance to increase public health awareness, self-efficacy, and treatment regimen adherence in various groups [8, 11]. Social media has the ability to change people's eating habits. According to the studies of Güneş and Demirer [12] and Xu et al. [13], as people's duration of social media use grows, so do their sedentary habits, and utilizing social media accounts with visual material is linked to an increased risk of eating disorders. In addition, physical appearance perfectionism used social media to have a higher impact on eating behavior. Considering these changes, it is clear that as social media becomes more integrated into daily life, people begin to build social identities in the digital realm. As a result, it is critical to investigate how health misinformation spreads and how much it influences people's decisions and health-related behaviors [14].

The widespread use of social media emphasizes the importance of assessing its impact on eating habits, particularly among students. This is the first study in Algeria to assess the impact of social media on eating habit among Algerian university students. We do not have any past data analysis on the SESMEB in Algeria. So, this condition warrants our research, which contributes to a deeper understanding. Therefore, to conduct such evaluations effectively, measuring instruments must be validated and adapted for the appropriate language and cultural environment. As a result, the purpose of this study was to adapt the SESMEB, a tool particularly created to evaluate how social media use affects eating habits, while maintaining its reliability and validity for the group being studied.

MATERIAL AND METHODS

Study design and data collection

The study took place between March 2025 and May 2025. Given that the produced scale had 18 items and one dimension, the study required at least 5 participants per item. In this scenario, a minimum of 90 volunteers were needed. Inclusion criteria required voluntary participation, active use of social media, and current enrollment at the university of Relizane in bachelor's, master's, or doctoral programs. Exclusion criteria included having a diagnosed chronic illness, any mental health disorder, or an existing eating-related problem. These parameters ensured that the survey targeted a healthy, university-based population actively engaged with social media, in line with the study's objectives. As a result, data from 179 individuals who answered all of the questions were analysed.

The questionnaire was created with Google Forms and conducted online. The questionnaire was divided into three sections: socio-demographic information, social media usage patterns, and the SESMEB (scale of effects of social media on eating behavior). The first section of the questionnaire consists of questions designed to identify participants' sociodemographic traits and educational background including age, gender, marital status, education level. The second section addressed participants' social media usage patterns. It included questions on the type of platforms most frequently used, the average daily time spent on social media, frequency of content sharing. The third section consisted of the scale of effects of social media on eating behavior (SESMEB). The SESMEB was originally developed by Keser et al. [3] to measure the perceived impact of social media use on eating habits. It is a unidimensional scale composed of 18 items rated on a five-point Likert scale ranging from 1 ("never") to 5 ("always"). Higher scores indicate a greater perceived influence of social media on eating behavior. The items address several aspects of this influence, including increased exposure to food-related content, the effect of social media on food choices and cravings. The English version of the SESMEB has good reliability and validity with a Cronbach's alpha coefficient of 0.928.

The SESMEB was translated from English into Arabic for use in the Algerian context. The translation process followed a forward-backward translation procedure to ensure linguistic and conceptual equivalence. First, the scale was independently translated from English into Arabic by a university English teacher. A back-translation into English was then carried out by a postgraduate in English interpretation who was unfamiliar with the original instrument. Discrepancies were resolved to maintain accuracy.

A pilot test was then conducted with a small group of university students from the target population to identify any ambiguous or confusing items. Based on their feedback, slight adjustments in wording were made.

Statistical analysis

All statistical analyses were carried out using IBM SPSS Statistics for Windows version 26.0 (IBM Corp., Armonk, NY, USA) and AMOS version 26.0

(IBM Corp., Armonk, NY, USA). A two-sided p-value < 0.05 indicated statistical significance.

Descriptive statistics for continuous variables were provided as mean ± standard deviation or median and interquartile range, based on the assumption of normal distribution. For categorical and ordinal variables, the findings were presented as frequencies and percentages. In addition, associations between categorical variable and Likert-scale items were assessed using *Chi*-square tests of independence. The normality assumption for continuous variables was specified with the Kolmogorov-Smirnov test and histogram, and boxplot. Tukey's non-additivity test result was used to determine if the total score could be computed.

Item analysis was used to investigate discrimination and internal coherence. Corrected item-total correlations were calculated; values > 0.40 were considered acceptable. Items were further analyzed using the extreme group approach, which involved comparing the highest-scoring 27% of participants to the lowest-scoring 27% on each question using two-sided independent samples t-tests. Items with statistically significant differences and appropriate critical ratio (CR) values were considered discriminative. Effects were found when at least 15% of responses fell into the lowest or highest score categories.

Confirmatory Factor Analysis was used to assess construct validity. Sampling adequacy was evaluated using the Kaiser-Meyer-Olkin (KMO) statistic and Bartlett's sphericity test. AMOS was used to evaluate a one-factor model that corresponded to the SESMEB's theoretical structure. Multiple indices were used to evaluate model fit, including *Chi*-square to degrees of freedom ratio (χ^2/df), Root Mean Square Error of Approximation (RMSEA), Goodness-of-Fit Index (GFI), Adjusted GFI (AGFI), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and Normed Fit Index (NFI). Acceptable fit was assessed as χ^2/df < 3, RMSEA < 0.08, and GFI/AGFI/CFI/TLI/NFI > 0.90. Factor loadings ≥ 0.40 were considered good.

Split-half and internal consistency metrics were used to assess reliability. Cronbach's alpha coefficient was determined for the complete scale, with $\alpha > 0.70$ indicating acceptable reliability and $\alpha \geq 0.80$ indicating good to outstanding reliability. The Spearman-Brown coefficient was used to test split-half reliability after dividing the scale in half based on item order. The "alpha if item deleted" values were analyzed to see if removing any item would significantly improve internal consistency.

Group comparisons were conducted to investigate variations in SESMEB scores based on sociodemographic and social media use characteristics. Because the distribution of scale scores was not always normal, nonparametric tests were used: Mann-Whitney U tests were employed for comparisons between two independent groups.

RESULTS

Sociodemographic and survey characteristics

A total of 179 university students participated in this study. Of these, 68.7% of participants were women and 31.3% were men. The mean age was 22.16 ± 3.5 years. Most participants (99.4%) were unmarried, and 50.3% were bachelor's students (Table 1).

Table 1. Socio-demographics characteristics of participants

Variables		Frequences (%)/ Mean ± SD
Sex	Male	31.3
	Female	68.7
Age (years)		22.16 ± 3.5
Marital status	Single	99.4
	Married	0.6
Level of studies	Bachelor student	50.3
	Master student	48
	Doctoral student	1.7

SD – standard deviations

Table 2 presents participant responses to items measuring SESEMB's perceived effect. A considerable majority of respondents indicated rare or occasional participation in content sharing, with 36% stating they "sometimes" share content, 31% "rarely" and only 15% expressing frequent or consistent posting. Similarly, nearly half (46%) said they "never" used filters, a significant association was found between gender and filter use ($\chi^2 = 21.66$ (4), $p < 0.001$) males were significantly more likely to report "never" using filters, whereas females were more likely to report "sometimes". In terms of food-related impacts, social media appears to increase hunger in a significant proportion of individuals, with 31% reporting "sometimes" and 37% reporting "often" or "always" feeling appetite stimulation. Male were significantly ($\chi^2 = 11.38$ (4), $p < 0.05$) more likely to report "never". Nonetheless, when asked about their fast-food intake, nearly half (46%) denied an increase since utilizing social media. The importance of social media in affecting brand selection elicited diverse responses: 34% indicated no effect, 25% "sometimes," and 23% expressed regular influence. Similarly, recipe adoption was rather widespread, with 61% of participants reporting at least occasional tries at recipes found online, males significantly ($\chi^2 = 36.98$ (4), $p < 0.001$) reported "never" while females reported more "always". Snack desires and food awareness produced

complex results. While 45% recognized an increase in snacking frequency, 58% also reported becoming more careful of their food intake as a result of social media exposure. A small percentage of respondents (28%) acknowledged following influencers for nutritional or eating habits recommendations. In terms of larger dietary behavior changes, 37% disputed that web information had influenced their eating patterns, while 43% recognized varied degrees of change. Nearly half (41%) said they avoided specific meals because of bad depictions. Visually appealing food posts were also a powerful incentive, with 53% stating that they occasionally or frequently induced consuming desire. Social media was also a source of food inspiration, with 63% reporting that they used it on occasion, females were significantly ($\chi^2 = 36.32$ (4), $p < 0.001$) more likely to choose "always" than males. Adoption of dietary trends was less evident, with 45% saying they were "never" affected, while 36% acknowledged to following trends such as vegan or keto diets on a regular or occasional basis, females were significantly ($\chi^2 = 36.32$ (4), $p < 0.001$) more likely to select "always", while males were more likely to choose "never". The motivation to make trending meals was relatively strong, with 61% claiming some impact. Psychological effects were also obvious; 59% claimed

Table 2. Associations between social media engagement (%), gender, and daily usage with food-related behaviors

Items	Never	Rarely	Sometimes	Often	Always	Gender association χ^2 (df) p-value	Spending time association χ^2 (df) p-value
How often do you share content on social media?	19	31	36	10	5	0.19 (4) 0.989	3.65 (1) 0.56
Do you use filters for your social media posts?	46	19	24	8	3	21.65 (4) < 0.001	4.563 (1) 0.033
The dishes I see on social media stimulate my appetite.	11	21	31	22	15	11.38 (4) 0.023	1.7 (4) 0.791
Since I started using social media, my fast-food consumption has increased.	46	22	18	7	6	4.93 (4) 0.295	6.64 (4) 0.156
Social media influences my preference for certain food or beverage brands.	34	20	25	13	10	3.35 (4) 0.5	11.758 (4) 0.019
I try new recipes that I see shared on social media.	18	21	26	16	19	36.97 (4) < 0.001	12.21 (4) 0.016
Social media content influences my food choices.	27	17	26	17	13	2.683 (4) 0.612	16.72 (4) 0.002
Social media makes me crave snacks more often.	31	24	22	13	10	9.519 (4) 0.049	4.36 (4) 0.359
Social media makes me more aware of the amount of food I consume.	20	21	32	13	13	2.497 (4) 0.645	30.9 (4) < 0.001
I follow influencers for advice on diets or eating habits.	30	22	21	17	11	1.358 (4) 0.851	25.42 (4) < 0.001
My eating habits have changed because of what I see online.	37	20	18	15	10	5.797 (4) 0.215	27.221 (4) < 0.001
I avoid certain foods due to how they are portrayed on social media.	31	28	22	11	8	4.74 (4) 0.315	17.85 (4) 0.001
Social media posts increase my desire to consume visually appealing foods.	25	22	20	16	17	3.847 (4) 0.427	9.05 (4) 0.06
I use social media to find meal ideas.	17	20	27	13	23	36.32 (4) < 0.001	21.82 (4) < 0.001
Social media content encourages me to adopt certain food trends (e.g., vegan, keto).	45	20	18	8	10	7.65 (4) 0.105	18.18 (4) 0.001
I feel motivated to prepare dishes that are trending on social media.	18	22	21	20	20	32.41 (4) < 0.001	14.13 (4) 0.007
Social media has made me more attentive to my calorie intake.	22	20	24	20	15	2.431 (4) 0.657	29.704 (4) < 0.001
I feel guilty about my eating habits after seeing posts about healthy lifestyles.	29	16	24	13	18	11.524 (4) 0.021	20.048 (4) < 0.001
I compare my food choices to those of the people I follow on social media.	48	20	14	14	5	0.754 (4) 0.944	19.59 (4) 0.001
I spend money on certain foods after seeing them on social media.	35	25	18	9	12	7.181 (4) 0.127	15.601 (4) 0.004

that social media increased their attention to calorie consumption, and 55% expressed occasional or regular guilt after seeing healthy living information, males were more significantly to select "sometimes" whereas females showed a slight agreement toward "often" and "always". In addition, higher education level was strongly associated with the feeling of guilt in response to healthy lifestyle ($\chi^2 = 22.25$ (8), $p = 0.004$). In terms of social comparison, over half (48%) said they "never" compare their food choices to influencers, while 33% acknowledged to doing so on occasion. Finally, economic effect was clear, with 39% of individuals reporting purchasing foods after seeing them advertised online.

Chi-square analyses (Table 2) found a significant relationship between daily social media usage (≤ 3 hours vs. > 3 hours) and all examined eating behavior variables (p-values varied from 0.03 to < 0.001). The examination of standardized residuals revealed consistent trends across items. Light social media users (≤ 3 hours/day) were more likely to be impacted by food-related information, especially in higher Likert categories ("often" and "always"). Trying out new recipes, selecting foods based on content, and following influencer diet recommendations. Awareness of food consumption, adoption of food trends, and drive to produce popular recipes. Calorie counting, feelings of guilt after viewing healthy living posts, and food purchases. While heavy social media users (> 3 hours/day) tended to select lower Likert categories ("never" or "rarely") for food/beverage preferences, and higher categories for using filter for post, trying new recipes and spending on specific foods.

Item analysis

Item-total correlations (Table 3) were positive ranging between 0.118 to 0.752. Items with adjusted item-total correlation values of less than 0.40 were removed, resulting in a final scale of 18 items.

Tukey's test for non-additivity indicated no significant violation of additivity assumptions ($F (1, 3025) = 2.016$, $p = 0.156$). Supporting the calculation of a total score across all items. No floor or ceiling effects were observed. Based on 27% highest and lowest scoring groups (Table 4), all items demonstrated satisfactory discrimination.

Confirmatory factor analysis (CFA) was conducted on responses from all 179 participants. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.912, and Bartlett's test of sphericity was statistically significant ($\chi^2 (153) = 1794.867$, $p < 0.001$), indicating sampling adequacy and suitability for factor analysis.

The one-factor model (Figure 1) showed the graphic expression of the CFA. The standardised

Table 3. Item analysis results for the SESMEB

Item No.	Items	Item total correlation
Item 1	How often do you share content on social media?	0.118
Item 2	Do you use filters for your social media posts?	0.245
Item 3	The dishes I see on social media stimulate my appetite.	0.466
Item 4	Since I started using social media, my fast-food consumption has increased.	0.615
Item 5	Social media influences my preference for certain food or beverage brands.	0.652
Item 6	I try new recipes that I see shared on social media.	0.640
Item 7	Social media content influences my food choices.	0.669
Item 8	Social media makes me crave snacks more often.	0.561
Item 9	Social media makes me more aware of the amount of food I consume.	0.649
Item 10	I follow influencers for advice on diets or eating habits.	0.508
Item 11	My eating habits have changed because of what I see online.	0.715
Item 12	I avoid certain foods due to how they are portrayed on social media.	0.584
Item 13	Social media posts increase my desire to consume visually appealing foods.	0.639
Item 14	I use social media to find meal ideas.	0.752
Item 15	Social media content encourages me to adopt certain food trends (e.g., vegan, keto).	0.602
Item 16	I feel motivated to prepare dishes that are trending on social media.	0.701
Item 17	Social media has made me more attentive to my calorie intake.	0.588
Item 18	I feel guilty about my eating habits after seeing posts about healthy lifestyles.	0.599
Item 19	I compare my food choices to those of the people I follow on social media.	0.612
Item 20	I spend money on certain foods after seeing them on social media.	0.676

Table 4. Comparison of total scores between the highest and lowest 27% of the sample

Item No.	Items	t	p-value
Item 3	The dishes I see on social media stimulate my appetite.	7.936	< 0.001
Item 4	Since I started using social media, my fast-food consumption has increased.	9.442	< 0.001
Item 5	Social media influences my preference for certain food or beverage brands.	11.308	< 0.001
Item 6	I try new recipes that I see shared on social media.	13.241	< 0.001
Item 7	Social media content influences my food choices.	13.098	< 0.001
Item 8	Social media makes me crave snacks more often.	8.045	< 0.001
Item 9	Social media makes me more aware of the amount of food I consume.	11.503	< 0.001
Item 10	I follow influencers for advice on diets or eating habits.	8.159	< 0.001
Item 11	My eating habits have changed because of what I see online.	14.364	< 0.001
Item 12	I avoid certain foods due to how they are portrayed on social media.	9.720	< 0.001
Item 13	Social media posts increase my desire to consume visually appealing foods.	12.758	< 0.001
Item 14	I use social media to find meal ideas.	19.554	< 0.001
Item 15	Social media content encourages me to adopt certain food trends (e.g., vegan, keto).	10.105	< 0.001
Item 16	I feel motivated to prepare dishes that are trending on social media.	13.747	< 0.001
Item 17	Social media has made me more attentive to my calorie intake.	11.769	< 0.001
Item 18	I feel guilty about my eating habits after seeing posts about healthy lifestyles.	11.384	< 0.001
Item 19	I compare my food choices to those of the people I follow on social media.	10.448	< 0.001
Item 20	I spend money on certain foods after seeing them on social media.	12.132	< 0.001

t – independent samples t-test statistic; p – probability value

Table 5. Factor loadings, t values and variances explained for the model

Item No.	λ	t	p-value
Item 3	0.49	-	-
Item 4	0.634	6.41	< 0.001
Item 5	0.683	6.05	< 0.001
Item 6	0.631	5.79	< 0.001
Item 7	0.702	6.12	< 0.001
Item 8	0.565	5.46	< 0.001
Item 9	0.699	6.11	< 0.001
Item 10	0.542	4.98	< 0.001
Item 11	0.748	5.87	< 0.001
Item 12	0.605	5.69	< 0.001
Item 13	0.640	7.59	< 0.001
Item 14	0.741	6.27	< 0.001
Item 15	0.650	5.55	< 0.001
Item 16	0.681	6.01	< 0.001
Item 17	0.634	5.81	< 0.001
Item 18	0.600	5.65	< 0.001
Item 19	0.624	5.78	< 0.001
Item 20	0.707	6.15	< 0.001

λ – standardized factor loading; t – critical ratio; p – probability value

factor loadings ranging from 0.49 to 0.748. Only Item 3 had a loading below 0.50, though all loadings exceeded 0.40, meeting minimum adequacy criteria. All t-values for the explanatory level of the theoretical structure (hidden variable) on the items (observed variables) were significant at $p < 0.01$ ranging from 4.98 to 7.59.

Model fit indices from the confirmatory factor analysis showed a good match between the hypothesized one-factor model and the observed data. The normed *Chi*-square (χ^2/df) was 1.056, which is significantly lower than the recognized criterion of 2, suggesting an excellent model fit. Additional fit indices verified the model's adequacy: root mean square error of approximation (RMSEA) = 0.018, goodness of fit index (GFI) = 0.94, adjusted goodness-of-fit index (AGFI) = 0.90. The incremental fit indices were likewise high, with comparative fit index (CFI) = 0.997, Tucker-Lewis index (TLI) = 0.995, and normed fit index (NFI) = 0.943, all exceeding the suggested 0.90 threshold.

The SESMEB construct is unidimensional and internally consistent, as evidenced by statistically significant standardized regression weights ranging from 0.490 to 0.748 ($p < 0.001$). These results support the unidimensional structure and construct validity of the Algerian SESMEB.

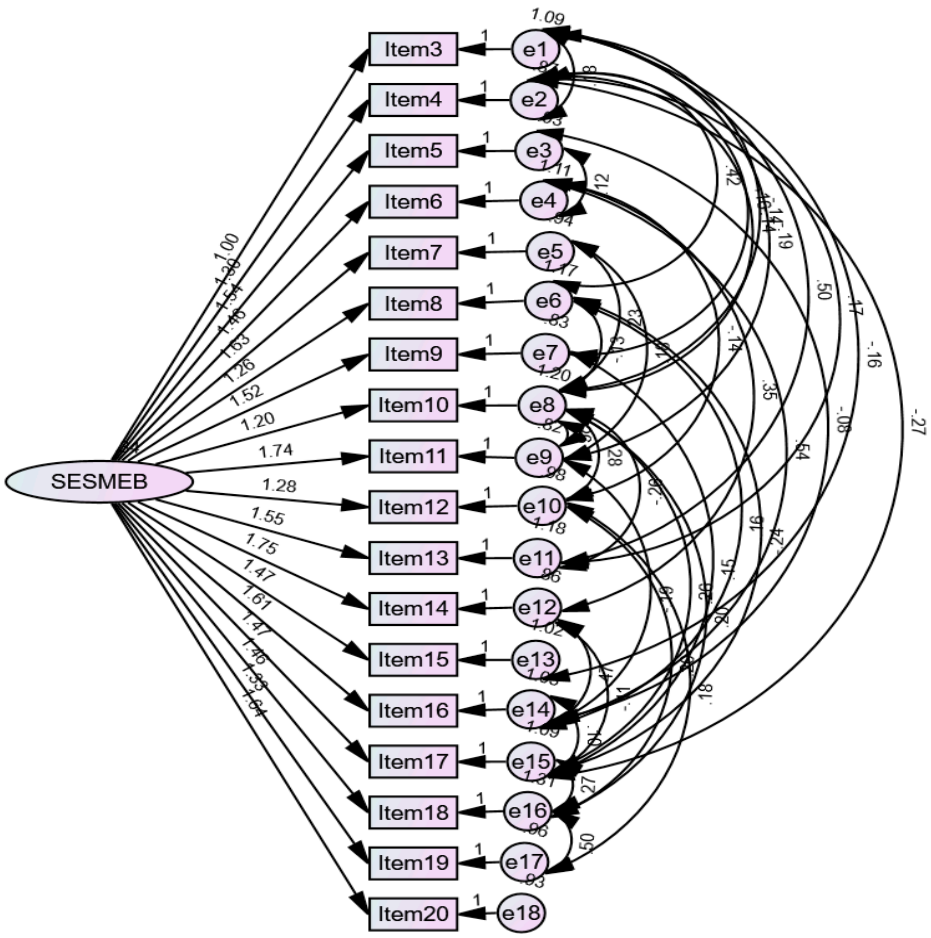

Figure 1. Standardised path coefficients of the SESMEB model

Reliability of the Algerian SESMEB

The Cronbach's alpha coefficient for the final 18-item scale was 0.930, indicating excellent internal consistency. The Spearman-Brown coefficient was 0.914, and the correlation between the two halves of the scale was 0.847, further confirming high reliability. The coefficient of 0.930 indicates great dependability, with values above 0.80 regarded exceptional [14].

SESMEB scores of students

Instagram, Facebook, and TikTok were the most frequently used social media platforms among students, with 45.3%, 38%, and 11.7%, respectively (Table 6). SESMEB scores differed significantly by daily social media usage, with higher usage associated with greater reported influence on eating behavior ($p < 0.001$).

Table 6. SESMEB scores of participants according to social media using

Variable	Frequency	SESMEB Score Median (IQR)	p-value
Daily time spent on social media			
< 3 h	22.9%	59.00 (15.50)	< 0.001**
≥ 3 h	77.1%	41.00 (20.00)	
Sharing frequency on social media			
Never or rarely	86%	47.00 (22.50)	0.083
Always	14%	52.00 (21.50)	
Using filters or photoshop for your social media posts			
Yes	54%	46.00 (20.00)	0.501
No	46%	48.00 (23.75)	

IQR – interquartile range; p – probability value; ** highly significant $p < 0.001$

DISCUSSION

The current study aims to modify and evaluate the scale of effects of social media on eating behavior for usage by Algerian university students. Providing a culturally and linguistically suitable instrument for assessing how digital platforms influence eating habits in this community. The findings show that the

modified scale has high psychometric qualities and give useful insights into how social media influences students' eating practices. The results emphasize social media's multidimensional effect. Our findings show that social media has a consistent influence on appetite stimulation, recipe experimentation, and food awareness. Previous research has found that exposure to food-related material can lead to increased snacking and impulsive eating [3]. At the same time, a paradoxical rise in both snacking and calorie awareness has been seen, implying that social media promotes both indulgence and self-regulation. Influencer-driven behaviors were less prevalent than anticipated, with just a minority indicating consistent reliance on influencer dietary recommendations. Whereas [15] found that influencer marketing of unhealthy foods has been shown to directly boost children's initial consumption, emphasizing the significance of influencer-mediated exposure. Many respondents reported trying new recipes or being inspired to produce visually appealing or trendy foods, demonstrating social media's motivating power. Finally, the economic impact of social media was proven, with nearly 40% saying they bought food after seeing it online. The substantial connections revealed between gender, particularly those related to food preparation, dietary influence, and attitudes about eating habits, can be understood in light of Algeria's sociocultural background. In Algerian families, women have historically been responsible for food planning and preparation. This employment is expected to boost their exposure and involvement with food-related social media material. As a result, women may be more likely to try new recipes, follow culinary fads, or display strong emotional responses.

Our data show a strong relationship between daily social media use and several aspects of eating behavior. Light social media users (≤ 3 hours/day) showed higher reactivity to food-related material. They were more likely to attempt new recipes, base their eating choices on social media material, follow influencer diet advice, track calorie intake, consume trendy foods, and feel guilty after seeing healthy living postings. Notably, heavy users demonstrated increased involvement for activities such as filter use, occasional recipe tinkering, and selective spending on specific items.

The SESMEB has strong internal consistency (Cronbach's $\alpha = 0.930$), exceeding the usually recognized criterion of 0.80, suggesting high reliability [16]. Confirmatory factor analysis confirmed the scale's unidimensional structure, with all factor loadings exceeding the acceptable threshold of 0.40 and fit indices indicating high model adequacy (e.g., RMSEA = 0.018; CFI = 0.997). These findings are consistent with earlier SESMEB adaptations, demonstrating its stability across several cultural contexts [3].

In today's world, social media has become the key source of health and nutrition information. Peer groups in adolescence have a major impact on health-related behaviors, including food patterns [17]. At this period of development, young people are more vulnerable to social influences, and their eating habits are frequently affected by the norms and expectations of others. These perceived social norms might generate different types of peer pressure, influencing how teenagers choose and consume food [18, 19]. Over time, the number of likes and views becomes more important to users, influencing their eating habits.

The confirmatory factor analysis (CFA) gave a Cronbach's alpha reliability rating of 0.930, validating the dependability of the social media influence scale on eating habit. This makes the Algerian version of SESMEB appropriate for research. In this survey, most participants used social media sites including Instagram, Facebook, and TikTok. Facebook continues to be the most popular social media network in Algeria, with 58.7% of internet users using it. However, students prefer Instagram over Facebook, with the majority of Instagram users aged 18 to 24, which is consistent with the study's findings. Furthermore, using the SESMEB, the study assessed the influence of social media on the eating habits of Algerian university students. The findings show that people who spent more time on social media had a bigger effect on their eating habits. A separate research of a nationally representative sample of young individuals aged 19 to 32 years discovered a substantial and persistent association between social media use and eating issues.

There is evidence that social media profiles with big followings encourage healthy eating, which may lead to good behavioral changes via social nudges from followers. As such, social media may be an effective tool for encouraging good eating habits and fostering a better lifestyle. However, the impact of social media can be troublesome, especially when anybody can submit anything without official qualifications or knowledge. Influencers, in particular, frequently disseminate health-related material without sufficient training, resulting in large audiences. The study found a high relationship between the amount of time spent on social media and the SESMEB score. The SESMEB scale was employed as a one-dimensional measure to assess the overall impact of social media on eating behavior. Higher SESMEB scores imply a greater vulnerability to food-related signals, cravings generated by exposure, and the persuasive power of food advertising seen on social media. Our findings demonstrated that students who spent more than three hours per day on social media had substantially higher

SESMEB scores, indicating a greater effect on their food choices, appetites, and susceptibility to unhealthy eating cues. This gives a credible and complete assessment of social media's worldwide influence on eating decisions, which is consistent with the original instrument's goal and validity. This is consistent with nationally representative research done in the United States among young individuals aged 19 to 32 found a significant association between frequent and high-volume usage of social media platforms such as Facebook and Instagram and greater worries about eating behaviors.

Interestingly, while social media use has been linked to disordered or problematic eating behaviors [20], these same platforms have also been shown to foster healthy eating habits in some users. This dual impact emphasizes social media's complicated and frequently paradoxical function in affecting people's views and actions toward food [21, 22]. Remarkably, while the frequency of content sharing and the use of image modifying tools (filters, Photoshop) on social media did not reveal statistically significant relationships with SESMEB scores in this group, frequent content sharers had higher median scores. This might suggest a trend that merits additional investigation.

Limitations of the study

The present study had several strong points such as the use of a validated scale (SESMEB) to assess social media's effects on eating behavior; inclusion of a diverse sample of university students across different academic levels (bachelor, master, doctorate); and clear inclusion and exclusion criteria to ensure participant relevance and data quality. However, the cross-sectional design limits the ability to establish causality; self-reported data may be subject to recall and social desirability biases, and it is hard to compare the results with other studies because of the lacking literature on SESMEB research. To address these issues, future research could employ experimental design to enhance the robustness and applicability of the results.

CONCLUSION

This study underscores the SESMEB scale's potential as a reliable tool for assessing the impact of social media on eating behavior among Algerian university students. With excellent reliability and great construct validity supported by statistical studies, the scale emerges as a powerful tool for investigating how social media impacts food patterns. The findings indicate that gender and Algerian students spending time on social media platforms have an impact on their eating behaviors. The findings are consistent with previous studies and emphasize the important, if often inconsistent, effect of social media on eating behavior. Through the finding of individuals who are more vulnerable to poor dietary patterns influenced by internet material, the scale can help guide focused health promotion efforts. In order to identify at-risk students early and provide specialized seminars, peer support groups, and digital literacy campaigns that promote healthy online involvement, institutions might integrate SESMEB tests into regular student wellness initiatives. In order to track trends, establish nutrition policy, public health officials might include the scale into population-based surveys. While social media provides potential for health promotion, such as access to healthy eating trends and lifestyle guidance, it also carries hazards, notably the dissemination of misinformation or untrained dietary advice. The dual nature of this effect necessitates a comprehensive understanding of digital media's function in altering dietary preferences and habits.

Conflict of interest

The authors declare no conflict of interest.

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ORIGINAL ARTICLE

NORMAL WEIGHT OBESITY – HIDDEN OBESITY BEHIND A NORMAL BMI: APPLICATION OF COMPOSITE BODY COMPOSITION INDICES IN NUTRITIONAL STATUS EVALUATION IN SLOVAK FEMALES

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ABSTRACT

Background. Normal weight obesity (NWO) is defined as a phenotype in which individuals present with a body mass index within the normal range, yet exhibit an excessive proportion of body fat (> 28%). This condition is linked to elevated risks of metabolic and cardiovascular disorders. Although BMI remains a widely applied screening parameter, it does not capture the distribution of fat and lean tissue, which may result in misclassification and underestimation of health hazards.
Objective. This study sought to compare the body composition profiles of women classified as normal weight according to BMI but differing in adiposity levels, and to determine the diagnostic value of composite indices – fat mass index (FMI), fat-free mass index (FFMI), skeletal muscle mass index (SMMI), and the fat mass (FM)/fat-free mass (FFM) ratio – in identifying NWO phenotype and assessing nutritional status.
Material and Methods. A total of 402 female Caucasian volunteers aged 18.6-65 years were included in the study. Body composition was analyzed using the InBody 270 (MF-BIA).
Results. Among 402 participants, 235 fell within the normal-weight BMI range, and 62 of them fulfilled the criteria for the NWO phenotype. Relative to their normal weight (NW) counterparts, the NWO group displayed higher adiposity (%FM: 32.85 vs. 24.08%; FMI: 7.53 vs. 5.08 kg/m²; FM/FFM: 0.49 vs. 0.32, respectively), greater visceral fat accumulation (VFL: 8.68 vs. 5.43), and lower values of lean body mass (FFM: 41.93 vs. 45.22 kg; SMM: 22.76 vs. 24.79 kg). In NWO, BMI correlated only weakly with body fat percentage, whereas FMI and FM/FFM showed substantially stronger associations with an unfavorable body composition pattern.
Conclusions. BMI in isolation does not provide sufficient sensitivity to detect the NWO phenotype. Composite indices offer a more precise depiction of body composition and should be considered as complementary tools in both diagnostic procedures and metabolic risk prevention strategies. Their integration into clinical assessment protocols may facilitate earlier detection and targeted intervention.

Keywords: *normal weight obesity, body composition, fat accumulation, lean mass, composite indices*

INTRODUCTION

Excess body fat is recognized as a major risk factor contributing to an estimated 2.8 million deaths worldwide each year. Elevated body weight, encompassing both overweight and obesity, substantially increases the likelihood of developing several chronic non-communicable diseases, including cardiovascular disease, type 2 diabetes, and certain cancers [1]. The World Health Organization (WHO) defines obesity as an abnormal or excessive accumulation of body fat that may impair health. As direct measurement of body fat percentage can be technically demanding, the WHO recommends the use of the body mass index (BMI) as a practical tool for estimating the prevalence of overweight and obesity within populations [2]. BMI has therefore long been established as a standard measure for evaluating nutritional status in individuals and plays a key role in obesity screening [3]. BMI, calculated as body weight in kilograms divided by the square of height in meters (kg/m²), provides a framework for classifying individuals into categories such as underweight, normal weight, pre-obesity, and obesity. These classifications serve as a basis for identifying individuals at elevated risk of chronic diseases, including cardiovascular disease, type 2 diabetes, asthma, chronic obstructive pulmonary disease, gastrointestinal disorders, musculoskeletal conditions, and multiple sclerosis [4-6]. Although BMI remains a valuable tool for assessing health risks at the population level, it cannot differentiate

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between fat mass and lean mass, nor does it account for fat distribution [7]. Its accuracy may be influenced by several factors – such as age, sex, and ethnicity – that affect patterns of body fat distribution [8-10].

As a result, an individual with a BMI in the "normal" range (18.5-24.9 kg/m^2) may have either an appropriate amount of body fat or an excess of fat that remains undetected due to their seemingly normal weight. This limitation can lead to misclassification of individuals [2]. One clinically significant manifestation of this limitation is normal weight obesity (NWO), a phenotype defined by normal BMI values coupled with an excessive body fat percentage. In the scientific literature, this condition has also been described using related terms such as metabolically obese normal weight (MONW) and thin-outside-fat-inside (TOFI), which emphasize the presence of excessive or ectopic fat accumulation and metabolic disturbances despite a normal BMI [11, 12]. These overlapping concepts collectively describe individuals who may appear lean based on BMI but display adverse metabolic profiles, increased visceral adiposity, and elevated cardiometabolic risk.

NWO is associated with increased mortality, morbidity, and risk of chronic metabolic diseases, despite BMI-based classification suggesting a "healthy" weight status [13-15]. This phenotype is particularly common among women, with multiple studies highlighting its association with higher prevalence of metabolic syndrome, insulin resistance, dyslipidemia, hypertension, and type 2 diabetes – even in the absence of overweight according to BMI [6, 8, 15].

In light of these findings, the literature increasingly advocates for complementing BMI assessment with composite body composition indices that enable more accurate identification of at-risk individuals. Such indices include the fat mass index (FMI), fat-free mass index (FFMI), skeletal muscle mass index (SMMI), and the FM/FFM ratio, which express fat mass relative to height, lean (muscle) mass relative to height, skeletal muscle proportion, and the ratio of fat to lean mass, respectively [16-18]. These parameters make it possible to distinguish between healthy and unhealthy body composition, even among individuals with identical BMI values [19].

The aim of this study was to compare two groups of women with similar BMI but differing body fat values, and to evaluate the applicability of selected composite indices in diagnosing the NWO phenotype and assessing nutritional risk.

MATERIAL AND METHODS

Study design

A total of 402 female Caucasian volunteers aged 18.6-65 years were included in the study. The selection of volunteers was random and voluntary. Before inclusion in the study, the participants were informed about the research protocol, which contained details about the research carried out with the objectives, methodological procedure, possible risks in the case of withholding important information regarding health status (risks in the case of an electrical device implanted in the body on the heart or in the case of pregnancy) and the volunteer's consent to inclusion in the study. Inclusion criteria included age between 18 and 70 years, BMI below 50 kg/m^2, absence of serious physical or psychological illnesses, no medication affecting body weight, physiological obstacles such as pregnancy or suspected pregnancy, no professional sports, no contraindication for bioimpedance measurement, no increased physical activity immediately before measurement, no recent weight loss, no increased intake of coffee, alcohol or fat ≤ 8 hours before testing and diuretics one week before testing. The study was conducted with the approval of the Ethics Committee of the Specialized Hospital of St. Zoerardus Zobor in Nitra, Slovakia (protocol no. 20230512/2) according to the guidelines of the Declaration of Helsinki.

Body composition

Body composition was analyzed using the InBody 270 (MF-BIA; InBody Corporation, Seoul, South Korea). Before the measurement, participants were asked to exclude and refrain from drinking large amounts of water, not to consume alcohol 24 hours before testing, to avoid food with a high sugar, salt or fat content for 12 hours before testing, to refrain from intense physical activity for at least 12 hours beforehand. In addition to informed written consent, all participants also signed consent to the processing of personal data.

Body height was measured using a professional electronic altimeter BSM370 (Biospace Co. Ltd., Seoul, Republic of Korea), the advantage of which lies in the automation of the measurement performance with the elimination of human errors during measurement. To assess the body composition, the following parameters were measured directly by bioimpedance analysis: basal metabolic rate (BMR, kcal); body weight (BW, kg); waist circumference (WC, cm); hip circumference (HC, cm); fat-free mass (FFM, kg); skeletal muscle mass (SMM, kg); body fat mass (FM, kg, %); visceral fat level (VFL); total body water (TBW, L).

Waist-to-hip ratio (WHR) and waist-to-height ratio (WHtR) were calculated as waist circumference (cm) divided by hip circumference (cm) or height (cm), respectively. Fat mass (kg), fat-free mass (kg) and skeletal muscle mass (kg) were taken to calculate fat mass index (FMI, kg/m^2), fat-free mass index (FFMI, kg/m^2) and skeletal muscle mass index (SMMI, kg/m^2)

as fat mass (kg) divided by square of the height (m^2) or fat-free mass (kg) divided by square of the height (m^2) or skeletal muscle mass (kg) divided by square of the height (m^2). We also expressed fat-free mass, skeletal muscle mass and total body water in relative proportions.

From the group of women with normal BMI values, we created two key groups – a normal weight group (NW; BMI 18.5-24.99 kg/m^2 and %FM < 28%) and normal weight obesity group (NWO; BMI 18.5-24.99 kg/m^2 and %FM > 28%).

Statistical analysis

We used Microsoft Office Excel 2016 (Los Angeles, CA, USA) in combination with XLSTAT (version 2019.3.1) for data processing. We performed statistical analysis using the computer software STATISTICA 13 (TIBCO Software, Inc., Palo Alto, CA, USA) and MedCalc software (MedCalc® Statistical Software Ltd, Ostend, Belgium, version 23.0.2). The normality of the variable distribution was checked by the Shapiro-Wilk test. We used the paired t-test if the data were normally distributed, if the distribution was not normal, the Wilcoxon signed rank test was used. We performed descriptive analysis using mean ± standard deviation. To evaluate the relationship between variables, we used Spearman›s correlation analysis and expressed it graphically with color scales through correlograms. The level of statistical significance was set as $p < 0.05$.

RESULTS

A total of 402 adult women aged 18.6-65.0 years (mean 42.51 ± 10.67 years) were included in the study. The sample encompassed a wide range of body height from 1.53 m to 1.83 m (mean 1.67 ± 0.06 m), body weight from 46.0 kg to 118.5 kg (mean 67.75 ± 13.02 kg), and BMI ranging from 18.50 to 40.70 kg/m² (mean 24.45 ± 4.60 kg/m²). The mean waist circumference was 78.39 ± 5.85 cm, the waist-to-hip ratio 0.87 ± 0.07, and the waist-to-height ratio 0.47 ± 0.04. The mean fat-free mass was 46.85 ± 6.09 kg, skeletal muscle mass 25.73 ± 3.64 kg, and fat mass 19.82 ± 9.27 kg. The average visceral fat level was 8.11 ± 4.66, total body water 34.35 ± 4.46 liters, and the mean basal metabolic rate 1384 ± 131.57 kcal. These values indicate considerable inter-individual differences in body composition and fat tissue distribution, which are detailed in Table 1.

Based on body mass index values, the women were divided into three primary weight categories. The

Table 1. Descriptive characteristics of the study group

Parameters N = 402	Mean	SD	Minimum	Maximum
Age (years)	42.51	10.67	18.60	65.00
Body weight (BW, kg)	67.75	13.02	46.00	118.50
Body mass index (BMI, kg/m²)	24.45	4.60	18.50	40.70
Height (m)	1.67	0.06	1.53	1.83
Waist circumference (WC, cm)	78.39	5.85	66.60	95.40
Waist-to-hip ratio (WHR)	0.87	0.07	0.74	1.06
Waist-to-height ratio (WHtR)	0.47	0.04	0.37	0.59
Fat-free mass (FFM, kg)	46.85	6.09	27.40	77.00
Fat-free mass (FFM, %)	69.62	7.99	42.06	90.03
Fat-free mass index (FFMI, kg/m²)	16.91	1.73	10.98	23.25
Skeletal muscle mass (SMM, kg)	25.73	3.64	14.50	44.20
Skeletal muscle mass (SMM, %)	38.23	4.39	23.16	50.00
Skeletal muscle mass index (SMMI, kg/m²)	9.28	1.05	5.81	13.34
Fat mass (FM, kg)	19.82	9.27	6.10	58.10
Fat mass (FM, %)	30.38	8.00	10.00	58.00
Fat mass index (FMI, kg/m²)	7.15	3.42	1.88	22.38
Fat mass to fat-free mass ratio (FM/FFM)	0.42	0.17	0.11	1.38
Visceral fat level (VFL)	8.11	4.66	2.00	25.00
Total body water (TBW, L)	34.35	4.46	20.10	56.40
TBW/BW (%)	51.06	5.89	30.74	66.34
Basal metabolic rate (BMR, kcal)	1384	131.57	961	2032

SD – standard deviation

normal weight category, with a BMI ranging from 18.5 to 24.99 kg/m², included 235 women. Another 106 women fell into the pre-obesity category, with a BMI between 25.0 and 29.99 kg/m², while the remaining 61 women were classified as obese, with a BMI equal to or greater than 30.0 kg/m². A detailed distribution of the entire sample according to BMI categories, along with the corresponding basic anthropometric characteristics, is presented in Table 2.

Women with normal weight adjusted for BMI and with healthy body fat

For NW group, positive correlations were observed between body weight, skeletal muscle mass, fat-free mass, and total body water content. Body weight showed strong positive correlations with FFM, SMM, TBW, and BMR. Body mass index was strongly and positively correlated with FFMI, SMMI, FM, and FMI. Moderate positive correlations were found with SMM, FFM, TBW, BMR, and VFL. Negative correlations were observed with %SMM, %FFM, and TBW/BW.

Fat mass index had a strong positive correlation with FM and %FM, while also being strongly and negatively correlated with %FFM, TBW/BW, and %SMM. Fat-free mass index showed positive correlations with SMM, FFM, TBW, and BMR. A moderate positive correlation was observed with %SMM. The only negative correlation was with %FM. Skeletal muscle mass index, similar to FFMI, showed very strong positive correlations with SMM, FFM, TBW, and BMR. A moderate positive correlation was found with %SMM, and negative correlations were found with %FM. The FM/FFM ratio exhibited a very strong positive correlation with %FM. Strong negative correlations were noted with %FFM, TBW/BW, and %SMM. Between %FM and composite indices, very strong negative correlations were found – the highest with %FFM, followed by TBW/BW and %SMM. All three components – FFM, TBW, and SMM –

Table 2. Anthropometric characteristics of subgroups adjusted for BMI

Parameters	Normal weight (N = 235)				Pre-obesity (N = 106)				Obesity (N = 61)			
	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max
Age (years)	39.19[a]	10.29	18.60	63.00	46.37[b]	9.30	26.00	63.00	48.56[c]	9.47	19.00	65.00
BW (kg)	60.35[a]	6.01	46.00	77.00	75.41[b]	6.45	58.70	91.40	90.47[c]	9.18	74.70	118.50
BMI (kg/m²)	21.58[a]	1.74	18.50	24.90	27.09[b]	1.42	25.00	29.70	33.09[c]	2.53	30.00	40.70
Height (m)	1.67[a]	0.06	1.54	1.82	1.67[b]	0.06	1.53	1.83	1.65[a]	0.06	1.53	1.82
WC (cm)	75.34[a]	4.16	66.60	88.20	81.58[b]	4.40	72.00	93.60	85.38[b]	4.98	71.10	95.40
WHR	0.84[a]	0.05	0.74	0.98	0.91[b]	0.05	0.80	1.04	0.95[c]	0.06	0.79	1.06
WHtR	0.45[a]	0.03	0.37	0.54	0.49[b]	0.03	0.44	0.56	0.52[c]	0.03	0.42	0.59
FFM (kg)	44.53[a]	5.09	27.40	62.90	49.04[b]	5.17	37.90	73.10	52.65[b]	6.01	41.60	77.00
FFM (%)	74.38[a]	5.85	52.09	90.03	65.40[b]	4.30	55.82	80.60	58.66[c]	4.35	42.06	72.30
FFMI (kg/m²)	16.05[a]	1.20	10.98	19.63	17.68[b]	1.12	14.95	22.07	19.40[c]	1.38	16.25	23.25
SMM (kg)	24.33[a]	3.03	14.50	35.80	27.04[b]	3.08	20.60	41.60	29.23[b]	3.57	22.80	44.20
SMM (%)	40.66[a]	3.44	27.57	50.00	36.08[b]	2.62	30.03	45.87	32.58[b]	2.60	23.16	41.50
SMMI (kg/m²)	8.78[a]	0.74	5.81	11.17	9.75[b]	0.69	8.08	12.56	10.78[c]	0.84	8.95	13.34
FM (kg)	15.54[a]	4.17	6.10	27.30	26.12[b]	4.16	17.60	35.80	37.02[c]	6.30	29.00	58.10
FM (%)	25.62[a]	5.86	10.00	48.00	34.60[b]	4.30	19.40	44.10	41.13[c]	4.35	27.70	58.00
FMI (kg/m²)	5.60[a]	1.57	1.88	10.15	9.42[b]	1.46	5.31	12.42	13.61[c]	2.27	8.91	22.38
FM/FFM	0.34[a]	0.11	0.11	0.92	0.54[b]	0.10	0.24	0.79	0.70[c]	0.14	0.38	1.38
VFL	5.79[a]	2.18	2.00	15.00	11.55[b]	2.60	7.00	18.00	16.72[c]	2.76	13.00	25.00
TBW (L)	32.66[a]	3.73	20.10	46.20	35.94[b]	3.79	27.80	53.90	38.60[b]	4.38	30.40	56.40
TBW/BW (%)	54.55[a]	4.33	38.21	66.34	47.94[b]	3.19	40.87	59.43	43.00[c]	3.19	30.74	52.96
BMR (kcal)	1334[a]	109.95	961	1729	1431[b]	111.77	1188	1949	1509[b]	129.72	1268	2032

BW – body weight; BMI – body mass index; WC – waist circumference – WHR – waist-to-hip ratio; WHtR – waist-to-height ratio; FFM – fat-free mass; FFMI – fat-free mass index; SMM – skeletal muscle mass; SMMI – skeletal muscle mass index; FM – fat mass; FMI – fat mass index; VFL – Visceral Fat Level; TBW – total body water; BMR – basal metabolic rate; SD – standard deviation; Min – minimum; Max – maximum; [a, b, c] – different letters indicate a significant difference; normal weight was defined as: BMI between 18.5-24.99 kg/m², pre-obesity: BMI between 25.0-29.99 kg/m², obesity: BMI equal to or greater than 30 kg/m².

showed strong positive correlations with each other, confirming their mutual interconnection and inverse relationship to body fat levels. An overview of the correlation relationships between individual variables is shown in the correlation matrix in Table 3.

Women with normal weight obesity phenotype

In this group of women with a normal BMI but elevated body fat percentage, BMI showed very strong correlations with body weight, SMMI, and FFMI. Correlations with SMM, FFM, TBW, FM, and VFL were strong, whereas relationships with key relative composition indicators – %FM and FM/FFM ratio – were weak. Fat mass index exhibited very strong positive correlations with %FM, FM, and VFL. Strong correlations were also confirmed with WC, WHR, and WHtR. Negative correlations were found with %SMM, %FFM, and TBW/BW. Fat-free mass index was very strongly correlated with SMMI, SMM, FFM, and TBW. Moderate negative correlations were recorded with %FM. Skeletal muscle mass index had very strong correlations with SMM, FFM, and TBW. Moderate negative relationships were noted with %FM. The FM/FFM ratio showed very strong positive correlations with %FM and VFL. Very strong negative correlations were confirmed with %SMM, %FFM, and TBW/BW, while the relationship with SMM was moderate. In the NWO group, BMI showed only weak correlations with %FM and FM/FFM ratio, whereas FMI and FM/FFM had very strong relationships with these indicators (FMI vs. %FM: r = 0.828; FM/FFM vs. %FM: r = 0.995). BMI was also less sensitive in reflecting the relationship between fat burden and muscle mass indicators (%SMM: r = 0.076; %FFM: r = -0.078) compared with FM/FFM (%SMM: r = -0.974; %FFM: r = -0.995). For absolute muscle and fat-free mass values, BMI was strongly correlated (SMM: r = 0.636; FFM: r = 0.622), but the associations were weaker than those for FFMI and SMMI (SMMI vs. SMM: r = 0.810; FFMI vs. FFM: r = 0.771). All correlation coefficient values for the NWO group are provided in Table 3.

Anthropometric differences between NWO and NW women

From the group of 235 women with a normal body mass index, 150 were classified – based on body fat percentage – into the group with a healthy body fat proportion, representing the "normal weight without obesity" (NW) phenotype. Another 62 women with a normal body mass index but with an elevated body fat percentage (above 28%) belonged to the phenotype referred to as "normal weight obesity" (NWO). The remaining 23 women had a body fat

Table 3. Correlation matrix of selected anthropometric variables in the NW and NWO phenotype groups

Parameters	BMI		FMI		FFMI		SMMI		FM/FFM	
	NW	NWO	NW	NWO	NW	NWO	NW	NWO	NW	NWO
Age (years)	0.20*	0.29*	0.15	0.43***	0.16*	0.04	0.15	0.04	0.08	0.34**
BW (kg)	0.73***	0.72***	0.40***	0.40**	0.70***	0.61***	0.72***	0.65***	0.13	-0.04
Height (m)	-0.01	0.07	-0.18*	-0.03	0.13	0.11	0.18*	0.15	-0.23**	-0.12
WC (cm)	0.23**	0.40**	0.37***	0.55***	0.02	0.10	0.04	0.13	0.36***	0.40**
WHR	0.23**	0.40**	0.37***	0.55***	0.02	0.10	0.04	0.13	0.36***	0.40**
WHtR	0.20*	0.35**	0.42***	0.56***	-0.07	0.03	-0.08	0.03	0.45***	0.47***
FFM (kg)	0.54***	0.62***	0.01	0.03	0.76***	0.77***	0.79***	0.80***	-0.29***	-0.44***
FFM (%)	-0.39***	-0.08	-0.92***	-0.83***	0.21*	0.52***	0.22**	0.51***	-1.00***	-1.00***
SMM (kg)	0.55***	0.64***	0.01*	0.04	0.77***	0.78***	0.80***	0.81***	-0.29***	-0.43***
SMM (%)	-0.23**	0.08	-0.83***	-0.72***	0.36***	0.64***	0.39***	0.64***	-0.97***	-0.97***
FM (kg)	0.71***	0.59***	0.93***	0.86***	0.24**	0.11	0.24**	0.15	0.83***	0.63***
FM (%)	0.39***	0.08	0.92***	0.83***	-0.21*	-0.52***	-0.22**	-0.50***	1.00***	1.00***
VFL	0.59***	0.40**	0.83***	0.88***	0.15	-0.16	0.15	-0.13	0.77***	0.81***
TBW (L)	0.54***	0.63***	0.00	0.03	0.76***	0.77***	0.79***	0.80***	-0.29***	-0.43***
TBW/BW (%)	-0.41***	-0.07	-0.92***	-0.82***	0.20*	0.53***	0.21**	0.51***	-1.00***	-0.99***
BMR (kcal)	0.54***	0.62***	0.01	0.03	0.76***	0.77***	0.79***	0.80***	-0.29***	-0.44***

BW – body weight; BMI – body mass index; WC – waist circumference – WHR – waist-to-hip ratio; WHtR – waist-to-height ratio; FFM – fat-free mass; FFMI – fat-free mass index; SMM – skeletal muscle mass; SMMI – skeletal muscle mass index; FM – fat mass; FMI – fat mass index; VFL – Visceral Fat Level; TBW – total body water; BMR – basal metabolic rate; NW – normal weight; NWO – normal weight obesity.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; 1.0 −1.0

Table 4. Comparison of selected anthropometric parameters in the NW and NWO phenotype groups

Parameters	NW (N = 150)		NWO (N = 62)		p-value
	Mean	SD	Mean	SD	
Age (years)	37.73	9.82	42.07	10.99	< 0.01
BW (kg)	59.60	6.00	62.52	5.59	< 0.01
BMI (kg/m²)	21.27	1.59	22.97	1.37	< 0.001
Height (m)	1.67	0.06	1.65	0.05	< 0.05
WC (cm)	74.83	3.46	78.53	3.99	< 0.001
WHR	0.83	0.04	0.87	0.04	< 0.001
WHtR	0.45	0.02	0.48	0.02	< 0.001
FFM (kg)	45.22	4.74	41.93	4.09	< 0.001
FFM (%)	75.85	3.28	67.07	2.84	< 0.001
FFMI (kg/m²)	16.17	1.13	15.40	1.08	< 0.001
SMM (kg)	24.79	2.83	22.76	2.40	< 0.001
SMM (%)	41.58	1.96	36.37	1.67	< 0.001
SMMI (kg/m²)	8.86	0.69	8.36	0.65	< 0.001
FM (kg)	14.38	2.58	20.59	2.50	< 0.001
FM (%)	24.08	3.27	32.85	2.84	< 0.001
FMI (kg/m²)	5.08	0.93	7.53	0.81	< 0.001
FM/FFM	0.32	0.06	0.49	0.07	< 0.001
VFL	5.43	1.15	8.68	1.86	< 0.001
TBW (L)	33.17	3.46	30.73	2.99	< 0.001
TBW/BW (%)	55.64	2.43	49.14	2.07	< 0.001
BMR (kcal)	1347	102.24	1276	88.28	< 0.001

BW – body weight; BMI – body mass index; WC – waist circumference – WHR – waist-to-hip ratio; WHtR – waist-to-height ratio; FFM – fat-free mass; FFMI – fat-free mass index; SMM – skeletal muscle mass; SMMI – skeletal muscle mass index; FM – fat mass; FMI – fat mass index; VFL – Visceral Fat Level; TBW – total body water; BMR – basal metabolic rate; SD – standard deviation; NW – normal weight; NOW – normal weight obesity.

percentage outside the defined reference range or incomplete data on its proportion, and therefore did not meet the criteria for inclusion in either of these two phenotypes.

When comparing the "normal weight without obesity" (NW) and "normal weight obesity" (NWO) phenotypic groups, statistically significant differences were confirmed in several key body composition indicators. Women with the NWO phenotype had higher mean age compared to the NW group (42.07 vs. 37.73 years; $p < 0.01$), body weight (62.52 vs. 59.60 kg; $p < 0.01$), body mass index (22.97 vs. 21.27 kg/m²; $p < 0.001$), and markedly higher fat mass indicators – FM/FFM (0.49 vs. 0.32; $p < 0.001$), FM (20.59 vs. 14.38 kg; $p < 0.001$), %FM (32.85 vs. 24.08%; $p < 0.001$), and FMI (7.53 vs. 5.08 kg/m²; $p < 0.001$). The NWO group also had higher values of visceral fat level (8.68 vs. 5.43; $p < 0.001$), waist circumference (78.53 vs. 74.83 cm; $p < 0.001$), waist-to-hip ratio (0.87 vs. 0.83; $p < 0.001$), and waist-to-height ratio (0.48 vs. 0.45; $p < 0.001$).

In contrast, the NW phenotype, despite the identical BMI classification, had higher values of fat-free mass and muscle mass indicators. BMR (1347 vs. 1276 kcal; $p < 0.001$), FFM (45.22 vs. 41.93 kg; $p < 0.001$), %FFM (75.85 vs. 67.07%; $p < 0.001$), and the FFMI (16.17 vs. 15.40 kg/m²; $p < 0.001$) were higher. A similar trend was observed for SMM 24.79 vs. 22.76 kg; $p < 0.001$), %SMM (41.58 vs. 36.37%; $p < 0.001$), and the SMMI (8.86 vs. 8.36 kg/m²; $p < 0.001$). The NW group also had a higher TBW (33.17 vs. 30.73 L; $p < 0.001$) and TBW/BW (55.64 vs. 49.14%; $p < 0.001$).

Correlation analyses indicated different sensitivity of the evaluated indices between phenotypes. In the NW group, BMI showed very strong correlations with SMM ($r = 0.549$), FM ($r = 0.712$) and relatively stronger with %FM ($r = 0.393$) compared to NWO (SMM: $r = 0.636$; FM: $r = 0.593$; %FM: $r = 0.079$). In the NWO phenotype, the strongest associations with fat indicators were observed for FMI (%FM: $r = 0.828$) and FM/FFM (%FM: $r = 0.995$), whereas BMI did not capture these relationships. Similarly, in

NWO, BMI weakly reflected the negative association between fat load and muscle mass (%SMM: r = 0.076; %FFM: r = -0.078) compared to FM/FFM (%SMM: r = -0.974; %FFM: r = -0.995). Differences in the sensitivity of BMI and FMI were most evident for parameters of relative and absolute body composition. In the NWO group, BMI had only weak correlations with %FM (r = 0.079), %SMM (r = 0.076), and %FFM (r = -0.078), whereas FMI showed very strong correlations with these indicators (%FM: r = 0.828) and strong negative associations with %SMM (r = -0.724; %FFM: r = -0.827). A similar difference was observed for absolute fat mass and visceral fat, where BMI correlated with FM (r = 0.593) and VFL (r = 0.400) less strongly than FMI (FM: r = 0.856; VFL: r = 0.884), indicating markedly higher sensitivity of FMI in assessing fat load in this phenotype.

These differences confirm that in the NWO phenotype, BMI is a less reliable indicator of body composition, whereas indices such as FMI, FM/FFM, FFMI, and SMMI provide a more sensitive picture of actual body composition and potential health risks. A comparison of the mean values of individual parameters for both groups is presented in Table 4.

DISCUSSION

In recent years, it has become increasingly evident that individuals with similar body mass index may exhibit markedly different values for the components of body composition, particularly in the proportion of fat mass and muscle mass, which clearly highlights the limitations of using BMI alone in nutritional status assessment. This issue is especially apparent when evaluating the phenotype of normal weight obesity (NWO), in which individuals classified as "normal" according to BMI simultaneously present with excessive body fat [20]. Our results confirm that, even among women with comparable BMI values, significant differences were observed in body composition parameters, particularly in fat mass percentage, fat mass index, and skeletal muscle indices. These findings illustrate the well-recognized limitation of BMI, which does not account for differences in fat and lean mass distribution. This observation is consistent with previous studies reporting that a notable proportion of women with a normal BMI present excessive body fat and can thus be classified as having the NWO phenotype [2, 7, 21]. The similarity between our results and those reported in other populations suggests that this phenotype – and its associated health risks – may also be relevant within the Slovak female population. Significant differences between the NW and NWO groups in our sample were observed primarily in parameters related to adipose tissue. Participants classified in the NWO group exhibited markedly higher mean values of body fat percentage compared to the NW group, fat mass index, FM/FFM, and visceral fat level. These findings indicate that even with identical BMI classification, body composition between the groups can differ substantially – an aspect that plays a key role in evaluating health risks for specific phenotypic groups. Our findings are consistent with previous observations showing that individuals with the NWO phenotype tend to have a higher proportion of total and visceral fat despite comparable BMI values [14, 22, 23].

Similar results were reported by Romero Corral et al. [14] in a U.S. adult population and by De Lorenzo et al. [22] in Caucasian Italian women with normal BMI. This agreement suggests that comparable adiposity patterns may also be present among Slovak women, indicating that excessive abdominal fat could be a key factor contributing to the less favorable metabolic profile observed in the NWO phenotype. Our results showed that women with the NWO phenotype had higher visceral fat levels and greater waist circumference compared to women with normal body composition, despite identical BMI classification. This pattern of central fat accumulation was also described in other populations, including U.S. adults [14] and middle-aged Europeans [24], as well as in broader reviews of NWO characteristics across ethnic groups [2]. The similarity of these findings suggests that excessive abdominal adiposity is a consistent feature of the NWO phenotype across diverse populations and is also evident in Slovak women, potentially contributing to an increased cardiometabolic risk profile. As central obesity may be present even with a normal BMI, Lee et al. [25] recommend specific waist circumference cut-off values for more accurate identification of at-risk individuals, which may also be beneficial in detecting the NWO phenotype.

Gómez-Ambrosi et al. [26] reported that individuals with a normal BMI but a high body fat percentage ("NOOB") had higher waist circumference, blood pressure, CRP levels, uric acid, ALT, and insulin resistance compared to individuals with a normal BMI and normal body fat percentage. The prevalence of abdominal obesity among individuals with NWO ranges from 15.6-28.8%, compared with only 3.7-4.4% in those with NW [27-29]. Reported values include Italian women aged 20-45 years [27], Chinese adults [28], and Ethiopian adults of both sexes [29], indicating population-related variability but consistently higher prevalence in NWO. Correa-Rodríguez et al. [30] also highlighted the high prevalence of NWO among young adults and its association with multiple cardiometabolic risk factors, further supporting the need for early identification of this phenotype. Interestingly, correlation analysis showed a stronger association

between BMI and visceral fat in the NW group than in the NWO group. This paradox suggests that BMI cannot reliably capture risky body composition in the NWO group – emphasizing the need for more targeted diagnostics beyond BMI alone.

Apart from adipose tissue, differences between the groups were also observed in indicators of fat-free mass. Despite having the same BMI, women in the NW phenotype group had higher values of FFM, SMM, as well as FFMI and SMMI compared to the NWO group. These differences indicate a more favorable representation of fat-free body tissue in the NW group and also suggest that the NWO phenotype is characterized not only by excess fat but also by a lower proportion of fat-free body mass, which in the long term may lead to the development of a condition known as sarcopenic obesity. This condition, described in detail by Barazzoni et al. [31], represents a combination of increased fat mass and reduced muscle mass, which significantly worsens an individual's metabolic profile.

In the NW group, BMI strongly correlated with muscle mass indicators – most notably with FFMI and SMMI – indicating that a higher BMI in this group is associated with muscle mass. In NWO, these correlations were similarly high, but due to lower absolute muscle mass values, BMI in this group cannot be interpreted as reflecting a favorable composition. The higher correlation simply means that even small changes in BMI are accompanied by changes in muscle mass – often alongside an increase in fat mass.

The differing nature of BMI in both groups is further illustrated by fat-related correlations. For NW, BMI showed a stronger relationship with FM and FMI than in NWO. This suggests that BMI in the NWO group fails to adequately reflect body fat content. A significant marker of the disproportion between fat and lean components proved to be the FM/FFM ratio, which showed markedly different values between the groups – 0.32 for the NW group compared to 0.49 for the NWO group. This difference confirms that the NWO phenotype is characterized not only by an absolute increase in fat mass but, more importantly, by a disturbed balance between fat and the functional components of the body.

In the NWO group, FM/FFM was strongly positively correlated with indicators of body fat content, particularly FMI and %FM, while at the same time showing pronounced negative associations with indicators of active tissue, such as FFM, SMMI, or TBW/BW. High FM/FFM values in this group thus result from an increase in fat mass combined with a loss of muscle mass, creating a metabolically risky profile that BMI fails to capture. In both groups, a very strong positive relationship was confirmed between fat mass (FM) and the FM/FFM ratio, meaning that as fat mass increases, this ratio rises. In the NW group, this relationship is stronger, possibly because changes in the ratio are mainly due to an increase in fat mass with relatively stable fat-free mass. In the NWO group, the correlation is weaker, since FM/FFM is influenced not only by higher fat mass but also by lower fat-free mass.

This difference indicates that in NWO, the worsening of the ratio is driven by a combination of increased fat load alongside a loss of muscle mass, which represents a less favorable health profile.

This imbalance between muscle and fat mass creates a metabolically risky profile that is not fully apparent when using BMI as a single indicator**.** This imbalance between fat and muscle mass, observed in Slovak women with the NWO phenotype, suggests a metabolically disadvantageous composition that may predispose to higher cardiometabolic risk. Similar patterns have been reported in other populations – young adults from Spain [30], medical professionals in India [32], and Ethiopian adults [29] – indicating that the coexistence of excess fat and reduced muscle mass is a globally observed feature of NWO. According to Mohammadian Khonsari et al. [33], such alterations in body composition are linked to higher mortality and metabolic disturbances, supporting the importance of maintaining adequate muscle mass as a protective factor. In our study, women with a higher proportion of muscle tissue showed a more favorable fat-to-lean ratio, consistent with evidence from U.S. adults [34] and Caucasian subjects studied by Poggiogalle et al. [35], where greater muscle mass was associated with lower cardiometabolic risk. These results reinforce that evaluating both fat and muscle compartments is essential for accurately identifying health risks in normal-weight individuals, as also emphasized by Ashtary Larky et al. [36].

However, it is also necessary to consider the quality of muscle tissue. Trouwborst et al. [37] point out the paradox that, although a higher fat volume may mask muscle loss in older adults, the function of these muscles is often impaired, highlighting the risk of so-called sarcopenic obesity and the importance of assessing the body's functional capacity.

It is also important to emphasize the methodological significance of distinguishing between absolute values (kg) and relative values (%) when comparing them, as each of these parameters reflects a different aspect of body composition. This fact is also noted by Gažarová et al. [38], who state that functional indicators should be assessed in mutually compatible units – such as ratio with ratio and weight with weight. Our findings support this recommendation, as comparisons between variables expressed in different units may produce misleading interpretations. In the NWO group, correlations between percentage-based indicators (%FM vs. %FFM and %SMM) were

strongly negative, reflecting their inherent proportional relationship, whereas correlations between %FM and SMM in kilograms were only weakly negative. A similar pattern was observed in the NW group. This demonstrates that percentage indicators can vary independently of their absolute counterparts, which should be taken into account when assessing body composition and functional status. Despite our efforts, our study has some weaknesses. The relatively small sample size, as well as the fact that the participants came from a homogeneous population, limit the possibility of transferring the conclusions to other ethnic groups. The study included only women, which does not provide a complete picture and limits the applicability of the findings to a wider population. The need for studies including the male population is desirable, therefore our further research activities will be focused in this direction. Likewise, the absence of functional indicators such as muscle strength or physical performance, which would complement the interpretation of muscle mass indices.

Among the strengths of the study can be included a detailed analysis of body composition using several composite indices (FMI, FFMI, SMMI, FM/FFM), which provided a comprehensive view of the differences between phenotypic groups. The inclusion of correlation analysis allowed us to reveal the links between absolute and relative indicators, as well as the accurate classification of the phenotype of the participants according to the combination of BMI and body fat percentage.

CONCLUSIONS

Our study confirms that women with similar body mass index values can differ substantially in composite indicators of body composition. By employing the composite indices fat mass index, fat-free mass index, skeletal muscle mass index, and fat mass to fat-free mass ratio, we identified that the normal weight obesity group exhibited higher fat mass index values and a less favorable FM/FFM ratio, accompanied by lower fat-free mass index and skeletal muscle mass index scores – indicating a combination of excessive fat mass and reduced muscle mass. In contrast, the normal weight group showed a higher proportion of muscle mass and more favorable values across all evaluated indices. These findings confirm that nutritional status assessment based solely on body mass index should be complemented with comprehensive body composition measures to enable accurate identification of individuals with the NWO phenotype and to support targeted preventive interventions. In line with current research trends, our work supports the integration of advanced body composition diagnostics alongside traditional BMI classification, providing a more nuanced evaluation that reflects individual characteristics of the assessed population.

Conflict of interest

There were no conflicts of interest.

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ORIGINAL ARTICLE

HEALTHCARE ACCESS AND CONSULTATION BEHAVIORS AMONG OVERWEIGHT AND OBESE ADULTS IN KÉNITRA, MOROCCO: A CROSS-SECTIONAL STUDY ON BARRIERS

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ABSTRACT

Background. Overweight and obesity are major public health challenges, yet access to appropriate healthcare and effective management remains limited. This study aimed to assess healthcare access, consultation behaviors, and barriers among overweight and obese adults.

Material and Methods. A cross-sectional study was conducted among 134 adults in Kénitra, Morocco. Sociodemographic information, body mass index (BMI), and healthcare access variables were collected using structured questionnaires and clinical assessments. Descriptive statistics were used to summarize consultation behaviors, barriers, types of healthcare providers consulted, and follow-up practices.

Results. Among participants, 47.0% were classified as obese, 25.4% as overweight, and 27.6% had normal BMI. Only 19.6% reported consulting specifically for weight-related issues, while 78.4% did not seek care. The main barriers were perception of no need (34.6%), financial constraints (25.6%), and lack of physicians (21.8%). Consultations primarily took place in the private sector (84.2%). Dietitians (40.4%) and specialist physicians (38.6%) were the most frequently consulted professionals, whereas general practitioners accounted for only 10.9%. Follow-up and referral rates were low, with just 3.1% of participants referred to specialists or dietitians and 91.8% receiving no regular monitoring.

Conclusion. Access to healthcare for overweight and obese adults is constrained by economic, social, and systemic factors. The low rates of consultation, referral, and follow-up underscore the need for structured care pathways, enhanced provider awareness, and multidisciplinary management strategies in Morocco.

Keywords: *obesity, overweight, healthcare access, barriers, follow-up, primary care*

INTRODUCTION

The prevalence of nutritional disorders has increased dramatically worldwide over recent decades, constituting what the World Health Organization describes as a global obesity epidemic [1, 2]. This trend forms part of a broader nutritional transition, characterized by rapid shifts in diet and lifestyle driven by globalization, urbanization, and economic development [3]. Populations in developing regions, including North Africa, as well as immigrant communities in high-income countries, are particularly vulnerable. In these settings, nutritional disorders pose a growing public health threat.

In developing countries, urbanization is a major driver of rising obesity rates [4, 5]. While Africa remains the least urbanized continent, North African cities are experiencing unprecedented growth. Urban residents, especially those with lower socio-economic status, increasingly consume inexpensive, energy-dense foods rich in fats, sugars, and refined carbohydrates, leading to the erosion of traditional dietary patterns [6]. In contrast, rural populations generally have lower fat intake, more physically demanding lifestyles, and reduced reliance on mechanized transport, which mitigates weight gain [3, 7].

Socio-economic development, urbanization, and aging have consistently been identified as determinants of obesity and related cardiovascular

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risk factors, including diabetes, hypertension, and hypercholesterolemia, across North African populations [4, 8]. Notably, unlike high-income countries, where obesity is more prevalent among disadvantaged groups [9], in North Africa, obesity is often linked to higher socio-economic status. Among women, cultural norms frequently associate fatness with beauty, fertility, and social prestige, and lower educational attainment is associated with reduced awareness of obesity-related health risks [10-13].

Despite the rising prevalence survey reported that 53.4% of adults were overweight and 20.2% obese, with women disproportionately affected (29.0% obese vs. 11.0% of men) [14]. These is exceeding regional averages and highlight the rapid nutritional and epidemiological transitions underway. Yet, access to obesity-specific care remains limited due to structural inequalities, financial barriers, and persistent cultural perceptions regarding body weight.

In Morocco, overweight and especially obesity are now a major public health issue, with a particularly high prevalence among women. Recent estimates indicate that approximately 35.7% of adult women and 22.6% of adult men are obese (BMI ≥ 30 kg/m²), levels higher than those observed on average in the North Africa-Middle East region (20.8% among women and 9.2% among men) [15]. Globally, the World Health Organization estimates that in 2022, 43% of adults aged 18 and over were overweight (BMI ≥ 25 kg/m²) and 16% were obese, confirming a continuous increase in excess weight since the 1990s [16]. Thus, although excess weight is a global phenomenon, the available data suggest that Morocco is experiencing a particularly worrying trend, particularly with regard to female obesity, which highlights the need to analyze its determinants and impacts, particularly in terms of access to healthcare, in the Moroccan context [15].

Obesity prevalence in Morocco, particularly among women, is rising due to rapid urbanization, socio-economic changes, and cultural factors, yet national healthcare systems remain unprepared to prevent or manage it effectively. Understanding the determinants of obesity and the barriers to healthcare access is essential for designing culturally appropriate, evidence-based public health interventions. Therefore, this study aims to: Evaluate access to obesity-specific healthcare services and the barriers to care, and provide evidence-based recommendations for public health strategies aimed at obesity prevention and management.

MATERIALS AND METHODS

Study design and area

A cross-sectional observational study was conducted between March 2022 and April 2024 in the province of Kénitra, Morocco. The study aimed to evaluate access to care, consultation behaviors, and barriers among overweight and obese adults aged 18-60 years.

Study sites

Data were collected across multiple healthcare and community settings, including the Provincial Hospital of Kénitra, the Kénitra Diagnostic Center, the Level I Urban Health Center "Diouri", an industrial automotive company located in the Atlantic Free Zone of Kénitra, and a private medical practice. These sites were purposively selected to capture diverse socioeconomic profiles and contexts of healthcare access.

Inclusion and exclusion criteria

An initial clinical examination to check the eligibility of participants was performed by the study physician. It included blood pressure and blood glucose measurements and a medical history. A total of 157 adults were interviewed, of whom 134 completed the questionnaire in a comprehensive and usable manner and were included in the analysis. The inclusion criteria were: age between 18 and 60 years and belonging to one of the BMI categories defined by the World Health Organization, namely normal BMI (18.5-24.9 kg/m²), overweight (25.0-29.9 kg/m²) or obese (BMI ≥ 30 kg/m²). Exclusion criteria included any chronic condition that could influence weight gain or limit physical activity (cardiovascular disease, thyroid disorders), any mobility limitations, and the use of medications that could affect sleep, eating behavior, or physical activity. All participants received detailed information about the study and signed an informed consent form. Participation was voluntary, and participants could withdraw from the study at any time.

Recruitment of the research group

The study was based on a convenience sample of eligible adults recruited across the different data collection sites during the study period (March 2022 to April 2024), according to established criteria. This sampling approach is commonly used in cross-sectional exploratory studies investigating healthcare access and consultation behaviors. A total of 157 individuals were recruited. After data verification, 134 participants with complete and usable questionnaires were included in the final analysis.

Data collection

The questionnaire used in this study was adapted from the Barriers to Care Questionnaire (BCQ), which is widely used in the literature [17]. It was adapted to the context of the study and its objectives, as described in the literature, particularly those relating to access

to care and barriers to obesity management, in order to meet the specific objectives of this study and the Moroccan sociocultural context. This adaptation made it possible to target the availability of health services, consultation behaviors, and perceived barriers to seeking care. The internal consistency of the questionnaire was deemed satisfactory (Cronbach's alpha = 0.71). The questionnaire was completely anonymous; no personal data was collected, and the information gathered was treated confidentially, exclusively for scientific research purposes. This structured questionnaire were administered to collect sociodemographic information (sex, age, education level, monthly income, residence), consultation behavior, barriers to healthcare access, type of provider consulted, and follow-up practices. Clinical measurements included weight and height to calculate body mass index (BMI). Data were collected by trained field investigators using face-to-face interviews in designated sites. All participants provided written informed consent before enrolment. The study received ethical approval from the Biomedical Research Ethics Committee of Mohammed V University in Rabat (Reference: 16/20) issued on March 13, 2022. Authorization to access public healthcare facilities was granted by the Ministry of Health and Social Protection, and site permissions were obtained from private institutions.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 22.0 (Released 2013; IBM Corp., Armonk, NY, USA), (Free).

RESULTS

A total of 134 participants completed the study. The sociodemographic and anthropometric characteristics of the study population are summarized in Table 1. The sample was predominantly female (62.7%, n = 84) and urban (65.1%, n = 84). Educational attainment was distributed across primary (36.2%), secondary/high school (33.8%), and higher education (30.0%). Economically, the largest proportion reported a monthly income between 1,000 and 3,000 Moroccan Dirhams (MAD) (36.4%). Nutritional status assessment revealed a high burden of excess weight. Nearly half of the participants (47.0%, n = 63) were classified as obese, while 25.4% (n = 34) were overweight. Consequently, 72.4% of study participants had a Body Mass Index (BMI) ≥ 25 kg/m². Analysis of the distribution by sex within BMI categories showed that women constituted the majority in both the overweight (58.8%) and obese (60.3%) groups. A *Chi*-square test confirmed a statistically significant association between sex and obesity status ($\chi^2 = 6.24$, df = 1, p = 0.012), with a higher prevalence of obesity observed among women.

Table 1. Sociodemographic and anthropometric characteristics of the study population

Variable	Category	Frequency (n)	Percentage (%)
Sex	Women	84	62.7
	Men	50	37.3
Residence	Urban	84	65.1
	Rural	45	34.9
Academic level achieved	Fundamental	47	36.2
	Middle school/High school	44	33.8
	Higher education	39	30.0
Monthly income (MAD)	< 1000	40	30.3
	≥ 1000 - < 3000	48	36.4
	≥ 3000 - < 5000	11	8.3
	≥ 5000 - ≤ 10000	4	3.0
	> 10000	29	22.0
BMI category	Normal	37	27.6
	Overweight	34	25.4
	Obese	63	47.0
Age (years)	18-30	68	50.7
	31-40	38	28.4
	41-50	22	16.4
	51-60	6	4.5

Table 2 presents the analysis of access to healthcare among individuals with overweight or obesity, revealing notable gaps in medical management. Only 19.6% of participants reported consulting a healthcare professional specifically for weight-related issues, whereas the majority (78.4%) had never sought such care. Several barriers to consultation were identified: the most frequently reported was the perception that consultation was unnecessary (34.6%), followed by financial constraints (25.6%). Additional barriers included the unavailability of physicians (21.8%) and lack of time (5.1%). When consultations did occur, they were largely concentrated in the private sector (84.2%), compared with just 15.8% in public healthcare facilities. Regarding the type of professionals consulted, dietitians accounted for the largest share (40.4%), followed closely by specialist physicians (38.6%), while general practitioners were less frequently sought (10.9%). A number of participants also turned to unqualified providers such as unlicensed coaches or nutritionists.

The quality of care during medical visits appeared limited. Only 22.6% of participants had their weight measured, 17.5% received a warning about excess weight, and just 12.4% were informed about the associated health risks. Follow-up care was particularly scarce, with 91.8% of participants reporting no regular monitoring and only 3.1% being referred to a specialist or dietitian.

These findings highlight major gaps in screening, counseling, and follow-up of obesity, pointing to the need for more structured care pathways and greater awareness among both patients and healthcare providers.

Table 3 shows among the study participants, only 19.6% reported having consulted a healthcare professional specifically for a weight-related problem, it showed no statistically significant difference between women and men ($\chi^2 = 0.00$; $p = 1.00$), despite a slightly higher number of women reporting consultation.

Similarly, the relationship between BMI category and consultation behavior was not statistically significant ($\chi^2 = 2.88$; $p = 0.41$). Participants across all BMI categories (overweight, obesity class I, II, and severe obesity) [18] exhibited comparably low consultation rates, indicating that a higher BMI did not translate into increased healthcare-seeking behavior for weight-related issues. Table 3 shows that the relationship between gender and seeking healthcare professional advice regarding weight problems was not statistically significant (χ^2 test, $p = 1.00$). Twenty-one out of 93 women reported seeking healthcare professional advice, compared to 14 out of 62 men, indicating similar consultation rates between the sexes. Similarly, no statistically significant relationship was observed between place of residence (urban vs. rural) and seeking healthcare professional advice regarding weight management (χ^2 test, $p = 0.44$). Participants residing in urban areas (29/118) and those residing in

Table 2. Data on access to care for overweight and obese individuals

Theme	Main findings	Percentage (%)
Consultation for weight problems	Did not consult	78.4
	Consulted	19.6
Barriers to consultation	Lack of physician	21.8
	Financial constraints	25.6
	Lack of time	5.1
	Did not feel the need	34.6
Type of consultation	Private sector	84.2
	Public sector	15.8
Health professionals consulted	Dietitian	40.4
	Specialist physician	38.6
	General practitioner	10.9
	Unqualified providers (coaches/ unlicensed nutritionists)	Not quantified (reported)
Care during other medical consultations	Weighing performed	22.6
	Warning about excess weight	17.5
	Information on health risks	12.4
Weight management follow-up	No regular follow-up	91.8
	Referral to specialist/dietitian	3.1

Table 3. Consultation for weight-related problems according to sociodemographic characteristics

Variable	Category	Total (n)	No consultation n (%)	Consultation n (%)	χ^2	p-value
Sex	Women	84	65 (77.4)	19 (22.6)	0.00	1.00
	Men	50	39 (77.4)	11 (22.6)		
Place of residence	Urban	84	63 (75.0)	21 (25.0)	0.58	0.44
	Rural	45	37 (82.2)	8 (17.8)		
Monthly income (MAD)	< 1000	40	33 (82.5)	7 (17.5)	10.07	0.039*
	≥ 1000 - < 3000	48	40 (83.3)	8 (16.7)		
	≥ 3000 - < 5000	11	10 (90.9)	1 (9.1)		
	≥ 5000 - ≤ 10000	4	2 (50.0)	2 (50.0)		
	> 10000	29	17 (58.6)	12 (41.4)		
BMI category	Normal	37	28 (75.7)	9 (24.3)	2.88	0.41
	Overweight	34	21 (61.8)	13 (38.2)		
	Obese	63	43 (68.3)	20 (31.7)		
Age (years)	18-30	68	53 (77.9)	15 (22.1)	2.59	0.45
	31-40	38	29 (76.3)	9 (23.7)		
	41-50	22	17 (77.3)	5 (22.7)		
	51-60	6	5 (83.3)	1 (16.7)		

Associations were tested using the χ^2 test; $p < 0.05$ indicates statistical significance (*)

rural areas (6/36) exhibited similar behaviors in seeking healthcare. Analysis by age group (18-30, 31-40, 41-50, 51-60 years) did not reveal any statistically significant relationship with seeking healthcare professional advice regarding weight problems (χ^2 test, $p = 0.45$). Consultation rates remained low and similar across all age groups. In this population group, access to and use of health services for weight management did not appear to be influenced by individual sociodemographic characteristics such as sex, age, or place of residence. These findings suggest that barriers to counseling are more likely to be related to structural, economic, or cognitive factors than to traditional sociodemographic determinants.

DISCUSSION

The findings of this study largely align with current research on barriers to healthcare access for individuals with overweight and obesity. Similar to previous studies, the low consultation rate for weight-related issues (19.6%) reflects persistent challenges in engaging patients in obesity management [19, 20]. Economic barriers were frequently reported in both this study (25.6%) and in the literature, where lack of insurance coverage and high consultation costs are consistently identified as significant obstacles [21, 22].

The predominance of consultations in the private sector (84.2%) is also consistent with findings in other settings, where patients often perceive private care as more accessible or of higher quality, particularly when public healthcare services are limited or overstretched [23]. However, the high reliance on private providers in this study may also indicate structural gaps in the public healthcare system that are less emphasized in some other studies.

The study also revealed insufficient follow-up and referral to specialists or dietitians (3.1%), which echoes the findings of Kim [20] and Foster et al. [24], who reported that primary care providers often lack the training, protocols, or resources to manage obesity effectively. This gap in multidisciplinary care and coordination appears to be a global challenge. Similarly, the low rate of weight monitoring and counseling (weighing performed in 22.6%, warning given in 17.5%) reflects observations in other studies, where routine assessment and patient education remain underutilized despite recommendations for proactive obesity management [25, 26].

Overall, the results of this study reinforce trends reported in the literature: access to care for overweight and obese individuals is limited by economic, social, and systemic barriers, and interventions remain inconsistent. While the prevalence of private sector consultations and low follow-up rates in this population may vary regionally, the underlying challenges including stigma, inadequate training, and insufficient care pathways are consistently highlighted across.

No statistically significant association was observed between BMI category and consultation behavior. Participants with overweight and different classes of obesity exhibited similarly low consultation rates, indicating that greater severity of excess weight did not translate into increased healthcare-seeking

behavior. Similar observations have been reported in other settings, where individuals with obesity often perceive excess weight as a personal or lifestyle issue rather than a condition warranting medical attention [18, 19, 20]. Weight-related stigma and fear of judgment by healthcare providers may further discourage individuals from seeking professional support, regardless of BMI level [19].

The absence of significant associations between consultation and sex, age, or place of residence indicates that limited utilization of healthcare services for weight management affected all sociodemographic groups. Although women are generally reported to engage more frequently in healthcare services, particularly preventive care [10, 13], this pattern was not observed in the present study. This finding may reflect systemic barriers within the healthcare system, including limited availability of structured obesity management programs and insufficient integrity. Similarly, the lack of age-related differences suggests that low consultation rates persist across adulthood. In contrast, a significant association was observed between monthly income and consultation for weight-related problems, with higher consultation rates among participants with higher income levels. This finding underscores the importance of economic barriers in access to obesity-related care. In Morocco, as in many countries undergoing nutrition transition, specialized weight management services are predominantly delivered through the private sector, where costs may limit access for individuals with lower socioeconomic status [14]. Similarly, the lack of age-related differences suggests that low consultation rates persist across adulthood, regardless of life stage. This contrasts with findings from high-income countries, where older age is often associated with increased healthcare utilization due to a higher burden of comorbidities and more frequent contact with health services [8]. In the present context, weight-related care does not appear to be systematically triggered by age or perceived health risk, suggesting that obesity is not consistently managed as a chronic condition requiring long-term medical follow-up. Taken together, these findings suggest that barriers to obesity care are primarily structural and economic rather than demographic. The persistence of low consultation rates across BMI categories and sociodemographic group

Strengths and limitations of the study

This study has several strengths. It provides original data on healthcare access and consultation behaviors among overweight and obese adults in a Moroccan urban-rural setting, a topic that remains insufficiently documented. The use of clinical measurements for anthropometric assessment, rather than self-reported data, enhances the reliability of BMI classification. In addition, the questionnaire was adapted from the literature, subjected to expert review, pretesting, and reliability assessment, supporting the methodological rigor of data collection. The inclusion of multiple recruitment sites allowed for a diversity of socioeconomic profiles, improving the descriptive relevance of the findings.

However, several limitations should be acknowledged. The cross-sectional design precludes any causal inference between sociodemographic factors and healthcare utilization. The study relied on a convenience sample, which may limit the generalizability of the results beyond the study population. Moreover, consultation behaviors and perceived barriers were self-reported, which may be subject to recall and social desirability biases. The relatively modest sample size may have reduced the statistical power to detect significant associations.

Despite these limitations, the study provides valuable insights into the structural and perceptual barriers to obesity-related care, highlighting critical gaps in consultation, referral, and follow-up that can inform future research and public health interventions.

CONCLUSION

This study highlights notable gaps in access to care for overweight and obese individuals in the Kénitra region of Morocco. Low consultation rates, predominance of private sector visits, and insufficient follow-up or referral to specialists indicate systemic and socioeconomic barriers. Effective obesity management requires improved patient education, structured care pathways, and better coordination between primary and specialized healthcare services. Interventions addressing both patient- and system-level factors are essential to optimize prevention and treatment outcomes for obesity.

Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent the views of their affiliated institutions. The authors are responsible for the accuracy and completeness of the information provided, but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article.

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ORIGINAL ARTICLE

KNOWLEDGE AND PERCEPTIONS OF PROBIOTICS AMONG MEDICAL AND DIETETICS STUDENTS: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background. The gut microbiota plays a key role in human health, and probiotics represent one of the main strategies for its modulation. Knowledge of probiotics among medical and dietetics students may influence their future clinical practice.
Objective. To compare the knowledge and perceptions of probiotics among medical and dietetics students.
Material and Methods. A cross-sectional study was conducted among 107 students of the Medical University of Bialystok (55 medical students, 52 dietetics students). A 34-item questionnaire was used (maximum score: 51 points). Analyses included the *Chi*-square test and the Mann-Whitney U test; $p < 0.05$ was considered significant.
Results. Dietetics students achieved a higher overall score than medical students (median: 31 vs. 27 points; $p = 0.005$). They more often correctly identified the definition of probiotics (94% vs. 69%; $p = 0.002$), appropriate product labeling (77% vs. 44%; $p < 0.001$), and distinguished fermented foods from probiotics (65% vs. 20%; $p < 0.001$). Differences were also observed regarding strain specificity (65% vs. 22%; $p < 0.001$), SIBO (75% vs. 42%; $p < 0.001$), and selected clinical indications, including IBS, atopic dermatitis, acne, ulcerative colitis, and upper respiratory tract infections. Medical students more frequently reported recommending probiotics to others (73% vs. 48%; $p = 0.009$).
Conclusions. The overall level of knowledge was low, with dietetics students outperforming medical students in key areas. The findings suggest a potential need for enhanced evidence-based education on probiotics at the Medical University of Bialystok.

Keywords: *knowledge, perception, probiotics, medical students, dietetics students, cross-sectional study*

INTRODUCTION

The human gut microbiota constitutes a highly complex ecosystem that plays a crucial role in maintaining the host homeostasis. An imbalance of the intestinal microbiota, known as dysbiosis, may manifest through various symptoms, such as an altered ratio of beneficial to pathogenic microorganisms, changes in microbial metabolism, bacterial translocation, or small intestinal bacterial overgrowth (SIBO) [1]. Dysbiosis has been observed in the course of numerous gastrointestinal disorders as well as extraintestinal conditions, including type 2 diabetes, obesity, chronic liver diseases, and neuropsychiatric disorders [2].

One of the fundamental approaches to modulating the gut microbiota is the use of probiotics, defined by the WHO as live microorganisms which, when administered in adequate amounts, confer a health benefit on the host [3]. There is high-quality evidence supporting the efficacy of probiotics in, among others, the prevention of antibiotic-associated diarrhea, treatment of acute infectious diarrhea, irritable bowel syndrome, ulcerative colitis, and as an adjunct to *Helicobacter pylori* eradication therapy [4]. Moreover, an increasing number of studies highlight their therapeutic potential in metabolic, dermatological, and psychiatric diseases [5, 6].

Physicians and dietitians are two medical professions that most frequently recommend probiotic supplementation to their patients for various reasons. It is therefore essential that they possess adequate knowledge regarding the use of probiotics. However, existing studies suggest that the level of knowledge among healthcare professionals is generally moderate, while their self-reported confidence in applying probiotic therapy varies considerably [7-11]. Particularly limited data are available concerning students of medical disciplines, although it is during their studies that the foundations of future clinical practice are formed. The few studies comparing students of medical-related disciplines (including medicine and dietetics) indicate significant differences in knowledge levels, which may translate into their

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subsequent clinical decision-making [12-15]. The aim of the present study was to assess and compare the knowledge and perceptions of probiotics among medical and dietetics students.

MATERIALS AND METHODS

Study group

A total of 107 students from the Medical University of Bialystok participated in the study, including medical (n = 55) and dietetics (n = 52) students. Inclusion criteria comprised being a student of the medical or dietetics program at the Medical University of Bialystok. No formal exclusion criteria were applied. Sociodemographic data collected included gender, field of study, and year of study. Data on participants' age were not collected; the study group was described by year of study. Other sociodemographic factors were not included in the analysis; the comparison was limited to the field of study (medicine vs. dietetics). The study was conducted between June 2021 and June 2022.

Questionnaire and study procedure

A self-designed questionnaire consisting of 34 closed-ended single- and multiple-choice questions was administered in both electronic and paper formats. Among dietetics students, approximately half of the questionnaires were collected in person during university classes and half via online distribution, while the vast majority of medical students completed the survey electronically. Participation was voluntary and anonymous, and completion of the questionnaire was considered equivalent to providing informed consent. The items addressed sociodemographic data, general knowledge about probiotics, indications and contraindications for their use, tailoring probiotics to patients' needs, correct methods of administration, as well as individual experiences and perceptions of probiotics among respondents. Only items assessing factual knowledge about probiotics were scored. For single-choice questions, one point was awarded for each correct answer. For multiple-choice questions, participants received one point for indicating each correct option while avoiding incorrect ones. Some items were excluded from scoring due to the absence of a single unambiguously correct answer. Questions addressing personal experiences and perceptions of probiotics were not scored. The maximum achievable knowledge score was 51 points, with higher scores indicating greater knowledge. The questionnaire was developed based on a review of the scientific literature and previously published surveys assessing knowledge of probiotics. Its content validity was reviewed by the academic supervisor, an expert in dietetics; however, it was not formally validated.

Statistical analysis

Statistical analyses were performed using STATISTICA 13.3 (StatSoft, Poland). The *Chi*-square test of independence, the *Chi*-square test with Yates' correction, and the Mann-Whitney U test were applied. Results were considered statistically significant at $p < 0.05$.

Ethical considerations

The study was approved by the Bioethics Committee of the Medical University of Bialystok (approval no. APK.002.338.2021). The approval concerned exclusively the research described in this manuscript.

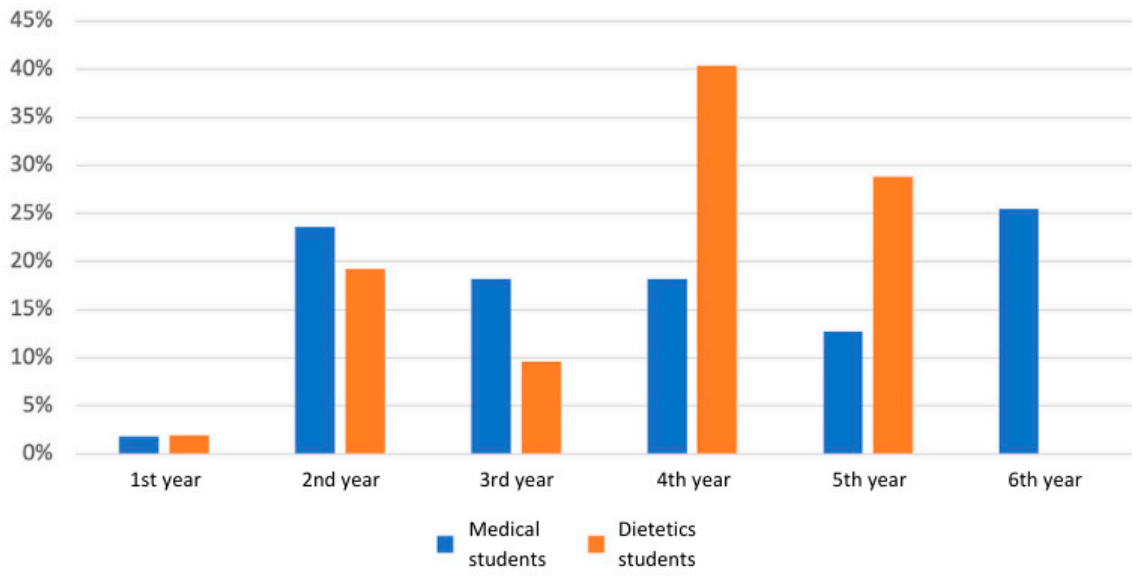

Figure 1. Distribution of medical and dietetics students by year of study (in %)

RESULTS

A total of 107 students from the Medical University of Bialystok participated in the study, including 89 women (83.2%) and 18 men (16.8%). The study group consisted of medical students (n = 55) and dietetics students (n = 52). Students from all years of both programs were included. The largest subgroups among dietetics students were from the 4th (40%) and 5th (29%) years, while the most numerous among medical students were from the 2nd (24%) and 6th (25%) years. The least numerous subgroup, for both programs, was 1st-year students (2%) (Figure 1).

Table 1 presents selected questions assessing general knowledge about probiotics. Dietetics students more frequently than medical students correctly identified the definition of probiotics and the proper labeling of probiotic preparations. Conversely, medical students were more likely to equate fermented foods with probiotics.

Table 2 presents selected questions assessing detailed knowledge about probiotics. A considerable proportion of respondents had difficulties in correctly evaluating the efficacy of multi-strain versus single-strain probiotic preparations. Dietetics students significantly more often indicated that the number of strains does not determine the effectiveness of a probiotic product. In the question on contraindications, dietetics students more frequently identified correctly that SIBO is not a contraindication to probiotic use. Conversely, medical students more often indicated that probiotics should not be administered to individuals with severe immunosuppression.

Table 3 presents selected questions on the use of probiotics in clinical practice. In both groups, the most frequently and accurately reported indication for probiotic use was antibiotic-associated diarrhea. Differences in favor of dietetics students were significant for several conditions, including irritable bowel syndrome (IBS), atopic dermatitis (AD), acne, ulcerative colitis (UC), and upper respiratory tract infections (URTI). Dietetics students were also more likely to recommend probiotic use for individuals on long-term nonsteroidal anti-inflammatory drug (NSAID) therapy, considering the potential for small intestinal mucosal injury.

Perceptions and experiences related to probiotics

The study also assessed students' perceptions of probiotics and their personal experiences. Medical students were significantly more likely than dietetics

Table 1. Selected questions assessing general knowledge about probiotics

Question (shortened)	Correct answers (%) Dietetics students (n = 52)	Correct answers (%) Medical students (n = 55)	p-value
Definition of probiotics: live microorganisms administered in adequate amounts that confer a health benefit	94	69	0.002
Labeling of probiotic preparations: the packaging should include information on the type, species, and strain	77	44	< 0.001
Fermented foods (e.g., kombucha, sauerkraut, kimchi): cannot be referred to as probiotics	65	20	< 0.001

p-values were determined using the *Chi*-square test or Yates' corrected *Chi*-square test, as appropriate

Table 2. Selected questions assessing detailed knowledge about probiotics

Question (shortened)	Correct answers (%) Dietetics students (n = 52)	Correct answers (%) Medical students (n = 55)	p-value
Is the purpose of probiotics to replace missing probiotic strains in the gut? – No	25	16	0.268
Are multi-strain preparations more effective than single-strain? – No	65	22	< 0.001
Are stool microbiota tests useful for selecting probiotics for patients? – No	12	9	0.677
Is SIBO a contraindication to probiotic use? – No	75	42	< 0.001
Should probiotics not be administered to individuals with severe immunosuppression? – Yes	31	69	< 0.001

p-values were determined using the *Chi*-square test or Yates' corrected *Chi*-square test, as appropriate

Table 3. Selected questions on the use of probiotics in clinical practice

Indication for probiotic use	Correct answers (%) Dietetics students (n = 52)	Correct answers (%) Medical students (n = 55)	p-value
Antibiotic-associated diarrhea	98	95	NA
Irritable bowel syndrome (IBS)	96	82	0.041
Atopic dermatitis (AD)	69	44	0.007
Acne	83	56	0.003
Ulcerative colitis (UC)	94	65	< 0.001
Upper respiratory tract infections (URTI)	58	36	0.027
Depression	71	64	0.407
Non-alcoholic fatty liver disease (NAFLD)	31	29	0.85
Infantile colic	62	53	0.357
Hyperlipidemia	52	38	0.153
Helicobacter pylori infection	73	60	0.151
Long-term NSAID use	71	36	< 0.001
Children in nurseries/kindergartens (infection prevention)	60	45	0.142
Cesarean delivery (prevention in newborns)	71	62	0.306

p-values were determined using the *Chi*-square test or Yates' corrected *Chi*-square test, as appropriate; NA – the test was not performed due to small sample sizes

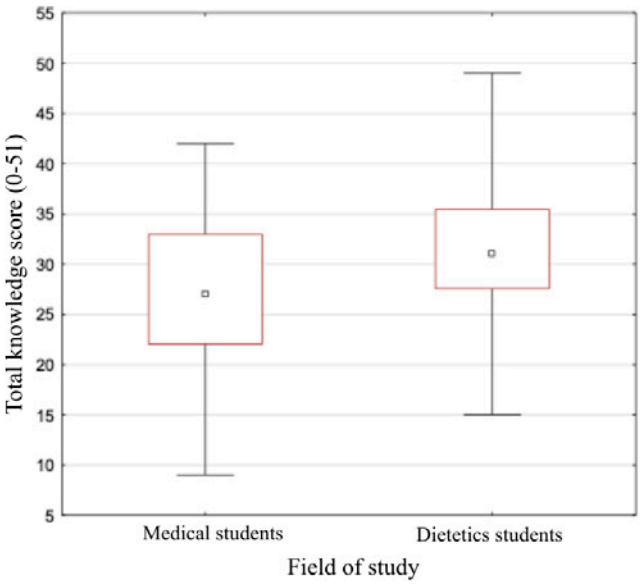

Figure 2. Total knowledge scores of dietetics and medical students (median, interquartile range, min-max)

students to recommend probiotic use to others (73% vs. 48%, p = 0.009). The main sources of knowledge about probiotics reported by both groups combined were the Internet (57%) and university (56.1%). The most frequently cited reasons for doubts regarding probiotic use included uncertainty about the quality of available probiotic products (39.3%) and insufficient knowledge (37.4%). The vast majority of students from both programs (medicine: 96%; dietetics: 90%) expressed willingness to further expand their knowledge on the role of probiotics in disease prevention and treatment.

Overall knowledge score

The total number of points obtained by dietetics students was significantly higher than in the group of medical students (median: 31 vs. 27 points, p = 0.005). Figure 2 presents the total scores achieved by dietetics and medical students.

DISCUSSION

In the present study, dietetics students achieved significantly higher overall knowledge scores on probiotics compared with medical students; however, the overall level of knowledge in both groups regarding the use of probiotics in disease prevention and treatment was assessed as low. In a cross-sectional study from 2024, only 37% of medical students and 48.5% of physicians demonstrated a good level of knowledge, while more than half of respondents identified lack of knowledge as the main barrier to the use of probiotics and prebiotics [8]. Similarly, among pharmacy and medical students, the majority rated their knowledge as fair or poor, and only advanced years of study were associated with better outcomes [13]. With regard to dietitians and dietetics students, it has been observed that although self-perceived knowledge is often rated highly, actual competencies are lower, and confidence in recommendations increases with education and clinical experience [14]. These observations are consistent with

the findings of the present study and underscore the need for systematic, evidence-based education.

Differences between students of the two study programs were particularly pronounced in questions concerning the definition of probiotics, the principles of proper labeling of probiotic products, and the understanding of strain specificity. Knowledge of the correct definition of probiotics and of the criteria a microbial strain must meet to be classified as a probiotic appears essential in the context of recommending their use in disease prevention and treatment. The results of this study show that some students – particularly those in medicine - fail to recognize the importance of strain designation on probiotic product labels. Such simplification (assuming that genus and species are sufficient) may lead to inappropriate recommendations in clinical practice, since probiotic properties are strictly strain-dependent [16]. Similar observations were reported by Ababneh Mera et al., where only 66.8% of physicians and pharmacists were aware of the importance of strain specificity in probiotics [17].

Another common misconception revealed in the study was the identification of fermented foods as probiotics. In this regard, dietetics students demonstrated greater knowledge, providing the correct response more than three times as often as medical students. In practice, although certain bacterial strains present in fermented foods may meet the criteria for probiotics, it is not possible to determine which microorganisms and in what quantities are present in a given food product [18]. Therefore, referring to fermented foods as probiotics is a major error, as it may imply, for example, that probiotic supplementation during antibiotic therapy can be replaced by consuming kefir or sauerkraut.

Another example of differences in knowledge concerned the perceived effectiveness of multi-strain versus single-strain probiotic preparations. In the present study, medical students were more than four times as likely as dietetics students to incorrectly indicate that multi-strain probiotics are more effective than single-strain products. In fact, McFarland reviewed studies on this topic and demonstrated that, in most cases, multi-strain preparations were not significantly more effective than single-strain ones, rightly emphasizing that the choice of a probiotic should be based not on the number of strains in the product but on clinical evidence for a specific probiotic strain [19]. It is also noteworthy that the vast majority of students in both groups incorrectly believed that stool microbiota testing may be useful for selecting probiotics for patients, which contradicts the current state of knowledge [20].

Significant differences also emerged regarding knowledge of clinical indications. The most commonly recognized indication was the prevention and treatment of antibiotic-associated diarrhea, which corresponds to the well-documented efficacy of probiotics in this area [21]. Dietetics students, more often than medical students, also identified other clinical conditions in which the role of probiotics is at least partially supported by the literature, such as IBS, atopic dermatitis, and ulcerative colitis. These differences are particularly important, as they concern disorders in which awareness of strain specificity and the limitations of evidence is crucial for appropriate clinical decision-making. Conversely, the incorrect perception of SIBO as a contraindication to probiotic use was more frequent among medical students, which contradicts findings from meta-analyses indicating the potential efficacy of probiotics in reducing symptoms and bacterial overgrowth [22, 23].

It is also worth noting students' attitudes toward probiotics. Medical students more frequently than dietetics students reported recommending their use to others, which may stem from the perceived role of physicians as the primary source of health advice. Different findings were reported by Johnson et al., where practicing dietitians were slightly more likely than family physicians to recommend probiotics to patients (91.2% vs. 78%) [11]. At the same time, in the present study both groups identified the Internet and academic classes as their main sources of knowledge about probiotics, while the most commonly reported concerns were related to the quality of available probiotic products and insufficient knowledge. These findings are consistent with observations of other authors, who emphasize that lack of knowledge and insufficient university-level education represent the main barriers to the use of prebiotics and probiotics among students [8, 13].

A major strength of the study is the direct comparison of two groups of students with different educational profiles, using a uniform questionnaire. Limitations include its single-center design, relatively small sample size, and cross-sectional nature, which does not allow for the assessment of changes in students' knowledge over time.

The findings of this study, together with available literature data, highlight the need for changes in the education of dietetics and medical students regarding probiotics. Particular attention should be given to the definition of probiotics, strain specificity, and practical clinical indications.

CONCLUSIONS

The level of knowledge about probiotics among medical and dietetics students at the Medical University of Bialystok was low, indicating a potential need for enhanced educational content in this area.

Dietetics students at the Medical University of Bialystok demonstrate a higher level of knowledge regarding the use of probiotics in disease prevention and treatment compared with medical students. This difference pertains to the understanding of the term "probiotic", recognition of fermented foods, awareness of strain specificity, factors determining probiotic efficacy, and knowledge of their applications in selected clinical conditions.

Students in both programs show a positive attitude toward probiotics and express willingness to further expand their knowledge in this field.

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Conflicts of interest

The author declares no conflict of interest.

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ORIGINAL ARTICLE

CULTURAL CHARACTERISTICS IN FOOD COMMUNICATION: CONSUMPTION PATTERNS, FOOD AND HEALTH NARRATIVES ACROSS EUROPEAN SOCIAL MEDIA COMMUNITIES

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ABSTRACT

Background. Food content on social media platforms has emerged as a powerful influence on consumer perceptions, preferences, and purchasing decisions, with growing implications for public health. Given that food preferences and eating habits are rooted in cultural background, understanding how these cultural dimensions shape digital food communication patterns represents a critical research gap.

Objective. This study aims to explore whether cultural value orientations are mirrored in the food content consumption patterns observed across European social media communities, and how these patterns reflect broader public health-related perceptions of food, health, and authenticity.

Material and Methods. A comparative quantitative and netnographic analysis was conducted on the social media profiles of food influencers from 14 European countries. The structure and thematic focus of food-related content were examined across cultural clusters. The segmentation of these cultural groups was based on the Inglehart-Welzel Cultural Map, an internationally recognized framework for analyzing cross-cultural value differentiation.

Results. The findings indicate culturally distinct patterns in how health is communicated through food-related content. Among food influencers from Mediterranean and Central European countries, health is predominantly communicated implicitly through homemade meals, traditional dishes, and mindful ingredient selection, rather than explicit nutritional or dietary claims. In contrast, influencers from Northern and Western European countries more frequently embed health communication within personal narratives and lifestyle-oriented content, where everyday experiences and emotional self-disclosure play a central role.

Discussion and Conclusions. The study demonstrates that health narratives in food communication are culturally constructed. Understanding such culturally embedded consumption behaviors contributes to more effective food communication and may support preventive health communication in online environments.

Keywords: *food, communication, health communication, social media, cultural characteristics*

INTRODUCTION

Food choices are fundamentally shaped by cultural values, traditions, social norms, and habitual practices. Eating habits and their social acceptance are closely linked to the cultural and economic context of a given country [1]. Virtually every region of Europe can be understood as a cultural landscape shaped by human activity [2]. Scholars suggest that European research should focus more intensively on unhealthy dietary patterns, such as obesity, rather than solely emphasizing the concept of "healthy food." According to this perspective, the emphasis should shift from studying "healthy foods" to exploring "healthy eating," integrating food and health research more comprehensively. This approach is expected to bring significant long-term economic and social benefits [3].

However, it is worth noting that "health" as a marketing keyword has long played a central role in consumers' lives, as nearly any product can be successfully promoted under the guise of health [4, 5]. The impact of dietary recommendations is often limited, and changing established eating habits remains challenging [6]. These findings suggest that marketing and communication play a crucial role in effectively reaching consumers and encouraging mindful food choices.

Consumer decisions are influenced not only by dietary guidelines but also by emotional factors and awareness levels [7]. For effective food communication, it is essential that nutrition experts,

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chefs, and influencers collaborate by aligning their respective strengths. The goal should not be for all actors to assume identical roles, but rather to combine their expertise in order to shape reliable and objective messages about food and health [8].

With the rise of social media, content about food has entered a new dimension, as consumers increasingly encounter and follow current dietary trends through online platforms. Social norms and values shape social media behavior within cultural contexts [9]. Organizations' ability to perceive and learn drives digital transformation [10], yet social media often functions more as a visibility channel than a platform for dialogue among stakeholders like scientists, farmers, and civil society [11].

In social media, content about food is intertwined with cultural identity, as food influencers often design their content in accordance with their own religious and cultural backgrounds [12], aligning it with the values of their target audiences. On social media platforms, messages about "good food" circulate differently across communities. The most common interpretation of "good food" is associated with a healthy lifestyle, which also facilitates the transformation of brands into lifestyle-oriented identities [13]. Research indicates that emotions mediate the link between a topic's social relevance and user engagement [14].

Previous findings suggest that culture itself shapes how social norms develop within nations and how these are reflected in media representations [1]. A cross-country comparison found that although food innovation systems vary between nations, they operate based on shared fundamental values [15]. Similarly, analyses across five countries revealed cultural differences in preferences for liked social media content, while negative evaluations showed greater consensus [16].

As influencer marketing continues to play an increasingly prominent role in the field of food communication, there is a growing need for deeper theoretical investigation to better understand its strategic applications and impacts. Images depicting healthy foods generate higher user interest and a greater willingness to try the associated products [17]. Researchers analyzing the posts of various influencers found that in 62% of 360 analyzed content pieces, a brand name was mentioned, yet only 6% were officially disclosed as advertisements [18]. These results indicate that, much like the ongoing debates surrounding influencer marketing, further research is needed to better understand the broader media policy frameworks.

It is essential that the diversity among stakeholders involved in food communication should foster cooperative and complementary partnerships rather than division [8]. When applied appropriately, influencer marketing may serve as a long-term preventive tool for public health. However, if misinterpreted, it can also contribute to the spread of unhealthy dietary practices.

Aim of the study

This study explores how health is represented and communicated in the content of food influencers, and how these messages are received and engaged with by audiences in Northern-Western and Mediterranean-Central Europe. The study focuses on the interplay between cultural background, influencer communication strategies, and audience engagement.

MATERIAL AND METHODS

Hofstede's cultural dimensions model [19] and Schwartz's value system model [20] laid the foundations for examining intercultural differences. Hofstede's framework explores social and economic disparities between cultures and their influence on individual behavior, while Schwartz's model emphasizes fundamental human values and needs. In addition to these theoretical contributions, the analytical approach of Inglehart and Welzel [21] also serves as a cornerstone of this research.

Based on the Inglehart-Welzel Cultural Map, which links socioeconomic development with value systems, this study classifies food contents from 14 European countries to explore how cultural background influences consumer behavior and content consumption patterns. Europe provides a unique context with diverse food traditions and health perceptions across countries that share similar socio-economic and regulatory frameworks. This balance allows for a clear examination of how cultural differences influence digital food and health communication.

This trend-exploratory study analyzes food influencers from fourteen European countries, classified into "Catholic" and "Protestant" cultural clusters according to the Inglehart-Welzel Cultural Map [22]. Food influencers were selected as the focus of analysis because they function as key trendsetters in digital communication, making it analytically sufficient to examine a limited number of highly influential actors to identify emerging patterns. The Northern and Western European (NWE) countries, representing the "Protestant" [22] cluster, include Germany, Switzerland, Sweden, Finland, Norway, Iceland, and Denmark. The Mediterranean and Central European (MCE) countries, representing the "Catholic" [22] cluster, are Croatia, France, Slovakia, Spain, Italy, Hungary, and Slovenia (Figure 1).

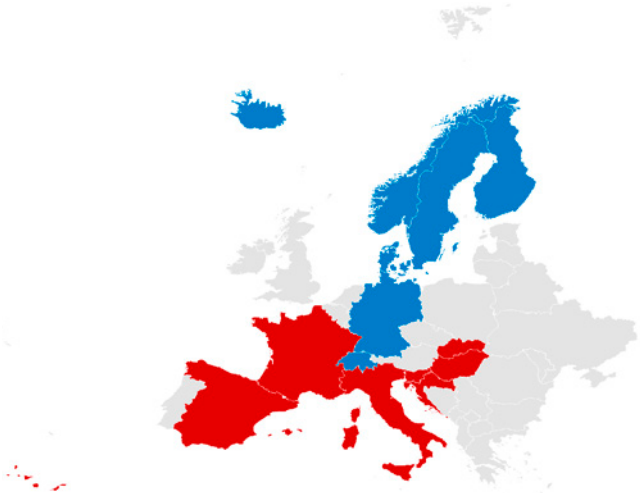

Figure 1. Northern and Western (NWE) and Mediterranean and Central European (MCE) countries included in the study
Source: edited by the Authors

Influencers were identified following Von-Polheim et al. [12] using the StarNgage.com platform. Inclusion criteria required that their main content focus be self-made dessert recipes, ensuring comparability. Only Instagram macro-influencers (100,000-1,000,000 followers) were considered, with one influencer selected per country, prioritizing those with the highest engagement rates [23] when multiple candidates met the criteria. In cases where suitable profiles were missing from StarNgage or macro-level thresholds could not be met, accounts sharing original food recipes with slightly higher or lower follower counts were included. Influencers primarily focused on lifestyle, travel, or fashion content were excluded. The size of the national influencer market was also considered in the selection process. Data collection was conducted between November 2024 and January 2025.

The dataset includes over 600 individual pieces of Instagram content produced by 14 influencers. Since Instagram posts often consist of multiple images or videos grouped together in a single carousel, the total number of content items substantially exceeds the 595 posts (286 from MCE and 309 from NWE countries) published during the data collection period. This multi-content format was carefully considered and analyzed using qualitative and netnographic methods to fully capture the influencers' communication strategies. The Sotrender analytics platform [24] was employed to conduct netnographic analysis, offering tools for detailed evaluation of content performance and audience engagement.

RESULTS

Quantitative findings

The quantitative findings present measurable patterns of audience dynamics, providing empirical support for the qualitative observations regarding food content consumption. Posting activity varied notably across countries: the German influencer published the most posts (96), while the Finnish influencer shared the fewest (12). Monthly distribution showed the highest activity in December (234 posts) and the lowest in January (155 posts), consistent across both cultural clusters (MCE: 119/71; NWE: 115/84).

The second Figure (Figure 2) compares food influencers based on their respective countries. The black bars represent follower counts (in millions), while the red line indicate growth in thousands of followers. This figure should not be interpreted as a direct comparison between countries, but rather

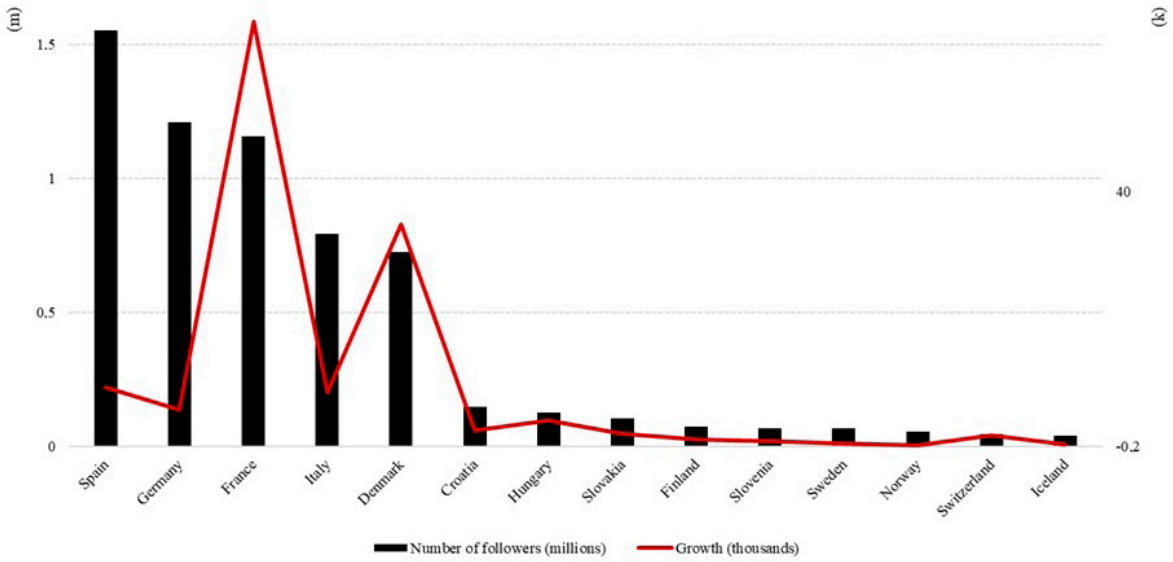

Figure 2. Comparison of influencers' follower numbers and follower change across the analyzed countries
Source: edited by the Authors

the focus should be on their growth rates, which serve primarily as indicators to provide contextual understanding of market dynamics.

Within the sample, Spain had the largest follower base (exceeding 1.5 million) along with substantial growth of over 9,000 new followers. France demonstrated the most significant follower increase, gaining approximately 67,000 new followers, the highest growth among all examined countries. Italy also maintained a large follower base of nearly 794,000, with an increase of 8,313 followers by the end of the study period. Although Croatia and Hungary had comparatively smaller follower bases, both showed steady growth, particularly Hungary, which gained 3,903 new followers. Germany, with more than 1.2 million followers, exhibited modest growth of only 5,532. Denmark stands out with 723,769 followers and an impressive 34,776 follower increase, representing the second most dynamic growth in the dataset. Norway was the only country to experience a slight decline in followers (–105), deviating from the overall positive trend. Smaller countries such as Switzerland and Iceland had relatively low follower counts (44,101 and 38,832, respectively), though Switzerland still recorded a positive increase of 1,465 followers. Slovakia, Finland, Slovenia, and Sweden all achieved modest growth, gaining only a few hundred new followers each.

Influencer marketing effectiveness

In influencer marketing, one of the most relevant performance indicators is the engagement rate [23]. Given the varying market sizes, direct performance comparisons are challenging and beyond the scope of this study. Instead, our focus lies on measuring effectiveness, for which engagement rate provides a more meaningful and comparable metric. This metric is of key importance because, in this market, success depends not only on the number of followers but also on the level of audience interaction. That is, the proportion of followers who actively engage with content through actions such as likes, comments, shares, or purchases.

In the case of food influencers, even the role of emotional attachment can be quantified through the degree of engagement and follower loyalty [25]. To assess audience involvement beyond follower counts, the engagement rate was calculated as a relative indicator of how actively users interact with content in relation to the size of the follower base.

Engagement rate = [(total number of user interactions on the page/number of posts)/number of followers] × 100 [26]

The average engagement rate among content creators from Mediterranean and Central European (MCE) countries was 2.09%, while for Northern and Western European (NWE) countries it was 1.92%. In both groups, the average rate hovered around 2%, indicating that audience activity and follower responsiveness remain generally stable and comparable across both Catholic and Protestant cultural markets.

Nevertheless, significant cross-country differences can be observed within both regions (Figure 3). In the MCE group, Italy (3.71%) and France (2.82%)

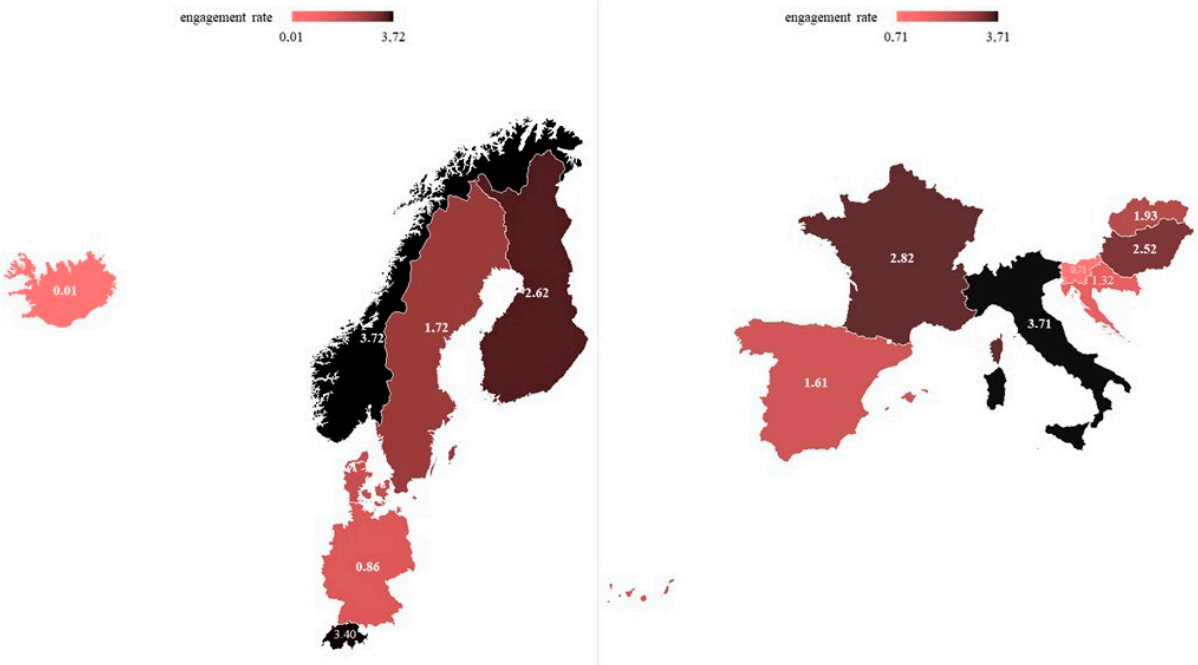

Figure 3. Comparison of engagement rates of the examined influencers by NWE and MCE country groups. Darker colors represent higher engagement rates
Source: edited by the Authors

exhibited the highest engagement levels, whereas Slovenia (0.71%) substantially lowered the regional average. Within the NWE countries, engagement rates showed even greater variation: Norway (3.72%) and Switzerland (3.40%) recorded exceptionally high values, while Iceland (0.01%) demonstrated almost no audience interaction, effectively representing a "dormant market".

It is evident that engagement levels do not correlate with the size of the country, yet they are not entirely independent of the specific market context. Countries with outstanding engagement levels in both regions offer strong potential for effective influencer campaigns. However, across both cultural groups, strategic market assessment and careful influencer selection remain crucial to ensure the efficiency and credibility of marketing efforts.

Netnographic findings

In the Mediterranean and Central European (MCE) countries, changes in influencers' follower counts were primarily determined by the nature of their food-related content.

In Hungary, a post featuring a traditional pastry generated a notable daily increase of 230 new followers. In contrast, a post promoting a vegan dessert as part of the "Veganuary" campaign marked a negative peak in audience response (Figure 4). This suggests that the audience tends to resonate more strongly with traditional culinary content than with alternative gastronomic themes.

Similarly, significant fluctuations were observed in Spain. While a post showcasing Dubai chocolates resulted in a loss of 584 followers, another post presenting mango panna cotta attracted 1,137 new followers. These findings indicate that authentic, culturally familiar content performs better among local audiences compared to globally themed or exotic material.

In Italy, a post about Tuscan soup produced one of the largest single-day follower increases in the entire dataset, gaining 5,558 new followers. However, when the influencer shared a Sri Lankan cooking vlog, the account experienced a series of unfollows (Figure 5). This pattern demonstrates that content rooted in different cultural contexts tends to be less well-received by Italian audiences, emphasizing the relevance of cultural proximity in influencer-driven food communication.

In the Northern and Western European (NWE) countries, changes in follower counts were primarily influenced by lifestyle-, event-, and public figure-related content.

In Germany, a post shared from a prestigious event celebrating the influencer's professional achievements resulted in a loss of 1,107 followers,

Figure 4. Posts of the Hungarian food influencer generating the highest (left) and lowest (right) follower change
Source: Instagram posts provided for analysis by the Sotrender analytics platform

Figure 5. Posts of the Italian food influencer generating the highest (left) and lowest (right) follower change
Source: Instagram posts provided for analysis by the Sotrender analytics platform

while a collaborative post featuring a public figure generated 1,204 new followers. A year-end, four-part recap series likewise led to a decline of 2,540 followers, whereas two Valentine's Day-themed posts published consecutively triggered a positive trend, attracting 1,701 new followers (see Figure 6).

In Sweden, a series of posts documenting the influencer's Caribbean vacation (Figure 7) led to continuous unfollows. These results suggest that lifestyle-oriented content tends to resonate less, or at least proves to be highly polarizing, within the food influencer segment among both German and Swedish audiences.

In Denmark, the dataset showed the most consistent growth throughout the observation period. Although

Figure 6. Posts of the German food influencer generating the highest (right) and lowest (left) follower change
Source: Instagram posts provided for analysis by the Sotrender analytics platform

Figure 7. Posts of the Danish influencer generating the highest follower change (left, 3 posts) and the Swedish influencer's post generating the lowest change (right)
Source: Instagram posts provided for analysis by the Sotrender analytics platform

Figure 8. Posts of the Icelandic influencer generating the lowest follower change
Source: Instagram posts provided for analysis by the Sotrender analytics platform

the influencer's content did not rely on personal branding, the account still achieved the second-highest growth rate among the Protestant countries. In Iceland (Figure 8), a New Year's Eve post featuring a non-self-made dessert, followed by the publication of more personal content, resulted in a series of unfollows. Similarly, in Finland, the audience size decreased after a Christmas family-themed post.

DISCUSSION

The role of food influencers in digital health narratives

A central contribution of this research lies in identifying culturally distinct content strategies among influencers from MCE and NWE countries. The findings confirm that consumer decisions related to food are influenced not only by dietary guidelines but also by emotional factors, awareness levels [3], and broader cultural components such as values, beliefs, traditions, and religion. In this context, effective food communication requires cooperation among nutrition experts, chefs, and influencers, not through role homogenization but by combining complementary forms of expertise. Such collaboration can contribute to the dissemination of reliable and meaningful messages about food and health [4].

Influencers operating in NWE contexts tend to integrate personal narratives, emotions, and everyday experiences more openly into their content, even when such openness leads to polarized reactions or follower loss. This pattern aligns with theoretical approaches that conceptualize influencer activity as the management of follower equity within the creator economy, where value is generated through sustained relational engagement rather than solely based on audience size [25]. In contrast, influencers from MCE countries adopt a more restrained, theme-centered communication style. Rather than emphasizing individual self-expression, MCE influencers appear to prioritize audience retention, social harmony, and the reinforcement of collective cultural identities through food-related themes. These differences among European cultures are reflected in food consumption patterns, such as dietary preferences, willingness to adopt sustainable eating behaviors, and the popularity of emerging food trends [1].

The results also contribute to the expanding literature on digital food cultures, which emphasizes the growing role of non-traditional actors in shaping norms of "good food" [13]. Food influencers increasingly act as cultural intermediaries who construct dietary meanings through everyday storytelling rather than expert authority. At the same time, the blurred boundaries between personal expression, cultural representation, and commercial communication. Earlier studies have documented the prevalence of undisclosed brand mentions and emphasized the need for clearer regulatory frameworks [18], alongside ongoing debates on digital media governance across countries [28]. Although explicit advertising was not the focus of this study, the subtle intertwining of health, authenticity, and lifestyle underscores the complexity of regulating influencer practices.

The representation of health in food communication

The present study demonstrates that food influencers conceptualize health in ways that differ from dominant biomedical or market-driven narratives. While previous studies have shown that images of healthy food tend to increase user interest and willingness to engage [17], the present findings highlight that the meaning of "healthy" itself is culturally constructed and interpreted differently across contexts. This implicit understanding of health aligns with broader research suggesting that eating habits and their social acceptance are deeply embedded in cultural, economic, and social contexts [1]. In this sense, health emerges not as a technical or nutritional category, but as a culturally meaningful practice rooted in everyday routines.

Our findings suggests a strong association between homemade food and health resonates with scholarly calls to move beyond the narrow analysis of "healthy foods" toward a broader understanding of "healthy eating" as a socially and culturally embedded phenomenon that integrates food, health, and lifestyle [3]. Notably, influencers appear to enact this perspective organically, without relying on explicit health claims or normative dietary advice. This indirect communication of health is particularly relevant given that "health" has long functioned as a powerful and frequently overused marketing concept [4, 5]. The findings of the present study suggest that food influencers may address this limitation by embedding health-related meanings in emotionally resonant and culturally familiar practices.

Overall, the findings reaffirm that food consumption and its interpretation are strongly influenced by local cultural, social, and economic conditions [1]. They also highlight the importance of acknowledging cultural diversity among actors involved in food communication and encouraging complementary rather than divisive approaches [8, 27]. On social media platforms, interpretations of "good food" circulate unevenly across communities, but they are most commonly associated with a healthy lifestyle, which also facilitates the transformation of food brands into lifestyle-oriented identities [13]. Within the discourse of digital gastronomy, homemade food emerges as a powerful yet culturally differentiated symbol of health, authenticity, and care.

Limitations of the study

When interpreting the results, it is important to acknowledge that the sample of food influencers analyzed was relatively limited in size; thus, the observed patterns cannot be generalized to the entire national markets. Moreover, given the dynamic nature of social media, engagement rates and follower fluctuations are influenced by numerous external factors such as algorithmic changes, seasonal effects, and global events. As a result, the findings should be interpreted as indicative trends rather than exhaustive representations of long-term behavior.

Strengths of the study

Despite these limitations, the study has several notable strengths. One key strength lies in its qualitative, netnographic approach. Rather than relying solely on quantitative metrics, the study captures the symbolic, emotional, and cultural dimensions of food–health communication on social media. The findings demonstrate how influencers function as cultural intermediaries who translate abstract health ideals into culturally resonant and emotionally meaningful everyday practices. Nonetheless, by segmenting influencers according to the Inglehart-Welzel (2023) cultural map, the research provides a fresh analytical framework for understanding how culinary cultures manifest in digital environments. The findings contribute to the growing scholarly discourse on the role of cultural factors in social media communication and consumer behavior.

Future direction

Future research should prioritize in-depth, short-term trend-exploratory studies that capture emerging patterns in food and health communication. Although longitudinal designs remain important for understanding long-term structural changes. The rapidly evolving nature of social media marketing, driven by frequent shifts in platforms, algorithms, and influencer practices, makes timely trend analyses particularly valuable. Conducting multiple focused studies over shorter periods may therefore provide more relevant and actionable insights than relying exclusively on extended longitudinal approaches. Expanding research to non-European regions would provide clearer insights into how different cultural values shape health-related food narratives and help identify common patterns across diverse digital food cultures.

CONCLUSIONS

This study offers a novel perspective on the examination of health narratives by comparing the social media content of food influencers from different European countries through the lens of cultural background. The primary aim was to explore how cultural differences that shape eating habits are reflected in patterns of food content consumption on social media.

Both quantitative and qualitative analyses revealed clear differences between the two cultural clusters. Across both clusters (NEW, MCE), health-related meanings are primarily articulated through the narrative of homemade food. Influencers frame health not through calorie restriction or dieting trends, but through mindful ingredient selection and home cooking practices. Through this discourse, food influencers contribute to reshaping how health is understood, shifting the focus from restriction and control toward care, creativity, and cultural continuity.

From a broader consumer perspective, the association between homemade food and health functions as a symbolic bridge between modern health-conscious attitudes and traditional culinary values. This connection strengthens cultural identity and fosters trust in food-related practices. While these insights offer practical implications for brands and organizations seeking culturally resonant food communication strategies, the deeper significance of the findings lies in their contribution to understanding how digital food cultures reflect wider social meanings of identity, health, and well-being across Europe's diverse cultural landscapes.

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Conflicts of interest

The authors declare no conflict of interest.

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ORIGINAL ARTICLE

LONGITUDINAL GROWTH TRAJECTORIES OF PRETERM INFANTS WITH AND WITHOUT INTRAUTERINE GROWTH RESTRICTION UP TO 24 MONTHS OF CORRECTED AGE: THE INFLUENCE OF EARLY FEEDING PATTERNS

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ABSTRACT

Background. Intrauterine growth restriction (IUGR) is common in premature infants and can significantly impact long-term physical and neurological development. While breastfeeding is the gold standard for nutrition, its role in optimizing postnatal growth for this specific population requires further investigation.

Objective. This study compared growth trajectories specifically weight, length, and head circumference between preterm infants with and without IUGR at 1, 3, 6, 12, and 24 months of corrected age (CA) in Rabat. It also evaluated the impact of maternal feeding during the first six months (CA).

Methods. This prospective study, conducted at the National Reference Center for Neonatology and Nutrition, followed 45 breastfed preterm infants (25 with IUGR; 20 without). Anthropometric data were collected over two years and compared against WHO growth standards and Fenton curves.

Results. Infants with IUGR had significantly lower birth weights and maintained lower weight throughout the follow-up ($p < 0.05$). At discharge, extrauterine growth restriction (EUGR) was present in 100% of the IUGR group and 80% of the without-IUGR group. By 3 months (CA), EUGR incidence decreased but remained length in the IUGR group (32% vs. 10%). Stunting was consistently more prevalent in IUGR infants: 92% vs. 75% at 1 month (CA), 64% vs. 25% at 3 months (CA), 24% vs. 0% at 6 months (CA), and 12% vs. 0% at 12 months (CA). By 24 months (CA), both groups reached normal weight, length, and head circumference. Notably, the feeding type showed no significant effect on growth parameters at 3 or 6 months (CA) ($p > 0.05$).

Conclusion. IUGR preterm infants exhibit significantly poorer growth than their without-IUGR peers. Although maternal feeding offers essential benefits, it does not fully prevent growth restriction. Continuous monitoring and individualized nutritional management are crucial to optimize long-term outcomes.

Keywords: *anthropometry, breastfeeding, prematurity, low birth weight, growth retardation*

INTRODUCTION

The survival of preterm infants has improved significantly over the last decade due to major advancements in perinatal medicine and neonatology [1]. However, this increased survival is paradoxically accompanied by a high burden of long-term morbidity, which remains closely proportional to the degree of

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prematurity [2]. Among the myriad of challenges faced by these vulnerable neonates, achieving optimal postnatal growth remains a primary concern. Growth failure in this population is often rooted in complex maternal-fetal complications, such as preeclampsia or placental insufficiency, which frequently necessitate early medical induction or cesarean section [1, 3].

Intrauterine growth restriction (IUGR) represents a critical clinical entity that significantly compounds the vulnerability of preterm infants. Beyond the immediate risk of neonatal mortality, IUGR is associated with specific systemic complications, including patent ductus arteriosus and impaired metabolic programming [4]. Characterized by a birth weight below the 10th percentile, IUGR reflects a failure to achieve genetic growth potential in utero, leaving the infant with limited nutritional reserves [5]. This initial deficit is frequently exacerbated during the hospital stay by extrauterine growth restriction (EUGR), a condition where the infant fails to maintain the expected growth velocity after birth [6, 7].

Global epidemiological data underscore the magnitude of this challenge. The prevalence of EUGR shows significant geographic and clinical variability, reaching 43.5% in China [8], 47% in Indonesia [9], and 46% in India [10]. Notably, in extremely preterm cohorts, such as those studied in Turkey, the prevalence can soar to 74%, highlighting the critical need for standardized nutritional strategies [11].

To mitigate these risks, precise anthropometric monitoring is essential. This requires a sophisticated transition between monitoring tools: the Fenton 2013 or INTERGROWTH-21st curves are utilized to assess growth during the intensive care period [5, 6], while the World Health Organization (WHO) standards are adopted after 50-52 weeks of postmenstrual age to ensure continuity and international comparability of long-term trajectories [6].

Despite the availability of these standardized tools, there remains a significant research gap regarding the 24-month longitudinal trajectories of IUGR infants in North African populations. Specifically, the interplay between early nutritional interventions particularly the role of breastfeeding in promoting healthy catch-up growth while avoiding metabolic over-nutrition, remains insufficiently characterized. This study aims to compare the growth trajectories including weight, length, and head circumference between preterm infants with and without intrauterine growth restriction (IUGR) at 1, 3, 6, 12, and 24 months of corrected age, at the National Reference Center for Neonatology and Nutrition in Rabat. Additionally, the study aimed to evaluate the impact of maternal feeding during the first six months of corrected age (CA).

MATERIALS AND METHODS

Study design and location

We conducted a prospective cohort study of preterm newborns (born at < 37 weeks of gestation) and their mothers, who were admitted to the National Reference Centre for Neonatology and Nutrition, Rabat. From February 2022, data collection continued until November 2024. A total of 45 newborns and their mothers were recruited for the study at birth and followed from hospital discharge to corrected ages of 1, 3, 6, 12, and 24 months. At birth, preterm infants were first classified into two groups via the Fenton 2013 growth charts: those with intrauterine growth restriction and those appropriate for gestational age (AGA) were referred to as those without IUGR in our study. The birth weight of each infant was compared to the corresponding percentile for gestational age: those below the 10th percentile were classified as IUGR, whereas those between the 10th and 90th percentiles were considered without IUGR. The inclusion criteria were as follows: preterm infants born before 37 weeks of gestational age without IUGR; preterm infants born before 37 weeks of gestational age with IUGR, exclusively breastfed at birth; and parental written consent for longitudinal follow-up. The exclusion criteria included major congenital malformations, known genetic syndromes, early neonatal death, loss to follow-up prior to the first corrected visit, and parental refusal.

Study Population

A total of 53 preterm neonates were assessed for eligibility. Eight infants were excluded: four infants were lost due to withdrawal of consent and four infants died. The final cohort comprised 45 preterm infants (25 with IUGR and 20 without IUGR).

Definitions

- Prematurity: Premature birth is defined as birth before the completion of 37 weeks of gestation. It is classified as extremely preterm (before 28 weeks), very preterm (between 28 and 31 weeks) or moderate to late preterm (between 32 and 36 weeks). It is associated with an increased risk of neonatal complications and potential long-term effects on growth and neurodevelopment [1].
- Intrauterine growth restriction (IUGR) is a condition in which a fetus does not reach its genetically determined growth potential. This often results in a birth weight below the 10th percentile for gestational age. IUGR is associated with an increased risk of perinatal complications, as well as long-term effects on growth and neurodevelopment [12].

- Extrauterine growth restriction (EUGR) is defined as postnatal growth failure in preterm infants, typically indicated by weight, length or head circumference below the 10th percentile for corrected age. Compared with intrauterine expectations, reflecting inadequate growth after birth is associated with long-term growth and neurodevelopmental risk [13].
- The corrected age (CA) is the age of a preterm infant adjusted for prematurity. It is calculated by subtracting the number of weeks of prematurity from the infant's chronological age. This provides a more accurate assessment of growth and developmental progress, enabling comparison with the standards for full-term infants of the same age [14].
- The Fenton 2013 growth charts provide sex-specific percentiles for weight, length and head circumference in preterm infants aged 22-50 weeks. Charts are widely used to classify infants as SGA (small for gestational age), AGA (appropriate for gestational age), or LGA (large for gestational age), and to assess intrauterine growth at birth [6].
- Exclusive breastfeeding: The infant receives only breast milk. No other liquids or solids are given, not even water, with the exception of oral rehydration solution, or drops/syrups of vitamins, minerals or medicines [15].
- Mixed feeding (partial breastfeeding): The infant receives both breast milk and infant formula or other non-human milks [16].
- Artificial feeding: The infant receives no breast milk and is nourished solely with commercial infant formula [17].
- Maternal feeding: This group included infants receiving human milk, encompassing both exclusive breastfeeding and mixed feeding (breast milk combined with infant formula or water-based liquids). This category was defined by the continued exposure to the biological benefits of maternal milk [18].

Data collection

Data on maternal and neonatal characteristics were collected from medical records. These characteristics included maternal age, parity, consanguinity, pregnancy complications, medical history, number of antenatal consultations, mode of delivery, hormone use, smoking and alcohol consumption during pregnancy, gestational age at birth, infant sex, and Apgar scores at one and five minutes. The age at which enteral feeding commenced was also recorded. The birth weight, length, and head circumference of newborn babies were measured within 24 hours of delivery using standardized techniques.

The newborns were evaluated at 1, 3, 6, 12 and 24 months (CA). Anthropometric indices (weight, length/height, head circumference (HC)) were measured using the same standardized procedures at each visit. The corrected gestational age was calculated to adjust the growth assessment relative to that of newborns at term. Growth outcomes were assessed using WHO growth charts at each corrected age to identify EUGR.

Nutritional assessment

Infant feeding practices were assessed prospectively at each follow-up visit (1, 3, 6, 12, and 24 months of corrected age) using a structured nutritional questionnaire administered to the mothers. To ensure the depth and accuracy of the nutritional data, mothers were specifically questioned about the introduction of water, other liquids (infusions/teas), and infant formula. This prospective tool allowed us to categorize infants based on their evolving nutritional status: exclusive breastfeeding, partial breastfeeding (mixed feeding), or exclusive formula feeding. The precise duration of exclusive breastfeeding was recorded in months to evaluate its impact as a time-dependent variable.

For the purpose of the comparative analysis during the first semester, feeding status was treated as a longitudinal variable rather than a static baseline. This enabled us to identify the exact weaning point (the transition to 100% artificial feeding) for each infant. At the 3-month and 6-month milestones, infants were categorized into two distinct nutritional cohorts:

Maternal feeding group and artificial feeding group

The duration of any breast milk exposure was recorded in months. For the analysis of growth trajectories up to 24 months, only infants who sustained maternal feeding throughout the critical first 6 months of life were included in the 'breastfed' cohort, ensuring that the results reflect the impact of sustained exposure to human milk versus an exclusively artificial diet.

Anthropometric indices

Anthropometric indices were measured in accordance with the standardized procedures of the World Health Organization (WHO) [19], for assessing the growth of children. Weight, length/height, and HC were measured at birth and at each follow-up appointment at 1, 2, 3, 12 and 24 months (CA). Weight was measured to the nearest 10 grams using a calibrated electronic scale, length to the nearest 0.1 cm using a rigid infant meter, and HC to the nearest 0.1 cm via nonstretchable tape. All indices were measured twice, and the mean value was recorded to ensure accuracy and reproducibility. BMI was calculated as an indicator of body proportions. All anthropometric data were converted into percentiles using WHO

growth charts that were appropriate for the infant's age and sex. EUGR was defined as anthropometric indices below the 10th percentile for corrected age. BMI was calculated as an indicator of body proportions. All anthropometric data were converted into percentiles using WHO growth charts that were appropriate for the infant's age and sex. EUGR was assessed in terms of weight-for-age, length-for-age, BMI-for-age, and head circumference-for-age. Infants with a weight below the 15th percentile were considered to have weight-based EUGR; those with a length below the 15th percentile were classified as stunted; infants with low weight-for-length or BMI were considered to have disproportionate growth restriction; and those with an HC below the 15th percentile were classified as having a small head circumference.

Statistical analysis

Statistical analysis and data processing were performed using Excel and R software (version 4.5.1, R Foundation for Statistical Computing, Vienna, Austria). The Kolmogorov-Smirnov test was used to test distribution normality. Categorical variables are expressed as numbers and percentages and were compared using either the *Chi*-square test of independence or Fisher's exact test. Quantitative variables that were normally distributed are expressed as the means and standard deviations and were compared using Student's t-test. Quantitative variables with an abnormal distribution are expressed as the median and quartiles and were compared using the Mann-Whitney test; $p < 0.05$ was considered significant for all the statistical analyses.

Ethics approval and consent to participate

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki (2024) and the guidelines of the Council for International Organizations of Medical Sciences (CIOMS, 2016) for research involving human subjects. It also complied with the provisions of Moroccan Law 28-13 on the protection of individuals in biomedical research and Law 09-08 on personal data protection. Ethical approval was obtained from the Ethics Committee of the Faculty of Medicine and Pharmacy in Rabat reference number (CERB 13-22). Informed consent to participate in the study was obtained from the parents or legal guardians of all participants under the age of 16, in accordance with ethical guidelines and national regulations.

RESULTS

Maternal and neonatal characteristics

The maternal characteristics are presented in Table 1. The median age of mothers was 27.5 (26-30) years among preterm infants without IUGR, and 34 (29-37) years among preterm infants with IUGR. A significant difference in maternal age was observed between the two groups ($p = 0.033$). Most mothers had no medical history. Hypertension (HTN) was more prevalent among mothers of preterm infants with IUGR than among those without IUGR (20% vs. 5%), although this difference was not statistically significant. Diabetes was more prevalent among mothers of preterm infants without IUGR than among those with IUGR (20% vs. 8%). Among the group with IUGR, 5% did not attend any visits; 10% attended two visits and 85% attended three or more visits. In the group without IUGR, 20% did not attend any visits, 8% attended two visits, and 72% attended three or more visits. There was no significant difference in the distribution of prenatal visits between the IUGR and without-IUGR groups. The majority of deliveries in the without IUGR group were vaginal 75%. Among those in the with-IUGR group, 52% delivered vaginally and 48% delivered by cesarean section. There were no significant differences between the groups in terms of this distribution.

When we analyzed the neonatal data (Table 2), we observed the following distributions by sex: among preterm infants without IUGR, 30% were male and 70% were female. In contrast, among preterm infants with IUGR, 56% were male and 44% were female. The median gestational age for preterm infants without IUGR was 33 (30-36) weeks. For preterm infants with IUGR, the median gestational age was 35 (33-36) weeks. The median length of hospitalization for preterm infants without IUGR was 18 (5-52) days. For those with IUGR, it was 22 (4-54) days. Anthropometric data at birth and discharge for all preterm infants, both with and without IUGR, are presented in Table 2.

Anthropometric indices

At each follow-up visit, the anthropometric indices of preterm infants with IUGR were compared with those of preterm infants without IUGR. Significant differences in weight were observed at 3 months (CA) (4440 (3700-4855) g vs. 4860 (4184-5590) g, $p = 0.048$), 6 months (CA) (6505 (6000-7005) g vs. 7458 (6655-7839) g, $p = 0.0017$), 12 months (CA) (8800 (7860-9500) g vs. 9910 (9223-10803) g, $p < 0.001$) and 24 months (CA) (11000 (10100-13000) g vs. 13000 (12000-15000) g, $p = 0.003$). A significant difference in length was noted at 12 months (CA) (71 (69-72) cm vs. 72 (72-73) cm, $p = 0.004$) and at 24 months (CA) (85 (82-85) cm vs. 85 (84-90) cm, $p = 0.042$). Significant differences in head circumference were observed at 3 months (CA) (38 (36-39.5) cm vs. 38.5 (38-41) cm, $p = 0.045$), 6 months (CA) (42 (41-43) cm vs. 43 (42.8-44) cm, $p = 0.048$), and 12 months (CA)

Table 1. Maternal characteristics

Maternal characteristic	Population N = 45		p-value
	Without IUGR n = 20	With IUGR n = 25	
Age (years), median (25th, 75th percentiles)	27.5 (26-30)[a]	34 (29-37)[a]	0.033[b]
Medical coverage, n (%)			
Yes	18 (90)	23 (92)	1.000[c]
No	2 (10)	2 (8)	
Medical history, n (%)			
No	14 (70)	15 (60)	
Diabetes	4 (20)	2 (8)	
Hypertension	1 (5)	5 (20)	0.421[c]
Anemia	0 (0)	1 (4)	
Asthma	1 (5)	1 (4)	
Dysthyroidism	0 (0)	1 (4)	
Number of prenatal visits, n (%)			
No	1 (5)	5 (20)	
2 visits	2 (10)	2 (8)	0.326[c]
3 or more visits	17 (85)	18 (72)	
Gravidity, n (%)			
1 pregnancy	9 (45)	6 (24)	
2 pregnancies	4 (20)	7 (28)	0.409[c]
3 or more pregnancies	7 (35)	12 (48)	
Parity, n (%)			
1 child	11 (55)	10 (40)	
2 children	6 (30)	4 (16)	0.228[c]
3 children	2 (10)	6 (24)	
4 or more children	1 (5)	5 (20)	
Mode of delivery, n (%)			
Caesarian section	5 (25)	12 (48)	0.135[c]
Vaginal section	15 (75)	13 (52)	

[a] non-normally distributed variables; [b] Mann-Whitney test; [c] Fisher's exact test; IUGR – Intrauterine Growth Restriction. Parity refers to the total number of deliveries reaching a viable gestational age

(45 (44-46) cm vs. 46.5 (45-47) cm, p = 0.012). Significant differences in BMI were observed at 6 months (CA) (16.8 (15.6-18.2) kg/m² vs. 18.6 (17-20) kg/m², p = 0.013), and at 24 months (CA) (16.6 (15.2-17.6) kg/m² vs. 17.6 (16.8-18.6) kg/m², p = 0.029).

The medians of the four anthropometric indices according to the WHO growth charts

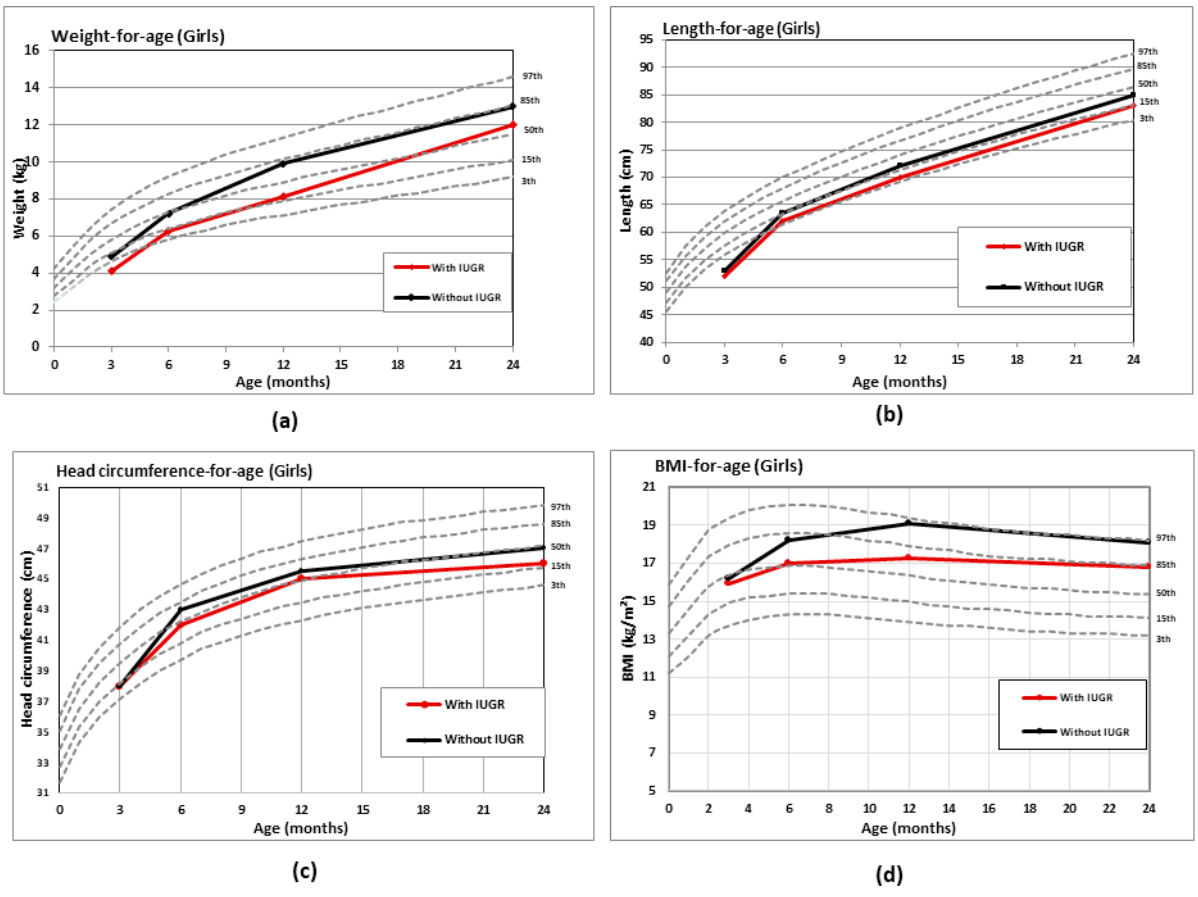
Figures 1 and 2 illustrate the growth trajectories of preterm infants from 3 to 24 months of corrected age (CA), categorized by their intrauterine growth status. To ensure alignment with the WHO growth references [20], all anthropometric data were plotted from three months (CA), the point where preterm trajectories begin to converge with term-born standards. The data show that head circumference (HC) demonstrated the most rapid recovery (Figure 1c). Without-IUGR infants tracked between the 15th and 50th percentiles from six months onwards, while those with IUGR reached the normal range for HC by six months (CA).

In contrast, the recovery of weight and length followed a more protracted course. Preterm girls without IUGR showed a steep upward trajectory in weight (Figure 1a), crossing percentiles to reach the 85th percentile by 12 months (CA). However, those with IUGR remained near the 3rd percentile until six months (CA), achieving normalization between 10 and 12 months (CA). Catch-up in length (Figure 1b) was more gradual; while without-IUGR infants reached the 50th percentile by 24 months, the IUGR group consistently tracked at lower percentiles throughout the observation period. The evolution of BMI-for-age

Table 2. Neonatal characteristics

Neonatal characteristics	Population N = 45		p-value
	Without IUGR n = 20	With IUGR n = 25	
Sex, n (%)			
Male	6 (30)	14 (56)	0.131[a]
Female	14 (70)	11 (44)	
Gestational age (weeks)	33 (30-36)	35 (33-36)	< 0.001[a]
Birth anthropometry			
Weight (g)	1722 ± 414	1438 ± 240	0.006[b]
Height (cm)	41.2 ± 3.98	40 ± 3.64	0.303[b]
Head circumference (cm)	30 (28-32)	29 (27-30)	0.066[a]
Discharge anthropometry			
Weight (g)	1762 ± 306	1660 ± 176	0.169[b]
Height (cm)	42.7 ± 3.48	42.3 ± 2.89	0.678[b]
Head circumference (cm)	30 (29-31.3)	31 (29-31.5)	0.872[a]
Length of hospital stay (days)	18 (5-52)	22 (4-54)	0.298[a]
Age at start of enteral feeding (days)	1 (1-2)	2 (1-2)	0.654[a]

The data are presented as means ± SDs for normally distributed continuous variables, median (25th, 75th percentiles) for nonnormally distributed variables, and n (%) for categorical variables; [a]Mann-Whitney test; [b]Student's exact test



The black curve represents preterm infants without intrauterine growth restriction (IUGR), and the red curve represents those with IUGR

Figure 1. Medians of anthropometric indices according to WHO growth curves for girls in the two subgroups [20]: (a) weight evolution; (b) length gain; (c) head circumference; (d) body mass index

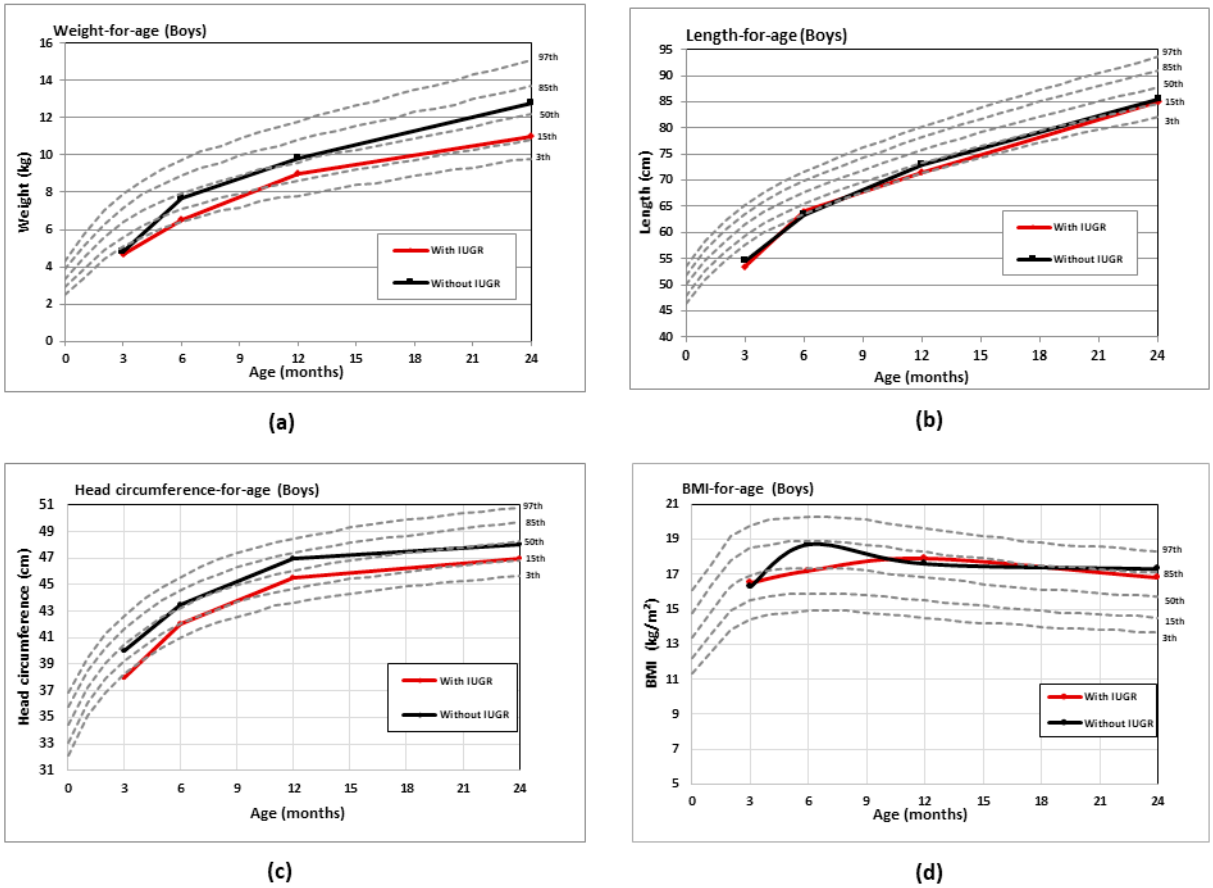
(Figure 1d) showed that values remained within the 15th to 85th percentiles during the first year of life. However, a sharp increase was observed at 24 months (CA). At this stage, the average BMI for infants without IUGR surpassed the 97th percentile, while the IUGR group reached the 85th-97th percentile range, reflecting a significant upward crossing of percentiles at the end of the second year.

Figure 2 illustrates the growth trajectories for preterm boys from 3 to 24 months (CA). Data were plotted from three months (CA) to align with WHO references.

Head circumference (HC) showed rapid recovery (Figure 2c); boys without IUGR tracked between the 15th and 50th percentiles from six months onwards, while the IUGR group reached the normal range by six months (CA). In terms of somatic growth, weight and length followed a more gradual trend. Boys without IUGR showed a steady weight increase (Figure 2a), crossing the 50th percentile by 6 months and approaching the 85th by 24 months. Conversely, boys with IUGR tracked along lower percentiles, with weight stabilizing above the 3rd percentile only after 10-12 months (CA). Recovery in length (Figure 2b) was the most protracted, with the IUGR group remaining near or below the 15th percentile throughout the study. Regarding BMI-for-age (Figure 2d), values remained within the 15th to 85th percentiles during the first year. However, a notable increase occurred at 24 months (CA), where the non-IUGR group reached the 97th percentile.

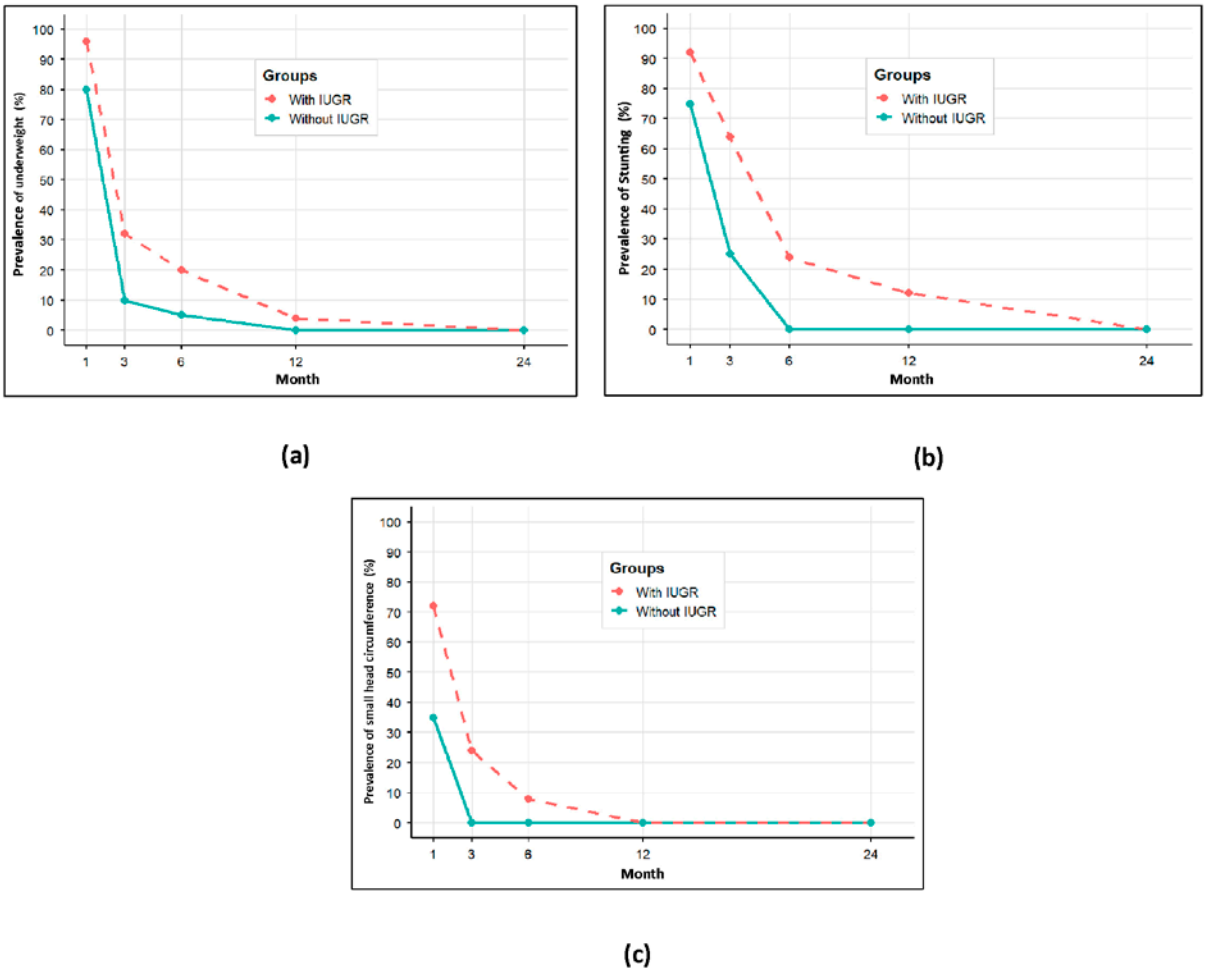
Prevalence of growth restriction

In addition to comparing anthropometric indices, the temporal evolution of growth restriction was analyzed between the two groups, as shown in (Figure 3). Among children without IUGR, at 1 month (CA), 80% had growth retardation in terms of weight (Figure 3a), 75% had growth retardation in terms of height (Figure 3b), and 35% had growth retardation in terms of head circumference (Figure 3c). By 3 months (CA), these prevalences began to decline: 10% of this group had weight retardation at 3a, 25% had stunted at 3b, and the entire group had normal



The black curve represents preterm infants without intrauterine growth restriction (IUGR), and the red curve represents those with IUGR

Figure 2. Medians of anthropometric indices according to WHO growth curves for boys in the two subgroups [20]: (a) weight evolution; (b) length gain; (c) head circumference; (d) body mass index



Infants are categorized as "With IUGR" or "Without IUGR" on the basis of intrauterine growth status; months with no affected infants are represented as 0%, and the y-axis ranges from 0-100%; lines represent the percentage of infants with EUGR for each parameter

Figure 3. Evolution of the prevalence of extrauterine growth restriction (EUGR) in preterm infants from 1 month (CA), to 24 months (CA): (a) weight (underweight), (b) length/height (stunted), (c) head circumference (small head circumference)

head circumference at 3c. From 12 months (CA) to 24 months (CA), the entire group had normal weight, height, and head circumference. Among the children with IUGR, 96% had growth retardation in terms of weight at 3a, 92% in terms of height at 3b and 72% in terms of head circumference at 3c at 1 month (CA). By 3 months (CA), these rates had begun to decline, with 64% experiencing weight retardation at 3a, 24% height retardation at 3b, and 8% head circumference retardation at 3c.

By 6 months (CA), 20% of the children had weight retardation at 3a, 24% had stunting at 3b and 8% had head circumference retardation at 3c. By 12 months (CA), only 4% of the children had weight retardation at 3a, 12% had stunted at 3b and the entire group had a normal head circumference at 3c. By 24 months (CA), the entire group had normal weight, height, and head circumference.

Feeding practices at 3 and 6 months and anthropometric indices

At 3 and 6 months (CA), anthropometric indices were compared between preterm infants receiving maternal (exclusive or mixed) or artificial feeding. The data are presented as the median in (Table 3). At 3 months (CA), there were no statistically significant differences in weight, length or head circumference between the groups, (weights: 4575 g (4005-4978) vs. 5085 g (3905-5590), p = 0.322). Height: 53 cm (51-54) vs. 54 cm (50.5-56.5), p = 0.873. HC: 38 cm (38-40) vs. 38 cm (36-40.5), p = 0.925. At 6 months (CA), infants receiving maternal feeding presented a slightly higher median weight than did those receiving artificial feeding, although the differences were small (7016 g (6462-7565) vs. 6655 g (6170-7440), p = 0.32).

At 3 months (CA), the prevalence of weight-based EUGR was lower among premature infants receiving maternal feeding than among those receiving artificial feeding. Specifically, 6 (17.6%) out of 34 infants in

Table 3. Anthropometric indices in preterm infants according to type of feeding practices at 3 and 6 month (CA)

Corrected age	Maternal feeding	Weight (g)	p-value	Height (cm)	p-value	HC (cm)	p-value
Month 3	Yes (n = 34)	4575 (4005-4978)	0.322	53 (51-54)	0.873	38 (38-40)	0.925
	No (n = 11)	5085 (3905-5590)		54 (50.5-56.5)		38 (36-40.5)	
Month 6	Yes (n = 20)	7016 (6462-7565)	0.320	62.5 (60-64.2)	0.334	42.5 (42-44)	1.000
	No (n = 25)	6655 (6170-7440)		64 (61-65)		43 (32-44)	

The data are presented as medians (25th, 75th percentiles); Yes – maternal feeding (exclusive or partial); No – artificial feeding; HC – head circumference; For each parameter, the Mann-Whitney test was used for calculation; A p-value < 0.05 was considered statistically significant

the maternal feeding group were EUGR, compared to 4 (36.4%) out of 11 infants in the artificial feeding group. However, this difference did not reach statistical significance (p = 0.227). Similarly, the prevalence of EUGR for length and HC was lower in infants receiving maternal feeding, although these differences also lacked statistical significance (p = 1.000 and p = 0.145, respectively). At 6 months (CA), the prevalence of weight discordance remained lower among the maternal feeding group than among the artificial feeding group. Among the 20 infants receiving maternal feeding, 1 (5%) was EUGR, whereas 5 (20%) of the 25 infants receiving artificial feeding were EUGR. However, this difference did not reach statistical significance (p = 0.20).

DISCUSSION

The present study provides a longitudinal perspective on the growth of preterm IUGR infants in a Moroccan cohort over the first 24 months of corrected age (CA). As illustrated in our growth charts (Figures 2 and 3 (a, b, and c)), infants born with IUGR (red lines) consistently maintain lower median values for weight, height, and head circumference (HC) compared to the non-IUGR group (black line) throughout the follow-up period. This persistent gap confirms that the initial deficit established in utero is not fully resolved during the "first 1000 days" of life, a period recognized as the most critical window for long-term health and human capital [21]. These findings align with global data from low- and middle-income countries, where the combination of prematurity and growth restriction significantly increases the risk of chronic undernutrition and stunting throughout early childhood [22]. Our findings regarding the difficulty of achieving complete recovery are strongly supported by the work of Vizzari et al. [23], who demonstrated that catch-up growth in small-for-gestational-age (SGA) infants is often a protracted process limited by the severity of the initial intrauterine insult. While Han et al. [24] reported a high catch-up rate of 85% by 24 months, our data suggest a more challenged recovery in the North African context. This discrepancy may be attributed to the biological constraint hypothesis; as suggested by Calek et al. [25], infants with true pathological IUGR face distinct metabolic and body composition challenges compared to those who are simply constitutionally small. Such early growth deficits can persist long-term, as evidenced by Saigal et al. [26], whose longitudinal research shows that growth trajectories of extremely low birth weight infants are often affected well into young adulthood.

In alignment with this perspective, the prevalence of underweight and stunting in our cohort remained significantly higher in the IUGR group, particularly during the first year. This indicates that the recovery window is not limited to the first few months but extends deep into the second year of life. By utilizing the WHO Child Growth Standards [20], we ensured that this lag was evaluated against a global benchmark. However, the clinical interpretation of this persistent deficit remains a subject of intense debate. While traditional models might view slow catch-up as a failure, the growth acceleration hypothesis (Singhal et al. [27]) suggests that the slower velocity observed in our IUGR cohort may paradoxically serve as a protective mechanism against the metabolic programming of obesity and cardiovascular disease in adulthood. This highlights a critical clinical dilemma: the need to promote sufficient growth for neurodevelopmental optimization, as indicated by our findings on cranial recovery, while avoiding the adiposity rebound associated with rapid weight gain. Consequently, our results emphasize the necessity for prolonged, nuanced clinical surveillance that moves beyond simple weight targets to ensure a steady, balanced recovery throughout the first 1000 days of life.

The persistence of growth deficits throughout the second year of life naturally raises question regarding the role of early nutritional interventions in modifying these trajectories. In our study, feeding practices were evaluated to determine their influence on catch-up kinetics and the prevalence of EUGR. For the purpose of this analysis, infants receiving any proportion of

breast milk were categorized under maternal feeding (including exclusive and partial feeding), reflecting the clinical reality that even partial exposure to human milk provides essential bioactive components, such as insulin-like growth factors (IGF-1), hormones, and immunoglobulins [28, 29], which act as critical signalling molecules for the somatic and metabolic development of preterm infants [30]. However, these mechanisms operate within a highly complex biological network involving thousands of genes and layers of epigenetic regulation. Rather than acting through isolated pathways, these factors contribute collectively to maintaining shared maternal-foetal homeostasis, thereby governing the intricate molecular adaptations that occur in both organisms [31, 32].

While the differences in median weight, height, and HC between feeding groups did not reach formal statistical significance at 3 and 6 months (CA), important clinical trends emerged. At 3 months (CA), infants receiving human milk exhibited a substantially lower prevalence of being underweight (17.6%) compared to those exclusively formula-fed (36.4%). A similar protective trend was observed for HC at 3 months, with an EUGR rate of 8.8% in the maternal feeding group versus 27.3% in the formula group. By 6 months CA, the prevalence of underweight remained four times lower in the maternal feeding group (5% vs. 20%). These findings suggest that while human milk supports a growth velocity comparable to formula, it may offer a crucial clinical advantage in reducing the severity of postnatal growth failure during the first 1000 days. Our results offer a necessary nuance to a study, who reported that breast milk did not significantly reduce EUGR prevalence at discharge [33]. This discrepancy is likely rooted in population differences. This study focused exclusively on very low birth weight (VLBW) infants with extreme metabolic demands. In our broader IUGR population, human milk appears to act as a metabolic regulator. This observation aligns with previous work demonstrating that early exposure to human milk modulates postnatal growth quality and tissue accretion patterns in preterm infants, suggesting a programming effect that may translate into improved long-term metabolic health rather than simply enhanced weight gain [34]. This concept is further supported by reviews indicating that human milk feeding in preterm populations is associated with growth patterns compatible with healthier cardio metabolic programming [35], even in the absence of marked differences in early anthropometric recovery. Furthermore, breastfeeding has been shown to exert a protective effect on the development of risk factors associated with metabolic syndrome in infants born preterm, specifically by influencing lipid profiles and adiponectin levels [36].

Furthermore, the favorable trend in HC attainment observed in our maternal feeding group is of significant prognostic value. This study [37] indicates that early cranial catch-up specifically when supported by human milk, is a superior predictor of white matter development and long-term neurocognitive scores compared to rapid weight gain. This is further corroborated by research [38], who demonstrated that the nutritional quality of human milk is uniquely linked to brain volume and metabolic safety. By achieving somatic growth equivalent to formula-fed infants without the metabolic stress of hypercaloric artificial feeding [39], human milk supports the "brain-sparing" effect through a more physiological pathway. This reinforces the argument that nutritional success in IUGR cohorts should be measured by the quality of catch-up prioritizing neurodevelopmental potential and metabolic health, rather than purely through absolute anthropometric parity.

The metabolic adaptations and growth responses observed postnatally are inextricably linked to the intrauterine environment and the timing of delivery. In our study, maternal characteristics and clinical management emerged as critical precursors to the infants' long-term trajectories. Our analysis revealed a significant correlation between advanced maternal age and the incidence of IUGR, a finding that aligns with contemporary obstetric literature. This association is largely attributed to the age-related decline in placental efficiency and increased uterine artery resistance. According to previous research [40], older maternal age is often linked to placental angiogenic dysfunction, which restricts the flow of essential nutrients and oxygen, thereby establishing the pathological basis for fetal growth restriction.

A notable observation in our cohort was the higher gestational age of IUGR infants compared to their non-IUGR counterparts. This discrepancy reflects a deliberate clinical strategy of fetal rescue. In managing growth-restricted foetuses, clinicians often attempt to prolong the pregnancy to maximize pulmonary maturity and minimize the risks of severe prematurity, even when the intrauterine environment is suboptimal. As detailed in the literature [41], this strategy requires a delicate balance; while extending the pregnancy can prevent neonatal respiratory distress, it also prolongs the foetus's exposure to chronic hypoxia and malnutrition. This prolonged deprivation may induce epigenetic modifications in growth-related genes, further cementing the growth lag observed postnatally. Furthermore, current scientific evidence [42] emphasize that postnatal catch-up in IUGR infants is not merely a continuation of the fetal trajectory but a distinct phase of metabolic adaptation. The fact that our IUGR group was born at a later gestational age yet still exhibited significant

postnatal stunting reinforces the idea that the insult of IUGR is profound and enduring. It suggests that while the fetal rescue strategy is successful in terms of immediate survival and respiratory health, it does not mitigate the long-term biological programming that restricts anthropometric attainment. This highlights the critical need for individualized neonatal follow-up that accounts for both the severity of the IUGR and the maternal context in which it developed.

A major strength of this study lies in the systematic comparison between preterm infants with and without IUGR, allowing for a robust assessment of how intrauterine growth restriction independently shapes postnatal trajectories. The longitudinal design, spanning up to 24 months of corrected age, provides a comprehensive view of the first 1000 days, while the analysis of feeding methods offers an original clinical perspective within a North African cohort. However, some limitations should be noted. The sample size remains relatively limited, which can affect the statistical power of certain subgroup comparisons, a common challenge in long-term neonatal follow-up. Furthermore, the findings of studies focused exclusively on very low birth weight (VLBW) infants, such as study [34], differ from ours primarily due to the distinct metabolic demands of that specific population compared to our broader preterm cohort. This methodological divergence necessitates a nuanced comparison of nutritional outcomes. Finally, while anthropometry is a validated proxy, the use of advanced body composition techniques, such as deuterium isotope dilution, would provide a more granular understanding of the quality of mass gain (lean vs. fat mass) in these infants.

CONCLUSION

In conclusion, our data confirm that preterm infants born with IUGR in this Moroccan cohort maintain significant growth deficits, compared to non-IUGR peers. While the findings suggest that maternal milk may help mitigate the severity of postnatal growth failure, this observation, along with the proposed influences of fetal rescue strategies, remains a clinical interpretation that requires validation through larger studies. Given the limited sample size and specific regional context, these results should be generalized with caution. Nevertheless, this study underscores the necessity for prolonged, individualized clinical surveillance during the first 1000 days.

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Conflict of interest

The authors declare no conflict of interest.

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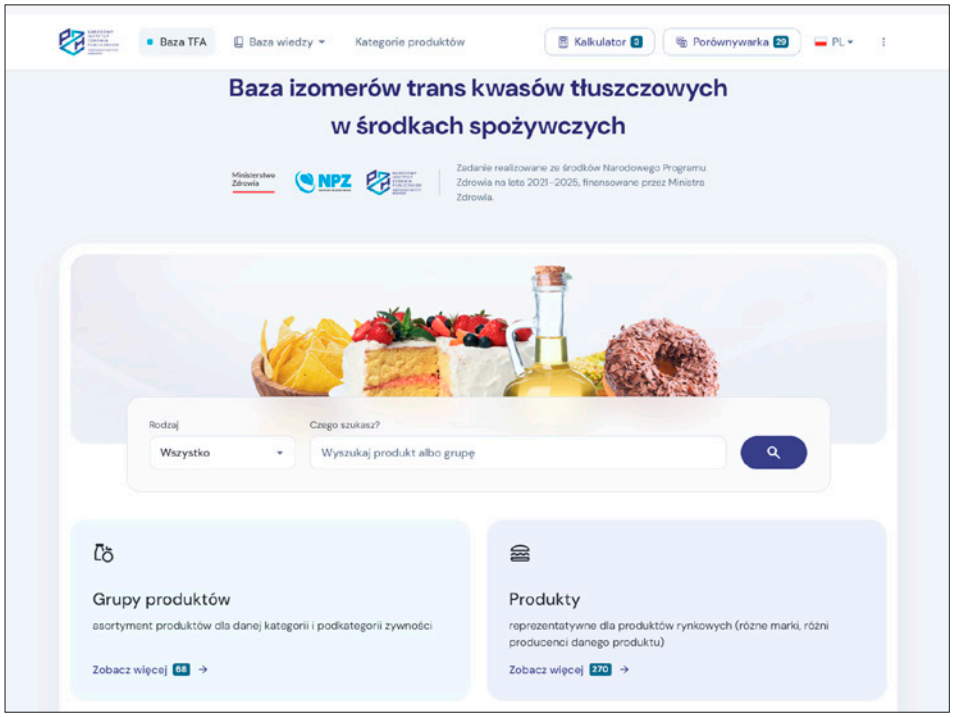
BAZA ZAWARTOŚCI IZOMERÓW TRANS KWASÓW TŁUSZCZOWYCH (TFA) W ŻYWNOŚCI (e-BAZA TFA)

Izomery trans kwasów tłuszczowych (TFA) obecne w żywności są jednym z głównych czynników ryzyka chorób sercowo-naczyniowych, w tym choroby niedokrwiennej serca. Zgodnie z zaleceniami Europejskiego Urzędu ds. Bezpieczeństwa Żywności (EFSA, 2019) i Normami żywienia dla populacji Polski opracowanymi w Narodowym Instytucie Zdrowia Publicznego PZH – Państwowym Instytucie Badawczym (NIZP PZH-PIB, 2024) spożycie TFA powinno być tak małe, jak to jest możliwe w diecie zapewniającej właściwą wartość odżywczą. Z kolei Światowa Organizacja Zdrowia (WHO, 2023) rekomenduje, aby spożycie TFA dostarczało nie więcej niż 1 % energii z całodziennej diety. Z powyższych względów istotne jest prowadzenie badań nad zawartością TFA w żywności, upowszechnianie wiedzy nt. skali występowania TFA, a w konsekwencji ograniczenie spożycia tych związków. Jednym z takich działań było utworzenie ogólnodostępnej elektronicznej bazy danych o zawartości izomerów trans kwasów tłuszczowych (TFA) w środkach spożywczych (e-Baza TFA).

e-Baza TFA jest prowadzona od 2017 r. w ramach zadania Narodowego Programu Zdrowia (NPZ) finansowanego z budżetu Ministra Zdrowia. Informacje nt. zawartości TFA w środkach spożywczych obecnych na polskim rynku są dostępne pod adresem: https://izomery.pzh.gov.pl/. Aktualnie w e-Bazie znajdują się dane o zawartości TFA w 1618 produktach należących do 14 kategorii żywności, 28 podkategorii, 68 grup produktów oraz w 270 reprezentatywnych produktach spożywczych. Zawartość TFA jest przedstawiona w postaci mediany oraz wartości maksymalnej i minimalnej dla każdej grupy, podgrupy i kategorii produktów i wyrażona dla każdego produktu w g/100 g, g/porcję i w g/cały produkt. Dane zawarte w e-Bazie są regularnie dwa razy w roku aktualizowane o nowe wyniki badań analitycznych. Zawartość TFA jest oznaczana analitycznie w NIZP PZH – PIB metodą chromatografii gazowej sprzężonej ze spektrometrią mas (GC-MS). Metoda posiada akredytację Polskiego Centrum Akredytacji (AB 509). Dane na temat zawartości TFA w środkach spożywczych mogą być wykorzystywane do wyboru produktów o najmniejszej zawartości TFA zarówno przez indywidualnych konsumentów, jak i w planowaniu żywienia zbiorowego m.in. w żłobkach, przedszkolach, szkołach, szpitalach i domy opieki. Mogą być wykorzystywane również w celach naukowych do szacowania populacyjnego pobrania TFA z dietą i oceny ryzyka związanego z ich ze spożyciem.

Warto podkreślić, że w 2025 r. e-Baza została zmodernizowana poprzez m.in. dodanie nowych narzędzi, takich jak kalkulator i porównywarka produktów, aktualizację ścieżek wyszukiwania produktów i zmianę szaty graficznej strony internetowej e-Bazy TFA. Opracowano również wersję anglojęzyczną e-Bazy.



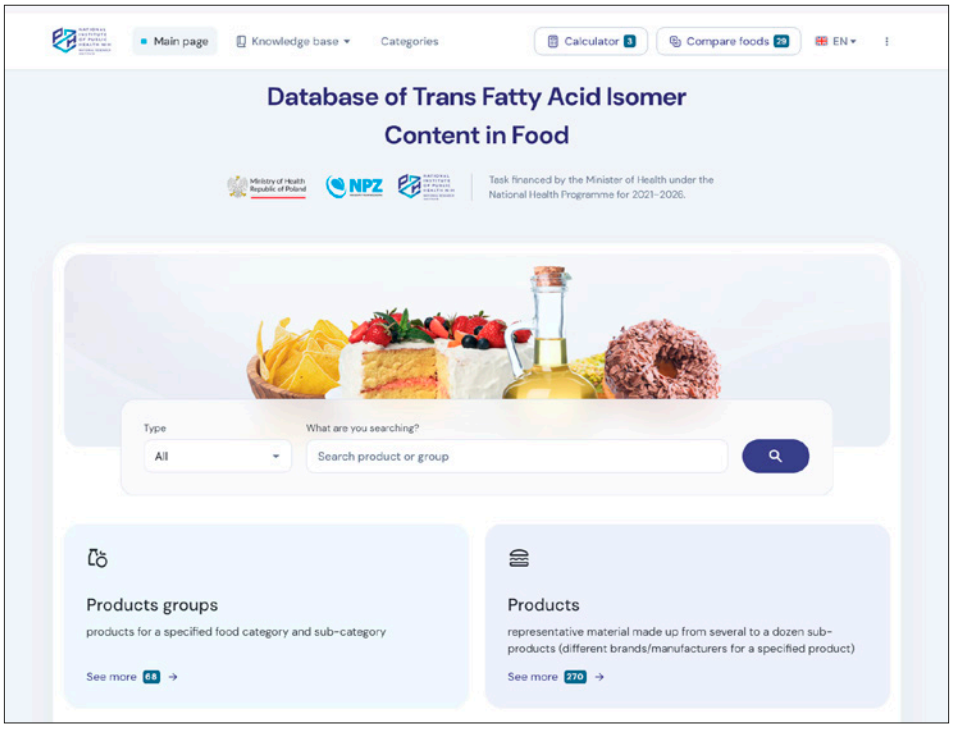
Zadanie realizowane ze środków Narodowego Programu Zdrowia na lata 2021-2025, finansowane przez Ministra Zdrowia.

TRANS FATTY ACIDS CONTENT IN FOOD (TFA E-DATABASE)

Dietary trans fatty acids (TFA) are one of the main risk factors for cardiovascular disease, including coronary heart disease. According to the recommendations of the European Food Safety Authority (EFSA, 2019) and the Nutrition Standards for the Polish Population developed at the National Institute of Public Health NIH – National Research Institute (NIPH NIH – NRI, 2024), TFA intake should be as low as possible in a diet that provides adequate nutritional value. In turn, the World Health Organization (WHO, 2023) recommends that TFA consumption should provide no more than 1% of energy from the total daily diet. For the above reasons, it is important to conduct research on the TFA content in food, disseminate knowledge about the scale of TFA occurrence and, consequently, limit the consumption of these compounds. One of these actions was the creation of a publicly available electronic database on the content of trans fatty acids in foodstuffs (TFA e-Database).

The TFA e-Database has been maintained since 2017 as part of the National Health Programme (NHP) financed from the budget of the Minister of Health. Information on the TFA content in foods on the Polish market is available at: https://izomery.pzh.gov.pl/. Currently, the e-Database contains data on TFA level in 1,618 products belonging to 14 food categories, 28 subcategories, 68 product groups, and 270 representative food products. The TFA content is presented as a median, maximum and minimum value for each group, subgroup and product category and expressed for each product in g/100 g, g/serving and g/whole product. Data in the e-Database are regularly updated twice per year with new analytical research results. TFA content is determined analytically at the NIPH NIH – NRI using gas chromatography coupled with mass spectrometry (GC-MS). The method is accredited by the Polish Centre for Accreditation (AB 509). Data on the TFA content in foods can be used to select products with the lowest TFA content both by individual consumers and in planning mass catering, including nurseries, kindergartens, schools, hospitals and nursing homes. They can also be used for scientific purposes to estimate population TFA intake from the diet and to assess the risk associated with consumption.

It is worth noticing that in 2025, the e-Database was modernized by adding new tools such as calculator and product comparison tool as well as product search paths and TFA e-Database website graphic design update. An English-language version of the TFA e-Database was also developed.



The project was carried out using funds of the National Health Programme 2021–2025, financed by the Minister of Health.

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https://roczniki.pzh.gov.pl/

INSTRUCTION FOR AUTHORS

Scope of the Journal

The journal Roczniki Państwowego Zakładu Higieny - Annals of the National Institute of Hygiene is the peer-reviewed scientific journal that publishes original research articles, reviews, short communications and letters to the Editor.
The journal is devoted to research studies on food and water safety, nutrition, dietetics, environmental hygiene, toxicology and health risk assessment, public health and other areas related to health sciences.

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Key words. 5-7 words or short phrases according to the MeSH (Medical Subject Headings) catalogue available at www.nlm.nih.gov/mesh/meshhome.html.

Original research article should be divided into the sections: Introduction/Background, Material and Methods, Results, Discussion, Conclusions, Acknowledgements, Conflict of interest and References.

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Material and Methods should provide detailed information on the subject of the study, methods, reagents, apparatus and techniques used in sufficiently exhaustive way to enable readers to repeat the experiments or observations. For generally known methods references should be given together with name of the methods or statistical analysis used in the study. For new or substantially modified methods detailed descriptions are to be added. In the case of experimental studies on laboratory animals, the information should be provided

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Results should be presented in a logical sequence in the text, the same applies to the tables and figures. The data from the tables and figures should not be repeated in the text, where only the most important observations from the studies are to be summarized.

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References should be presented according to the Vancouver referencing style. References should be cited in the order in which they first appear in the text. If the same publication is cited again the same number should be given. The journal title should be abbreviated in accordance with MEDLINE. Each position in the list of references should start from the new line and contain: consecutive number, author's (authors') surname(s) and initials of name(s), full title of the paper, official journal title abbreviation (according to the List of Journals Indexed in Index Medicus), year, volume, number, the first and the last page number. If the cited article or book has a DOI (Digital Object Identifier), it should be included in the references. The titles of the cited papers in other language than English should be translated into English. In the text of the manuscript only the number referring to the cited publication listed in references should be given in square brackets. The list of references should include only those that are cited in the text of the manuscript.
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The examples of reference style are given below:

Journal article with 1-6 authors:

1. Mertens E, Colizzi C, Peñalvo JL. Ultra-processed food consumption in adults across Europe. Eur J Nutr. 2022;61(3):1521-1539. doi: 10.1007/s00394-021-02733-7.

Journal article with more than 6 authors:

2. Osei-Kwasi HA, Boateng D, Danquah I, Holdsworth M, Mejean C, Terragni L, et al. Acculturation and Food Intake Among Ghanaian Migrants in Europe: Findings From the RODAM Study. J Nutr Educ Behav. 2020;52(2):114-125. doi: 10.1016/j.jneb.2019.09.004.

Book:

3. Kerner S, Chou C, Warmind M. Commensality: From Everyday Food to Feast. London: Bloomsbury Publishing PLC; 2015. ISBN 9780857857361.

Book chapter:

4. Lucas BL, Feucht SA. Nutrition in childhood. In: Mahan LK, Escott-Stump S, editors. Krause's Food & Nutrition Therapy. 12th ed. St. Louis, MO: Saunders Elsevier; 2008. p. 222–245. ISBN 9780808923787.

Internet source:

5. World Health Organization. GHE: Life expectancy and healthy life expectancy [Internet]. Geneva: World Health Organization; 2024. [cited 2024 Jan 19] Available from: https://www.who.int/data/gho/data/themes/mortality-and-global-health-estimates/ghe-life-expectancy-and-healthy-life-expectancy.

Legislative acts:

6. Regulation (EC) No 1333/2008 of the European Parliament and of the Council of 16 December 2008 on food additives (Text with EEA relevance). OJ L 354, 31.12.2008, p. 16–33. Available from: http://data.europa.eu/eli/reg/2008/1333/oj.

Tables should be prepared in separate file(s) in doc, docx, rtf, odt formats and numbered using Arabic numerals. The title should be place directly above each table. Tables should always be cited in the text in consecutive numerical order. Each column in tables should have a brief heading, more extensive explanation should be given below the table, if necessary. The number of tables should be limited to the necessary minimum.

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Abbreviations, symbols, units. Generally known and used abbreviations may be left unexplained, others must be explained at the first use in the text. Metric SI units are recommended, however also other generally used units are accepted.

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