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

Volume 76 **2025** **Number 2**

OD REDAKTORA NACZELNEGO

Szanowni Państwo,

Oddajemy do Państwa rąk nr 2/2025 Roczników PZH, w którym pragnę zwrócić uwagę na artykuły związane ze zdrowiem kobiet i niemowląt. E. Niedźwiedzka i wsp. oceniali w jakim stopniu kobiety w wieku rozrodczym, realizują zalecenia dotyczące spożywania produktów mlecznych i aktywności fizycznej oraz jaki ma to wpływ na gęstość mineralną kości. Z kolei B. Mekkaoui i wsp. zbadali czynniki, w tym sposób żywienia, wpływające na nadwagę i otyłość kobiet w wieku rozrodczym w Maroku. Sposób żywienia kobiet był również istotnym czynnikiem determinującym występowanie bardzo niskiej urodzeniowej masy ciała w Indiach, na co wskazuje artykuł J. Mukhopadhyay. Stan wiedzy matek na temat żywienia niemowląt oceniły E. Malczyk i wsp. wskazując, że chociaż powszechna jest wiedza młodych matek o przewadze karmienia piersią nad preparatami do żywienia niemowląt w pierwszym półroczu życia dziecka, to wiedza młodych matek na temat żywienia w drugim półroczu życia jest niewystarczająca. M. Dobosz i K. Suligowska, na podstawie danych z „Programu wczesnego wykrywania czynników ryzyka chorób cywilizacyjnych SOPKARD-Junior" przeprowadziły ocenę wpływu różnych czynników psychosocjologicznych na postrzeganie masy ciała w grupie młodzieży. Ocena stanu wiedzy na temat zawartości sodu w diecie oraz zachowań żywieniowych związanych ze spożyciem sodu, były z kolei przedmiotem badań przeprowadzonych przez S. Chaiwong i wsp. w grupie dorosłych pacjentów z nadciśnieniem tętniczym w Tajlandii. Również osób dorosłych dotyczyły badania przeprowadzone przez M. Dobosza i wsp., którzy w swojej publikacji przedstawili wyniki analizy częstości występowania choroby wieńcowej u pacjentów Oddziału Kardiologicznego szpitala w południowej Polsce, w powiązaniu m.in. z parametrami socjologicznymi oraz oceną wpływu nadciśnienia tętniczego na częstość występowania zawału mięśnia sercowego. W obszar bezpieczeństwa żywności wpisuje się publikacja Lewińskiego i wsp., prezentująca wyniki badań pilotażowych nad obecnością, niestosowanych już obecnie, chloroorganicznych pestycydów w próbkach miodu pobranych z terenów kilku województw środkowej i wschodniej Polski.

W części *In memoriam* przedstawiamy sylwetkę Prof. dr hab. Danuty Palut, wybitnego naukowca i długoletniego pracownika Zakładu Toksykologii i Oceny Ryzyka Zdrowotnego Narodowego Instytutu Zdrowia Publicznego – Państwowego Zakładu Higieny w Warszawie, która odeszła w dniu 7 marca 2025 r.

Zapraszam do czytania i publikowania w Rocznikach PZH. Jednocześnie uprzejmie informuję, że rok 2025 jest ostatnim, w którym Roczniki PZH będą się ukazywały w formie papierowej.

Z poważaniem,

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

EDITORIAL INTRODUCTION

Ladies and Gentlemen,

We are presenting to you issue No. 2/2025 of the journal Roczniki Państwowego Zakładu Higieny (Annals of the National Institute of Hygiene), in which I would like to draw your attention to articles related to the health of women and infants. E. Niedźwiedzka et al. assessed the extent to which women of reproductive age adhere to recommendations regarding dairy product consumption and physical activity, and the impact this has on bone mineral density. B. Mekkaoui et al. examined factors, including dietary patterns, influencing overweight and obesity among women of reproductive age in Morocco. Women's dietary patterns were also a significant factor in determining the prevalence of very low birth weight in India, as indicated in the article J. Mukhopadhyay. The state of mothers' knowledge about infant nutrition was assessed by E. Malczyk et al., who indicated that although young mothers' knowledge about the advantages of breastfeeding over infant formulas in the first six months of a child's life is common, their knowledge about nutrition in the second six months of a child's life is insufficient. M. Dobosz and K. Suligowska, based on data from the „Program for early detection of risk factors for lifestyle diseases SOPKARD-Junior", assessed the influence of various psychosociological factors on the perception of body weight in a group of adolescents. The assessment of the state of knowledge about the sodium content in the diet and dietary behaviors related to sodium consumption were the subject of a study conducted by S. Chaiwong et al. in a group of adult patients with hypertension in Thailand. Adults were also included in the study conducted by M. Dobosz et al., who in their publication presented the results of the analysis of the incidence of coronary heart disease in patients of the Cardiology Department of a hospital in southern Poland, in connection with, among others, sociological parameters and the assessment of the impact of arterial hypertension on the incidence of myocardial infarction. The publication by Lewiński et al., which presents the results of pilot studies on the presence of organochlorine pesticides, no longer used today, in honey samples collected from several voivodeships of central and eastern Poland, falls within the area of food safety.

In the *In memoriam* section, we present the profile of Professor Danuta Palut, PhD, an outstanding scientist and long-time employee of the Department of Toxicology and Health Risk Assessment of the National Institute of Public Health – National Institute of Hygiene in Warsaw, who passed away on March 7, 2025.

I invite you to read and publish in the Annals of the National Institute of Hygiene. At the same time, I would like to kindly inform you that 2025 is the last year in which the Annals of the National Institute of Hygiene will be published in paper form.

Kind regards,

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

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ORIGINAL ARTICLE

THE KNOWLEDGE OF DIETARY SODIUM, SODIUM CONSUMPTIVE BEHAVIOR, SODIUM IN FOOD, AND URINARY SODIUM OF HYPERTENSIVE PATIENTS IN THAILAND

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ABSTRACT

Background. Consuming salty foods raises blood pressure because of their sodium and salt. Educating hypertension patients about sodium contributes to their diets and can decrease the future effects on their health.

Objective. The objectives aimed to investigate the knowledge about the sodium content in different condiments and raw foods, consumer preferences regarding sodium-rich foods and condiments, the sodium levels in local food, and the urine of hypertensive patients at Nakhon Si Thammarat Province, Thailand.

Material and Methods. The total sample size consisted of 203 individuals. The data collection tool consists of two components: the questionnaire used to assess knowledge and behavior related to consuming foods containing sodium, and the salt meter and the ion-selective electrode (ISE) were the instruments applied to the determination of sodium in food and urine, respectively. Descriptive statistics including averages and percentages, and analytical statistics, namely analysis of variance (ANOVA) were employed.

Results. The study revealed that the sample was mostly made up of females, married, aged over 60 years, and had finished primary education. Participants were most knowledgeable about condiments, especially fish sauce, shrimp paste, and fermented fish. Hypertensive patients have a modest level of awareness regarding sodium. The shrimp paste had the highest consumption behavior, followed by fish sauce, monosodium glutamate (MSG), and seasoning powder or soup cube at a moderate level. Sour soup with mullet fish, stir-fried luffa with eggs, and Nile tilapia fish sour soup with taro stalk are the top 3 southern local meals preferred to consume and are rich in sodium. The sodium in the food of the low-knowledge differed considerably in moderate and high knowledge ($p < 0.05$). In contrast with urinary sodium, in the high-knowledge group, it was considerably different in low and moderate knowledge ($p < 0.05$).

Conclusions. Hypertension patients' degree of knowledge has a significant role in determining their health and ability to lower blood pressure, particularly about using spices that include sodium, and their consumption habits of local foods high in sodium.

Keywords: *hypertensive patients, sodium knowledge, sodium consumptive behavior, sodium in local food, sodium in urine, Thailand*

INTRODUCTION

The WHO observed a rise in hypertension, which now affects over one billion people. The UN aims to reduce non-communicable disease (NCD)-related premature mortality by 30% by 2030. Projections show that 1.5 billion people will be impacted by 2025, with two-thirds in emerging nations. Each year, 7.5 million individuals die from hypertension [1, 2]. Hypertension was the second-highest non-communicable disease

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mortality rate in Thailand between 2018 and 2020, with 134.0 per 100,000 population [3]. The Sixth National Health Examination Survey in 2019 and 2020 detected excessive hypertension in 24.7% of Thais [4].

A sedentary lifestyle and nutrition, including consuming sodium-rich meals (above 2,000 mg sodium (Na) or 5 grams of salt daily), are the leading causes of high blood pressure [5-6]. Cardiovascular illness, renal disease, renal stones, osteoporosis, and stomach cancer are complications of high blood pressure [7-13]. The usage of salt is a significant public health concern in Thailand. Thais consumed 4351.7 mg of sodium daily in 2009, twice the recommended minimum [14]. Reduce salt intake to lower blood pressure and risk of related issues [15]. Research in Iran found that over 79% of rural hypertensives add salt to their meals [16]. In the US diet arm and the DASH diet arm, a reduction in sodium intake of 1771 mg was observed. Additionally, the mean blood pressure on the US diet with high sodium intake was 128/81 mmHg, which was shown to decrease by 5.6/-2.8 mmHg after the low sodium intervention was implemented in the pre-hypertensive subgroup [17]. The World Health Organization's guideline of consuming fewer than 2,000 mg of sodium per daily is a preventive step to decrease the incidence of hypertension. The majority of participants (98.40%) stated that they had cooked or prepared food at home at least once in the previous three months. Over 70% of participants in total stated that they had used monosodium glutamate (MSG) in food preparation (72.8%) and bouillon cubes or seasonings (73.1%) at least once in the previous three months [18].

High salt intake contributes to NCD. Thus, limiting salt consumption may improve health and save healthcare expenses [19]. All WHO member nations accepted a 30% salt reduction as one of nine global NCD reduction goals [20]. Health promotion should be emphasized, encompassing the education of individuals on health, increasing knowledge of the dangers associated with high-sodium diets, advocating for a low-sodium regimen, and monitoring sodium consumption within the community. According to the research, patients' diets can help normalize their blood pressure. However, many hypertensives overeat salt or use salt or fish sauce to flavor their meals. These activities cause blood pressure dysregulation and high blood pressure.

The second-largest and most populous province in southern Thailand is Nakhon Si Thammarat Tha Sala District, one of Nakhon Si Thammarat Province's 23 districts, employs most people in agriculture, livestock, and fisheries. Tha Sala District comprises 13 subdistricts, including Ban Han. People consume mostly sour, spicy, and salty cuisine. Salt, fish sauce, and shrimp paste are household staples. Salt, included in many condiments, can raise blood pressure. Because of increasing salt in food and spices, the prevalence of high blood pressure patients in 2021-2023 was 477.1, 507.8, and 858.9 per 100,000 population. Thus, the staff focused on sodium-rich meals, sodium consumption from different seasonings, and sodium levels in hypertensive diets and urine. This data would provide the basis for a campaign to reduce salt in food and condiments to prevent high blood pressure patients from eating too much sodium.

MATERIAL AND METHODS

The research design was cross-sectional descriptive research.

The population consisted of 426 individuals who were officially registered as hypertension patients in the jurisdiction of Ban Han Subdistrict Health Promoting Hospital. Using Crazy and Morgan's (1970) [21] formula, the total sample group was 203 persons.

Inclusion criteria: The sample size must consist of a hypertensive patient over 35 years old, registered in the area under the responsibility of Ban Han Subdistrict Health Promotion Hospital, Tha Sala District, Nakhon Si Thammarat Province, Thailand, who can read and listen in Thai and is willing to participate in the project. Exclusion criteria: A sample group that moved out of the area during the research, abstaining from diuretic medication, and admitted or required hospitalization.

Exclusion criteria: A sample group that moved out of the area during the research, abstaining from diuretic medication, and admitted or required hospitalization.

The researcher received approval from the Human Research Ethics Committee at Walailak University in Nakhon Si Thammarat Province for the human research project, designated WUEC-19-172-01, to protect the rights of the sample group.

Workflow

The first step was treating hypertension patients based on the specified inclusion criteria. Afterward, we gathered data by utilizing a questionnaire that consisted of three sections: 1) General information, 2) Evaluation of knowledge of sodium in food, and 3) Evaluation of behavior in using different condiments containing sodium. The southern area consisted of 14 different varieties of cuisine. Subsequently, we categorized individuals with hypertension into three distinct categories based on their level of knowledge: low, moderate, and high, and performed an essentially random selection of 9 persons with hypertension conditions from each of the three knowledge groups (high, moderate, and low) to get samples of 27 regular breakfast, lunch, and dinner items and urine samples. We analyze salt levels in food and urine specimens. Conduct a thorough examination of the sodium concentration in alimentary and urinary specimens.

Research instrument

The research instruments were divided into two categories:

1. The instrument for data collection was a questionnaire consisting of three parts, as follows:
   Part 1: A questionnaire on general information, including gender, age, status, education, occupation, direct relatives, and income, consisting of a total of seven items.
   Part 2: The assessment of sodium consumption knowledge has 15 items, encompassing both affirmative and negative inquiries [22]. A positive response to a correctly posed question results in a score of 1 point, but a negative response to an incorrectly posed question also results in a score of 1 point. When analyzing the significance of the score values, the researcher establishes the criteria based on the scores. A scores ranging from 0-8, 9-11, and 12-15 points indicate a low, moderate, and high degree of knowledge, respectively.
   Part 3: Sodium Intake: The behavior assessment comprises 14 questions presented in a Likert scale format [23], with respondents assessing their consumption levels on a scale of five levels: the highest, high, moderate, low, and the lowest. The criteria are as follows: The scores for consuming sodium for 7 days, 5-6 days, 3-4 days, 1-2 days, and no weekly consumption ranged from 0-4 points. We interpret the sodium consumption behavior scores as follows: 0.00-0.80, 0.81-1.60, 1.61-3.40, 3.41-4.20, and 4.21-5.00, indicating commendable, good, moderate actions requiring improvement, and poor behavior, respectively.
2. Laboratory tools:

We divided the hypertension patients into three knowledge groups based on their level of expertise: low, moderate, and high, by random sampling. Each group consisted of nine individuals. The study team took 24-hour food and urine samples in the morning to check for sodium. The following were the steps in sample preparation:

2.1. Urinary sodium analysis

Container preparation: A sodium urine test was conducted in a laboratory. To maintain contamination, one cleaning approach involves rinsing with deionized water (DI water) for 24 hours. Then, it is submerged in a solution of 3% nitric acid for 24 hours. Seal the cover and dehydrate in an oven set to 60˚C, then store in a storage until needed.

24-hour urine sample collection: Upon awakening, obtain a midstream urine specimen of 2-10 ml. Subsequently, the name, last name, date, and time will be affixed onto the urine sample and dispatched to the laboratory for examination utilizing the ion-selective electrode (ISE) apparatus.

We utilized the 24-hour urine collection to determine the individuals' salt excretion during the same period. A brochure including information and the requisite equipment (standard urine collection container) was provided to 27 participants throughout the experiment, and the 24-hour urine retention method was employed. The urine collection location collected the 24-hour urine volume and documented the start and finish times of collection to evaluate the completeness of the 24-hour urine sample. Urine specimens were deemed incomplete if the collection duration was under 22 hours or if the total volume was insufficient. The capacity was under 100 ml. We aliquoted 100 mL of 24-hour urine into a cryotube using a pipette and subsequently transported it to Tha Sala hospital laboratory. An automated biochemical analyzer quantified urine sodium using the ion-selective electrode (EForL ATELICA).

2.2. The determination of sodium in food

Food samples were collected from the sample group and consumed for 24 hours, encompassing breakfast, lunch, and supper, to determine the sodium content. If the food did not dissolve, it should be liquefied, crushed, or dissolved in 100 mL of water. The steps for conducting the test were as follows: 1) Immerse the probe tip of the sodium meter into the liquid meal measurement, 2) To obtain an accurate measurement, refrain from measuring the temperature of the meal. At the same time, if it is still hot, ensure that the probe tip remains in the food and avoid touching the container, and 3) Press and hold the power button to initiate the measurement and view the sodium value on the screen (https://www.thaisaltsurvey.com/manual_app).

Quality control for instruments

We utilized the content validity of the instrument, employing the index of item objective congruence (IOC) to identify and evaluate three hypertension experts by academics from the Ministry of Public Health, university lecturer, and experts in non-communicable diseases based on the following criteria: A score of +1, 0, and -1 indicates a high level of confidence, a lack of confidence, and an incongruous confidence in the questionnaire, respectively. The researcher selected questions with IOC values ranging from 0.50 to 1.00. After that, the revised questionnaire was tested on 30 hypertensive patients in the Pho Thong Subdistrict of Tha Sala District, Nakhon Si Thammarat Province, and found that the knowledge questionnaire had a Kuder-Richardson 20 value of 0.70 and the behavior questionnaire had a Cronbach's alpha coefficient of 0.72, which were found using the correct formulas.

Data analysis employing two categories of statistics: descriptive statistics, including mean, frequency, and

percentage, and inferential statistics, incorporating ANOVA at a significance level of 0.05.

RESULTS

Demographic data

The majority of the sample were female (61.1%), with an average age of 66.2 years and marital status (57.6%), followed by widowed (31.5%), single (8.4%), and divorced or separated (2.5%). Education is at the primary school level (78.3%). The most common occupation is agriculture (57.1%). Most have an average income of less than 137 USD per month (73.3%), followed by an income between 137-274 USD (18.7%). Moreover, a direct relative with hypertension, including parents (27.6 %), is presented in Table 1.

Knowledge-related sodium consumption

The questions that received the highest number of correct answers were related to understanding

Table 1. Number and percentage of personal information (n = 203)

Personal information	Number	Percentage
Gender		
Male	79	38.9
Female	124	61.1
Age		
37-47 years	17	8.4
50-59 years	48	23.6
60 years or higher	138	68.0
Marital status		
Single	17	8.4
Married	117	57.6
Divorced/Separated	5	2.5
Widowed	64	31.5
Level of education		
Not educated/Less than primary school	1	0.5
Primary school	159	78.3
Secondary school	21	10.3
High school level 4-6/Vocational certificate	16	7.9
Associate degree/Vocational certificate	3	1.5
Bachelor's degree or higher	3	1.5
Careers		
Agriculture	116	57.1
Employee	29	14.3
Trade	14	6.9
Private business	6	3.0
State enterprise	2	1.0
Others	36	17.7
Average monthly income		
Less than 137 USD	149	73.4
138-275 USD	38	18.7
276-410 USD	12	5.9
More than 410 USD	4	2.0
Direct relatives		
No having	147	72.4
Having (Identified)	56	27.6
Father	15	26.8
Mother	30	53.6
Both father and mother	11	19.6

fermented fish, shrimp paste, and fish sauce as goods with a high sodium content, with an accuracy rate of 83.3% (169 persons). It was closely followed by the awareness that ingesting a large quantity of sodium can lead to high blood pressure, with an accuracy rate of 82.3% (167 persons).

The somewhat accurate responses were as follows: consuming a significant quantity of sodium (79.3%) leads to cerebral infarction (161 persons); consuming substantial amounts of sodium (75.4%) in instant noodles and instant porridge (153 persons); and abstaining from salt intake (71.4%) hinders the body from obtaining sufficient sodium (145 persons).

The knowledge question group with the least correct answers was: some vegetables such as cucumbers, tomatoes, long beans, Chinese cabbage, and Chinese morning glory also contain sodium at 52.7% (107 persons), eating pork or beef causes the body to receive sodium at 51.7 % (105 persons), and milk is a food that does not contain sodium at 47.8% (97 persons), respectively, as detailed in Table 2.

The evaluation of sodium intake knowledge revealed that the participants in the sample group had knowledge scores categorized as moderate (49.3%), low (35.0%), and high (15.8%), as indicated in Table 3.

The examination of the conduct of individuals with hypertension who ingested sodium-rich food in the previous week revealed that shrimp paste (mean = 0.6) was the most often consumed food, followed by fish sauce and MSG (mean = 1.7). The behavior with the

Table 2. Percentage and interpretation of knowledge on sodium consumption of hypertensive patients classified by item (n = 203)

Item	Knowledge of sodium consumption	Correct answer (%)	Interpretation of knowledge.
1.	Fermented fish, shrimp paste, and fish sauce are sodium-rich items	83.3	High
2.	High sodium intake leads to hypertension	82.3	High
3.	Excessive sodium consumption leads to cerebral infarction	79.3	Moderate
4.	Instant noodles and instant porridge are sodium-rich dietary options	75.4	Moderate
5.	Insufficient sodium intake occurs when sodium is not consumed	71.4	Moderate
6.	Hypertensive patients should avoid processed meals such as Chinese sausage and pork buns due to their high salt content	67.0	Moderate
7.	Using soy sauce or seasoning sauce in cooking aids the body in obtaining sodium	66.5	Moderate
8.	Bananas, watermelon, and guava are fruits that have a low salt content	65.0	Moderate
9.	Monosodium glutamate (MSG) is sodium-free	61.6	Moderate
10.	Hypertensive patients should limit their daily sodium intake to 2 teaspoons, equivalent to 1 gram, or around 400 mg	61.6	Moderate
11.	Certain veggies, including cucumbers, tomatoes, green beans, Chinese cabbage, and Chinese morning glory, also possess sodium	52.7	Low
12.	Consuming pork or beef leads to the body's absorption of sodium	51.7	Low
13.	Milk is a sodium-free food	47.8	Low
14.	Sodium is exclusively present in foods that have a salty taste	41.9	Low
15.	Foods that include sodium only utilize salt throughout the cooking process	25.1	Low

Table 3. Number and percentage of knowledge level of sodium consumption in hypertensive patients (n = 203)

Knowledge Group	Number	%
Low	71	35.0
Moderate	100	49.3
High	32	15.7

lowest consumption rate was instant porridge, with a mean value of 3.6, as presented in Table 4.

Sodium content in the diets of hypertensive patients

The analysis of sodium content in each meal, daily sodium intake, and sodium in urine revealed that patients with knowledge about low hypertension consumed high-sodium breakfasts and lunches. The moderate knowledge group, on the other hand, consumed the most sodium-containing dinners. In addition, it was found that the low knowledge group had the highest sodium intake in food and urine among the three knowledge groups. All three groups exceeded the World Health Organization's recommended limit of 2,000 mg of sodium per day [24]. The moderate and low knowledge groups had higher levels of urinary sodium than the specified limit of 1,800 mg per day, except for the high knowledge group of hypertension. The body excretes sodium through urine in 24 hours, not exceeding 1,800 mg daily [24]. The statistical analysis showed a notable disparity in sodium intake between the groups with low knowledge and those with moderate and high knowledge. Additionally, there was a substantial contrast in the quantity of sodium in urine between the moderate and low knowledge groups and the high knowledge group, as shown in Table 5.

The hypertensive patients predominantly consumed foods with high sodium content, such as

Table 4. The averages and interpretations of sodium-related food consumption behavior in 1 week (n = 203)

Items	Consumption behavior related to foods containing sodium	Mean	Interpretation of consumptive behaviors
1.	Shrimp paste	0.6	High
2.	Fish sauce	1.7	Moderate
3.	Monosodium glutamate	1.7	Moderate
4.	Seasoning powder or soup cube	2.1	Moderate
5.	Light soy sauce	2.7	Low
6.	Salted fish	3.0	Low
7.	Canned fish	3.1	Low
8.	Pickled cabbage	3.3	Low
9.	Processed foods such as sausages	3.4	Low
10.	Salted egg	3.5	Low
11.	Pickled fish	3.5	Low
13.	Bean paste	3.5	Low
14.	Instant porridge	3.6	Low

Table 5. Mean of dietary sodium at each meal, total sodium, and urinary sodium by knowledge group of hypertensive patients (n = 27)

Knowledge levels	Meal	Average sodium content in each meal (mg)	Average sodium intake (mg)	Average urinary sodium (mg/day)
High	Breakfast	269.8	2084	1710
	Lunch	342.0		
	Dinner	291.7		
Moderate	Breakfast	361.0	2144	1961[b]*
	Lunch	395.0		
	Dinner	361.2		
Low	Breakfast	439.3	2474[a]*	2300[b]*
	Lunch	439.3		
	Dinner	358.2		

Note: For adults, WHO recommends less than 2000 mg/day of sodium (equivalent to less than 5 g/day salt (just under a teaspoon) [24]; [a]* – the average sodium intake (mg) of the low-knowledge group significantly differed from that of the moderate- and high-knowledge groups ($p < 0.05$); [b]* – the average urinary sodium (mg/day) of moderate- and high-knowledge groups significantly differed from that of the low-knowledge groups ($p < 0.05$).

Nile tilapia fish sour soup with taro stalk (707 mg), sour soup with mullet fish (511 mg), and stir-fried luffa with eggs (511 mg). On the other hand, foods with the least sodium content were chicken with roasted chili curry (197 mg), caramelize pork (sweet pork) (138 mg), and catfish curry recipe with coconut milk (Thai style) (98 mg). The World Health Organization's standards on acceptable salt levels in food revealed that 16 varieties of food, accounting for 69.6% of the total, included amounts of sodium that were deemed hazardous [24]. The sodium content in 100 mL of meals should not exceed 275 mg [25] as indicated in Table 6.

DISCUSSION

According to the study's findings, hypertension patients' knowledge about foods rich in sodium, including components containing sodium and spices containing sodium, was at a low level of 35.0% and a moderate level of 49.3% [26]. The study focused on the factors connected to dietary sodium linked to the risk of hypertension in rural northern Thailand (Rusmevichientong et al., 2021). Comparable research in other nations revealed a link between hypertension and knowledge, attitudes, and dietary salt intake [27-29]. After analyzing each item, we found that fish sauce, shrimp paste, and fermented fish include high sodium content (83.3%), and high sodium might cause hypertension (82.3%). However, it is at odds with the sample group's consumption patterns, which showed that they preferred to use the top three condiments – shrimp paste, fish sauce, and monosodium glutamate (Table 4). In Thailand and Southeast Asian countries like Malaysia and Indonesia (93.35%), shrimp paste is considered a common condiment [18]. The knowledge and behavior of the sample group should be coordinated with the study's findings. According to

Table 6. Typically consumed meals in southern Thailand by individuals with hypertension and associated sodium content

Items	Names of traditional foods	Sodium contents (mg per 100 mL)
1.	Nile tilapia fish sour soup with taro stalk	707*
2.	Sour soup with mullet fish	511*
3.	Stir-fried luffa with eggs	511*
4.	Pork curry with parkia speciosa	472*
5.	Chicken curry with yellow curry paste	472*
6.	Spicy curry bitter bean with pork	472*
7.	Pork curry with morning glory (Kaeng thepho)	472*
8.	Fish curry with pickled bamboo shoots	393*
9.	Stir-fried papaya with pork	358*
10.	Thai fish organs sour soup (Gaeng tai pla)	342*
11.	Tofu soup	322*
12.	Vegetable soup (Kaeng lieng)	314*
13.	Fried fish	314*
14	Paco fern salad	287*
15.	Stir-fried vegetables	283*
16.	Herbed soya beans dipping (Tao jiaw lon)	279*
17.	Fish boil	259
18.	Pork boil	248
19.	Coconut cream soup with galangal and pork	248
20.	Mackerel in dried red curry	208
21.	Chicken with roasted chili curry	197
22.	Caramelize pork (Sweet pork)	138
23.	Catfish curry recipe with coconut milk (Thai style)	98

* Denotes food with a sodium content above 275 mg/100 mL.

the social cognitive theory (SCT), to carry out a certain activity, an individual must be proficient in both knowledge and skills [30]. Most campaigns focus on increasing information, which may or may not transfer into action. It occurs because practical applications sometimes overemphasize the transmission of knowledge and downplay the significance of belief. The fact that existing measures to reduce sodium intake have not increased people's interest in or attitudes about engaging in sodium reduction is one of the barriers preventing progress in sodium reduction among the general population [31]. As a result, the WHO advises limiting sodium consumption, which involves evaluating the amount of sodium in food and its sources. Improving sodium-related knowledge, attitudes, and behaviors should be the initial step in this strategy WHO Guideline [32]. Understanding how attitudes and knowledge affect an individual's sodium consumption behavior is valuable [33]. Related to the findings of Jung et al. study (2012) [34], which showed that nutrition education was the only time when there was a positive shift ($p < 0.001$) in the overall nutrition knowledge score connected to sodium consumption and hypertension and the dietary behavior score associated with excessive salt intakes. The instruction program on reducing sodium consumption and the subsequent study demonstrated favorable outcomes for hypertensive individuals' blood pressure, sodium intake, nutrition knowledge, and dietary behavior. Positive consumer attitudes, behaviors, and knowledge are associated with better health outcomes. Aligned with the findings of Claro et al. (2012) [33], who indicated that the sample group's awareness of salt intake constitutes the primary risk factor and necessitates vigilant oversight as a personal competency. Excessive sodium consumption positively correlates with blood pressure, particularly higher systolic blood pressure if daily salt or sodium intake is uncontrolled (James et al., 2014) [35], and queued up with study findings, which showed that urinary sodium was significantly higher in the low and moderate knowledge groups than in the high knowledge group ($p < 0.05$) and that the low sodium knowledge group had a significantly higher mean daily sodium intake than the moderate and high knowledge groups. Because it affects consumption, raising awareness of the effects of food-related sodium on attitudes, behaviors, and knowledge is crucial, particularly for patients with hypertension. The sample's knowledge and awareness rose after participating in an educational program focused on reducing salt or sodium intake. Ultimately resulted in a decrease in behaviors associated with reduced salt intake, including the avoidance of pickles, the utilization of less salt in culinary practices, and restricting snacks to under 3 mg per day. According to Johnson et al. (2017) [36], there was no statistically significant difference in the mean salt consumption between those with greater education (9.21 ± 8.55-9.87 g/day) and those with lesser education (9.34 ± 8.57-10.12 g/day) ($p = 0.82$). Therefore, alternative channels must be employed to inform people about sodium's negative health impacts. The involvement of community volunteers was crucial in lowering salt intake, according to the Aziz et al. (2003) [37] study. They demonstrated a statistically significant decrease in the behaviors of individuals who ingested fat and salt by 48% and 41%, respectively, and provided family education following home visits. According to Claro et al. (2012) [33], over 80% of the sample group requested that food labels include explicit warnings and a high, medium, and low salt content on the packaging of high-salt goods. Furthermore, using a salt meter to measure the sodium content of food consumed by patients with high blood pressure is an activity that combines behavior and knowledge in providing patients with evidence-based information. The population of hypertensive patients is also elderly. Spicier food may be necessary due to the deterioration of the salty taste receptors. An alternative to enhance food flavor is to practice good personal hygiene, such as brushing and tongue exercises to stimulate the taste buds. By stimulating the salivary glands and quickening the turnover of taste bud cells, these techniques improve tongue taste perception for meals. This is compatible with the findings of Trachootham et al. (2018) [38], who examined the taste buds of Thai and Japanese individuals and discovered that Thais perceive salty flavors less strongly than Japanese do. Thais thus frequently use strong spices to season their food, which causes them to consume more salt than is healthy and eventually results in hypertension.

Furthermore, residents of the coastal southern area are well-known for their love of spicy, salty, and sour cuisine. Thus, fisheries products are transformed into spices for regular meals, such as fish sauce and shrimp paste. Similar to the study's results, which state that the top three regional dishes that those with high blood pressure enjoy are stir-fried lentils with eggs, mullet fish soup, and Nile tilapia fish soup with taro stalks. Table 6 shows that these three items have the highest salt content (707, 511, and 511 mg/100 mL, respectively). The use of food and flavors like salt, fish sauce, and shrimp paste defines a particular food culture. Food cravings result from ingrained attitudes and values transmitted from one generation to the next. Consequently, each region's social culture has an impact on the cuisine that people consume. As a result, it is challenging to encourage individuals to reduce their sodium intake since determining the appropriate amount of salt to use when cooking calls for expertise and experience. However, the following

associated issues should be the attention of relevant organizations to limit salt intake in the community:

1. To increase awareness, food labels should include details on the health impacts, optimum consumption quantities, and salt content.
2. Creating a support network and promoting community involvement in creating policies or community charters about using sodium in the community.
3. Public health organizations can set up self-efficacy awareness improvement programs as part of their health services to encourage at-risk groups to improve their self-efficacy in preventing disease.

Limitation of the study

The study revealed that the majority of the sample groups were over 60 years of age and had completed primary education, which influenced their comprehension of the questionnaire content, encompassing both positive and negative inquiries. It necessitated the involvement of additional assistants to elucidate the content, resulting in potential bias and leading responses in the questionnaire. Furthermore, the researchers failed to quantify the food intake during each meal by the sample groups, potentially influencing salt consumption. Furthermore, statistical analysis examining the correlation between variables, including body weight relative to sodium consumption per meal and body weight relative to urinary sodium, should be employed in this research.

CONCLUSIONS

The study found that the sample group still lacked knowledge about the amount of sodium in natural foods, especially in plant foods, vegetables, milk, and meat, as well as the preference for consuming processed foods, canned foods, adding seasonings, and ready-to-eat foods available in the market. In addition, the popularity of consuming spicy foods, such as high-fat, salty, and spicy foods in South Thailand, has affected sodium intake. It aligns with the research findings, which demonstrated that groups with low and moderate levels of knowledge about sodium and their consumption of sodium-containing foods differed significantly from those with high levels of knowledge, and this difference impacted the amount of sodium present in their urine. It was found that the group with high and moderate levels of knowledge about sodium had a statistically significant amount of sodium in urine compared to the group with low knowledge. So, it's essential for agencies to quickly start a campaign to educate people about sodium in natural foods, especially in plants, vegetables, milk, and meat, to help lower sodium intake from different seasonings, including creating labels for foods and seasonings that have high sodium levels. We urgently need to implement and publicize the study through various media channels.

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Conflicts of interest

The authors declare no conflict of interest. The funders had no role in the design of the study, in the collection, analysis, or interpretation of data, in the writing of the manuscript, or in the decision to publish the results.

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ORIGINAL ARTICLE

HOW DO ADOLESCENTS PERCEIVE THEIR WEIGHT? THE IMPACT OF VARIOUS PSYCHOSOCIAL FACTORS ON BODY WEIGHT ESTIMATION – A PILOT STUDY

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ABSTRACT

Background. Body image perception among adolescents is crucial for their mental health and is influenced by a variety of factors. Incorrect body weight estimation is common among this population and is usually overestimated by females and underestimated by males.

Objective. This study aimed to evaluate body weight perception and related factors among adolescents aged 11 and 14.

Material and Methods. This pilot study was based on data collected from the Polish health program "A program for the early detection of risk factors for lifestyle diseases SOPKARD-Junior" from the years 2015, 2017, 2019, 2021, and 2022. According to the BMI and weight perception, a total of 315 adolescents aged 11 and 14 were divided into three groups: "underestimating their weight", "properly estimating their weight", and "overestimating their weight". These data were then compared to different psychosocial variables, such as parental education, life satisfaction, parental weight assessment, dieting, Family Affluence Scale (FAS), and subjective health.

Results. Males underestimated their weight more often than females, while females overestimated their weight more frequently than males (all $p < 0.001$). These results were most prevalent for 14-year-olds. Dieting was observed in both age and sex groups, even despite being of normal weight. Moreover, dieting, parental weight assessment, and parental education were statistically significant factors related to children's weight estimation.

Discussion. Body weight misperception is prevalent among Polish teenagers aged 11 and 14. Factors, such as parental weight assessment or parental education, influence teenagers' weight perception and should be investigated further.

Conclusions. Incorrect weight perception is common among adolescents. Teachers, parents, and medical professionals, such as doctors or nurses, should be aware of this problem and provide proper education and support.

Keywords: *adolescents, dieting, psychosocial factors, body, weight perception, parents*

INTRODUCTION

It is well known that adolescence is a critical period for personal development and brain maturity [1]. That period of life between childhood and adulthood has been broadly discussed over the years, and the age range of this life phase has been changing. It has been observed that puberty nowadays starts earlier than years ago, which is associated with better overall child health [2].

Adolescence is crucial for developing body image and weight perception, both of which have an impact on mental health [3-5]. The concept of body image refers to the perception of the body in terms of seeing, feeling, and thinking about it [4]. The development of body image perception is related to everyday challenges and coping mechanisms [6]. Incorrect body image, particularly throughout adolescence, is important in terms of the development of eating disorders or obesity [4]. The many factors impacting body image perception include social, physical, cultural, and psychological. Relationships and support from parents and peers also deserve special attention in this regard [4]. Furthermore, widespread and problematic use of social media may affect it [6, 7].

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Body image dissatisfaction is, in general, related to a negative assessment of one's appearance [8]. According to previous studies, body image dissatisfaction is more prevalent in young females, is associated with a higher risk of emotional and behavioral problems, and causes weight loss behaviors more often than in young males [9-12]. Moreover, a significant percentage of girls present extreme weight behavior at least once a week or more [12].

Body weight perception refers to the personal assessment of the body weight, regardless of the actual value [10]. Usually, body weight perception is not correctly associated with the actual weight status of teenagers [10], with overestimation being more common in girls and underestimation being more prevalent in boys [11, 13, 14]. Moreover, misperception of body weight is less likely in males in general [14, 15]. Adolescents who overestimate their weight report higher body dissatisfaction, disordered eating, lower happiness levels, depressive symptoms, suicidal ideation, and suicide planning [5, 13, 14]. Weight overestimation and underestimation are also associated with cigarette smoking, alcohol consumption, and binge drinking among teenagers [14, 16].

This study aimed to evaluate body weight perception and related factors among adolescents aged 11 and 14.

MATERIAL AND METHODS

This retrospective analysis used data from a health program, "A program for the early detection of risk factors for lifestyle diseases SOPKARD-Junior" (SOPKARD-Junior), aimed at children and adolescents attending elementary schools in Sopot, Northern Poland. SOPKARD-Junior is a program held regularly every one or two years by the medical professionals and students. It includes anthropometric measurements, electrocardiogram (ECG), medical examinations, and health questionnaires completed by children and their parents or legal guardians. All participants had to obtain written consent from their parents or legal guardians. The study was approved by the local ethical committee (UCC107/2021). It was conducted according to the guidelines of the Declaration of Helsinki and approved by the Institutional Ethics Committee.

This was a pilot study. The representative sample included students aged 11 (n = 149) and 14 (n = 166) from grades six and eight, respectively. For a wider research sample, data were collected from 2015, 2017, 2019, 2021, and 2022 for 315 students, including 139 females and 176 males. Statistical analysis employed R version 3.6.3 R (R Core Team, version 3.6.3), with *Chi*-squared tests used to evaluate differences between categorical variables.

Body mass index

Qualified medical professionals estimated body mass index (BMI; weight [kg]/height [m^2]) using a verified WPT 100/200 scale (Radwag, Radom, Poland), with 100 g accuracy, and a Leicester Height Measure (1 mm accuracy), used in a standing position without shoes. According to World Health Organization (WHO) recommendations and its cut-off z-scores for age and gender, BMI was classified as underweight (thinness), normal weight, overweight, or obese [17].

Health Behavior in School-Aged Children Questionnaire

Data was obtained from the Polish version of the HBSC (Health Behavior in School-Aged Children) questionnaire completed by the child or their parents or legal guardians. The HBSC is a cross-national study supported by the WHO to investigate and track teenage health behaviors and their determinants. Data from the HBSC are used in an International Report every four years [18, 19]. Specific questions from the HBSC related to body weight and mental health were selected for this study, including demographic data of children and their parents (legal guardians), weight estimation, diet, and other aspects of children's mental and physical health.

The study questions asked if the adolescents used any diet ("yes" or "no") and how students rated their weight (weight perception defined as individual's assessment of weight, regardless of actual body mass), with responses ranging from "perceived underweight," "perceived normal weight," to "perceived overweight." The next question concerned life satisfaction and used Cantril's Ladder, an instrument with a rating scale from 0 (the worst possible life) to 10 (the best possible life). The responses were classified as low life satisfaction (0-5), average life satisfaction (6-8), or high life satisfaction (9-10) [20]. Children also subjectively rated their health as "excellent", "good" or "poor" which is a validated measure of physical health in adults and adolescents [21].

The FAS (Family Affluence Scale) section of the HBSC questionnaire evaluated the children's family wealth. Since 2013/2014, FAS III has been widely utilized. According to the answers to specific questions, FAS indicates "lower family affluence" (0-6 points), "medium family affluence" (7-9 points), and "higher family affluence" (10-13 points) [20, 22].

Assessment of the education level of mothers and fathers (or legal guardians) was divided into "lower than high school", "high school" and "university level". Furthermore, parents were asked to rate their child's weight as "underweight", "normal weight" or "overweight".

Weight perception

Subjects were classified as "underweight", "normal weight" or "OWOB" (overweight or obese) based on their BMI and further categorized according to their weight perception as "perceived underweight", "perceived normal weight" or "perceived overweight". The children were then stratified based on sex, age, and the estimation of their weight into "underestimating their weight" (OWOB and perceived normal weight or underweight; normal weight and perceived underweight), "properly estimating their weight" (normal weight and perceived normal weight; OWOB and perceived overweight; underweight and perceived underweight), and "overestimating their weight" (underweight and perceived overweight or normal weight; normal weight and perceived overweight). Weight estimation groups were then compared to parental education, children's life satisfaction, parental assessments of their child's weight, the use of any diet, FAS, and subjective health.

RESULTS

According to the BMI findings, 65.7% of respondents were of normal weight, 26.9% were OWOB, and 7.3% were underweight. Furthermore, males were more likely to be OWOB (29.6% vs. 23.7%) or underweight (8% vs. 6.5%) than females, though none of the data was statistically significant. Medium family affluence was recorded for 47.9% of

Table 1. The total characteristics of the group

Characteristics	Girls	Boys	Total	p-value
BMI				0.220
Number of subjects	139	176	315	
Underweight	9 (6.5%)	14 (8.0%)	23 (7.3%)	
Normal weight	97 (69.8%)	110 (62.5%)	207 (65.7%)	
Overweight	18 (12.9%)	19 (10.8%)	37 (11.7%)	
Obese	15 (10.8%)	33 (18.8%)	48 (15.2%)	
FAS				0.941
Number of subjects	129	169	298	
Lower family affluence	41 (31.8%)	54 (32.0%)	95 (31.9%)	
Medium family affluence	60 (46.5%)	81 (47.9%)	141 (47.3%)	
Higher family affluence	28 (21.7%)	34 (20.1%)	62 (20.8%)	
Life's satisfaction				0.035*
Number of subjects	126	169	295	
Low	40 (31.7%)	34 (20.1%)	74 (25.1%)	
Average	47 (37.3%)	62 (36.7%)	109 (36.9%)	
High	39 (31.0%)	73 (43.2%)	112 (38.0%)	
Subjective health				0.023*
Number of subjects	129	170	299	
Poor	22 (17.1%)	17 (10.0%)	39 (13.0%)	
Good	72 (55.8%)	83 (48.8%)	155 (51.8%)	
Excellent	35 (27.1%)	70 (41.2%)	105 (35.1%)	
Mother education level				0.930
Number of subjects	123	152	275	
Lower than high school	11 (8.9%)	12 (7.9%)	23 (8.4%)	
High school	40 (32.5%)	52 (34.2%)	92 (33.5%)	
University level	72 (58.5%)	88 (57.9%)	160 (58.2%)	
Father education level				0.855
Number of subjects	114	142	256	
Lower than high school	24 (21.1%)	28 (19.7%)	52 (20.3%)	
High school	38 (33.3%)	44 (31.0%)	82 (32.0%)	
University level	52 (45.6%)	70 (49.3%)	122 (47.7%)	

FAS – Family Affluence Scale; * statistically significant ($p < 0.05$) values

boys and 46.5% of girls, while life satisfaction was high for boys (43.2%) and average for girls (37.3%) (p = 0.035). Subjective health was rated as good in 55.8% of girls and 48.8% of boys (p = 0.023). Most of the parents (legal guardians) had a university-level education in both sex groups. Table 1 presents group characteristics, with characteristics by age available in the supplementary materials.

Overall, 25% of boys underestimated their weight, 60.7% properly estimated their weight, and 14.3% overestimated it. In the group of girls, 12.7% underestimated their weight, 61.1% estimated their weight accurately, and 26.2 % overestimated it.

In the 11-year-old male group (n = 79), 21.5% (n = 17) underestimated, 65.8% (n = 52) properly estimated, and 12.6% (n = 10) overestimated their weight. In the group of 14-year-old males (n = 89), 28% (n = 25) underestimated, 56.2% (n = 50) correctly estimated, and 15.7% (n = 14) overestimated their weight.

In the 11-year-old female sample (n = 61), 16.3% underestimated their weight, 70.5% properly estimated their weight, and 13.1% overestimated their weight. Meanwhile, the 14-year-old female (n = 65) weight data showed that 9.2% (n = 6) underestimated, 52.3% (n = 34) accurately estimated, and 38.5% (n = 25) overestimated their weight. Tables 2 and 3 describe the exact data on weight perception, and Tables 4 and 5 present diet usage findings.

Table 6 provides weight estimation in relation to different psychosocial factors in the males aged 11 and 14. In both age groups, most parents/legal guardians had a university-level education. Among the 11-year-old boys, most respondents in all weight estimation groups had high life satisfaction, while most 14-year-olds had average life satisfaction. In the group of 11-year-olds, most parents assessed their child's weight as normal, which was also observed in the group of 14-year-olds. Diet was used by 23.1% of 11-year-olds

Table 2. Boys' weight perception according to the BMI

Age	Perceived underweight (N = 38)	Perceived normal weight (N = 80)	Perceived overweight (N = 54)	Total (N = 172)	p-value
11 years					< 0.001*
Number of subjects	17	38	24	79	
Underweight	5 (29.4%)	3 (7.9%)	0 (0.0%)	8 (10.1%)	
Normal weight	11 (64.7%)	30 (78.9%)	7 (29.2%)	48 (60.8%)	
OWOB	1 (5.9%)	5 (13.2%)	17 (70.8%)	23 (29.1%)	
14 years					< 0.001*
Number of subjects	20	40	29	89	
Underweight	3 (15.0%)	3 (7.5%)	0 (0.0%)	6 (6.7%)	
Normal weight	17 (85.0%)	29 (72.5%)	11 (37.9%)	57 (64.0%)	
OWOB	0 (0.0%)	8 (20.0%)	18 (62.1%)	26 (29.2%)	

OWOB – overweight or obese; * statistically significant (p < 0.05) values

Table 3. Girls' weight perception according to the BMI

Age	Perceived underweight (N = 15)	Perceived normal weight (N = 59)	Perceived overweight (N = 56)	Total (N = 130)	p-value
11 years					< 0.001*
Number of subjects	10	32	19	61	
Underweight	3 (30.0%)	1 (3.1%)	0 (0.0%)	4 (6.6%)	
Normal weight	7 (70.0%)	28 (87.5%)	7 (36.8%)	42 (68.9%)	
OWOB	0 (0.0%)	3 (9.4%)	12 (63.2%)	15 (24.6%)	
14 years					< 0.001*
Number of subjects	5	25	35	65	
Underweight	4 (80.0%)	0 (0.0%)	0 (0.0%)	4 (6.2%)	
Normal weight	1 (20.0%)	20 (80.0%)	25 (71.4%)	46 (70.8%)	
OWOB	0 (0.0%)	5 (20.0%)	10 (28.6%)	15 (23.1%)	

OWOB – overweight or obese; * statistically significant (p < 0.05) values

Table 4. Diet usage among boys according to the BMI

Age	Not using a diet (N = 142)	Using a diet (N = 31)	Total (N = 173)	p-value
11 years				0.002*
Number of subjects	64	15	79	
Underweight	8 (12.5%)	0 (0.0%)	8 (10.1%)	
Normal weight	43 (67.2%)	5 (33.3%)	48 (60.8%)	
OWOB	13 (20.3%)	10 (66.7%)	23 (29.1%)	
14 years				0.083
Number of subjects	75	15	90	
Underweight	6 (8.0%)	0 (0.0%)	6 (6.7%)	
Normal weight	51 (68.0%)	7 (46.7%)	58 (64.4%)	
OWOB	18 (24.0%)	8 (53.3%)	26 (28.9%)	

OWOB – overweight or obese; * statistically significant ($p < 0.05$) values

Table 5. Diet usage among girls according to the BMI

Age	Not using a diet (N = 106)	Using a diet (N = 23)	Total (N = 129)	p-value
11 years				0.025*
Number of subjects	51	10	61	
Underweight	4 (7.8%)	0 (0.0%)	4 (6.6%)	
Normal weight	38 (74.5%)	4 (40.0%)	42 (68.9%)	
OWOB	9 (17.6%)	6 (60.0%)	15 (24.6%)	
14 years				0.188
Number of subjects	54	11	65	
Underweight	4 (7.4%)	0 (0.0%)	4 (6.2%)	
Normal weight	40 (74.1%)	6 (54.5%)	46 (70.8%)	
OWOB	10 (18.5%)	5 (45.5%)	15 (23.1%)	

OWOB – overweight or obese; * statistically significant ($p < 0.05$) values

who properly estimated their weight and 30% of those who overestimated their weight ($p = 0.036$). Meanwhile, around 8% of 14-year-olds underestimating their weight used a specific diet, 14% of properly estimating weight used any diet, and 42.9 % of those overestimating their weight used a diet ($p = 0.021$).

Table 7 presents data on 11 and 14-year-old females and shows that most parents or legal guardians of 11-year-olds had a university-level education. For the 14-year-old girls who underestimated their weight, most mothers/legal guardians had a high school education (66.7%), while a university-level education was most prevalent in those accurately estimating and overestimating their weight (63.3% and 78.9%, respectively) ($p = 0.018$). A similar situation was observed for fathers' education, with a high school education most common for those underestimating their weight (80%) and a university-level education frequently found for those accurately estimating and overestimating weight (46.4% and 72.2%, respectively) ($p = 0.031$). Life satisfaction was generally high among the 11-year-old girls and mostly low for the 14-year-olds.

Most parents/legal guardians assessed their child's weight as normal in both age groups across all weight estimation groups, which was statistically significant for the 11-year-old female group ($p = 0.039$).

For 11-year-old girls, any diet was used by 18.6% of those properly estimating their weight and 25% overestimating their weight. In the 14-year-old group, 16.7% who underestimated, 11.8% who accurately estimated, and 24% who overestimated their weight were using any diet. FAS and subjective health were not statistically significant in either gender or age group.

DISCUSSION

The study evaluated the perception of body weight by adolescents aged 11 and 14 and compared it with various psychosocial factors.

Table 6. Boys' weight estimation in relation to different psychosocial factors

Age	Psychosocial factors	Underestimating (N = 42)	Properly estimating (N = 102)	Overestimating (N = 24)	Total (N = 168)	p-value
11 years	Mother education level					0.584
	Number of subjects	15	45	9	69	
	Lower than high school	2 (13.3%)	2 (4.4%)	1 (11.1%)	5 (7.2%)	
	High school	3 (20.0%)	13 (28.9%)	3 (33.3%)	19 (27.5%)	
	University level	10 (66.7%)	30 (66.7%)	5 (55.6%)	45 (65.2%)	
	Father education level					0.232
	Number of subjects	14	43	6	63	
	Lower than high school	5 (35.7%)	5 (11.6%)	2 (33.3%)	12 (19.0%)	
	High school	3 (21.4%)	13 (30.2%)	2 (33.3%)	18 (28.6%)	
	University level	6 (42.9%)	25 (58.1%)	2 (33.3%)	33 (52.4%)	
	Life's satisfaction					0.792
	Number of subjects	17	50	10	77	
	Low	1 (5.9%)	4 (8.0%)	1 (10.0%)	6 (7.8%)	
	Average	4 (23.5%)	19 (38.0%)	3 (30.0%)	26 (33.8%)	
	High	12 (70.6%)	27 (54.0%)	6 (60.0%)	45 (58.4%)	
	Parental weight assessment					0.066
	Number of subjects	17	42	9	68	
	Underweight	6 (35.3%)	3 (7.1%)	2 (22.2%)	11 (16.2%)	
	Normal weight	7 (41.2%)	30 (71.4%)	6 (66.7%)	43 (63.2%)	
	Overweight	4 (23.5%)	9 (21.4%)	1 (11.1%)	14 (20.6%)	
	Diet usage					0.036*
	Number of subjects	17	52	10	79	
	No	17 (100.0%)	40 (76.9%)	7 (70.0%)	64 (81.0%)	
	Yes	0 (0.0%)	12 (23.1%)	3 (30.0%)	15 (19.0%)	
	FAS					0.680
	Number of subjects	16	51	9	76	
	Lower family affluence	6 (37.5%)	14 (27.5%)	2 (22.2%)	22 (28.9%)	
	Medium family affluence	5 (31.2%)	26 (51.0%)	5 (55.6%)	36 (47.4%)	
	Higher family affluence	5 (31.2%)	11 (21.6%)	2 (22.2%)	18 (23.7%)	
	Subjective health					0.156
	Number of subjects	17	51	10	78	
	Poor	0 (0.0%)	3 (5.9%)	1 (10.0%)	4 (5.1%)	
	Good	11 (64.7%)	20 (39.2%)	2 (20.0%)	33 (42.3%)	
	Excellent	6 (35.3%)	28 (54.9%)	7 (70.0%)	41 (52.6%)	

Age	Psychosocial factors	Underestimating (N = 42)	Properly estimating (N = 102)	Overestimating (N = 24)	Total (N = 168)	p-value
14 years	Mother education level					0.716
	Number of subjects	22	37	12	71	
	Lower than high school	3 (13.6%)	2 (5.4%)	2 (16.7%)	7 (9.9%)	
	High school	9 (40.9%)	16 (43.2%)	5 (41.7%)	30 (42.3%)	
	University level	10 (45.5%)	19 (51.4%)	5 (41.7%)	34 (47.9%)	
	Father education level					0.677
	Number of subjects	22	35	10	67	
	Lower than high school	6 (27.3%)	5 (14.3%)	2 (20.0%)	13 (19.4%)	
	High school	6 (27.3%)	15 (42.9%)	3 (30.0%)	24 (35.8%)	
	University level	10 (45.5%)	15 (42.9%)	5 (50.0%)	30 (44.8%)	
	Life's satisfaction					0.124
	Number of subjects	25	49	14	88	
	Low	7 (28.0%)	14 (28.6%)	7 (50.0%)	28 (31.8%)	
	Average	7 (28.0%)	24 (49.0%)	3 (21.4%)	34 (38.6%)	
	High	11 (44.0%)	11 (22.4%)	4 (28.6%)	26 (29.5%)	
	Parental weight assessment					0.381
	Number of subjects	19	38	12	69	
	Underweight	7 (36.8%)	5 (13.2%)	2 (16.7%)	14 (20.3%)	
	Normal weight	9 (47.4%)	25 (65.8%)	8 (66.7%)	42 (60.9%)	
	Overweight	3 (15.8%)	8 (21.1%)	2 (16.7%)	13 (18.8%)	
	Diet usage					0.021*
	Number of subjects	25	50	14	89	
	No	23 (92.0%)	43 (86.0%)	8 (57.1%)	74 (83.1%)	
	Yes	2 (8.0%)	7 (14.0%)	6 (42.9%)	15 (16.9%)	
	FAS					0.883
	Number of subjects	24	50	14	88	
	Lower family affluence	9 (37.5%)	17 (34.0%)	3 (21.4%)	29 (33.0%)	
	Medium family affluence	11 (45.8%)	25 (50.0%)	8 (57.1%)	44 (50.0%)	
	Higher family affluence	4 (16.7%)	8 (16.0%)	3 (21.4%)	15 (17.0%)	
	Subjective health					0.006*
	Number of subjects	24	50	13	87	
	Poor	1 (4.2%)	6 (12.0%)	5 (38.5%)	12 (13.8%)	
	Good	10 (41.7%)	33 (66.0%)	5 (38.5%)	48 (55.2%)	
	Excellent	13 (54.2%)	11 (22.0%)	3 (23.1%)	27 (31.0%)	

FAS – Family Affluence Scale; * statistically significant ($p < 0.05$) values

Table 7. Girls' weight estimation in relation to different psychosocial factors

Age	Psychosocial factors	Underestimating (N = 16)	Properly estimating (N = 77)	Overestimating (N = 33)	Total (N = 126)	p- value
11 years	Mother education level					0.578
	Number of subjects	10	39	6	55	
	Lower than high school	0 (0.0%)	6 (15.4%)	0 (0.0%)	6 (10.9%)	
	High school	5 (50.0%)	11 (28.2%)	2 (33.3%)	18 (32.7%)	
	University level	5 (50.0%)	22 (56.4%)	4 (66.7%)	31 (56.4%)	
	Father education level					0.553
	Number of subjects	9	36	6	51	
	Lower than high school	2 (22.2%)	8 (22.2%)	3 (50.0%)	13 (25.5%)	
	High school	2 (22.2%)	14 (38.9%)	1 (16.7%)	17 (33.3%)	
	University level	5 (55.6%)	14 (38.9%)	2 (33.3%)	21 (41.2%)	
	Life's satisfaction					0.449
	Number of subjects	9	41	7	57	
	Low	2 (22.2%)	5 (12.2%)	2 (28.6%)	9 (15.8%)	
	Average	4 (44.4%)	18 (43.9%)	1 (14.3%)	23 (40.4%)	
	High	3 (33.3%)	18 (43.9%)	4 (57.1%)	25 (43.9%)	
	Parental weight assessment					0.039*
	Number of subjects	10	41	7	58	
	Underweight	3 (30.0%)	4 (9.8%)	0 (0.0%)	7 (12.1%)	
	Normal weight	7 (70.0%)	25 (61.0%)	7 (100.0%)	39 (67.2%)	
	Overweight	0 (0.0%)	12 (29.3%)	0 (0.0%)	12 (20.7%)	
	Diet usage					0.308
	Number of subjects	10	43	8	61	
	No	10 (100.0%)	35 (81.4%)	6 (75.0%)	51 (83.6%)	
	Yes	0 (0.0%)	8 (18.6%)	2 (25.0%)	10 (16.4%)	
	FAS					0.653
	Number of subjects	9	43	8	60	
	Lower family affluence	3 (33.3%)	16 (37.2%)	1 (12.5%)	20 (33.3%)	
	Medium family affluence	4 (44.4%)	15 (34.9%)	5 (62.5%)	24 (40.0%)	
	Higher family affluence	2 (22.2%)	12 (27.9%)	2 (25.0%)	16 (26.7%)	
	Subjective health					0.627
	Number of subjects	9	43	8	60	
	Poor	1 (11.1%)	3 (7.0%)	0 (0.0%)	4 (6.7%)	
	Good	5 (55.6%)	24 (55.8%)	3 (37.5%)	32 (53.3%)	
	Excellent	3 (33.3%)	16 (37.2%)	5 (62.5%)	24 (40.0%)	

Age	Psychosocial factors	Underestimating (N = 16)	Properly estimating (N = 77)	Overestimating (N = 33)	Total (N = 126)	p- value
14 years	Mother education level					0.018*
	Number of subjects	6	30	19	55	
	Lower than high school	1 (16.7%)	1 (3.3%)	2 (10.5%)	4 (7.3%)	
	High school	4 (66.7%)	10 (33.3%)	2 (10.5%)	16 (29.1%)	
	University level	1 (16.7%)	19 (63.3%)	15 (78.9%)	35 (63.6%)	
	Father education level					0.031*
	Number of subjects	5	28	18	51	
	Lower than high school	1 (20.0%)	4 (14.3%)	2 (11.1%)	7 (13.7%)	
	High school	4 (80.0%)	11 (39.3%)	3 (16.7%)	18 (35.3%)	
	University level	0 (0.0%)	13 (46.4%)	13 (72.2%)	26 (51.0%)	
	Life's satisfaction					0.173
	Number of subjects	6	34	25	65	
	Low	1 (16.7%)	13 (38.2%)	15 (60.0%)	29 (44.6%)	
	Average	2 (33.3%)	13 (38.2%)	7 (28.0%)	22 (33.8%)	
	High	3 (50.0%)	8 (23.5%)	3 (12.0%)	14 (21.5%)	
	Parental weight assessment					0.076
	Number of subjects	4	26	20	50	
	Underweight	1 (25.0%)	6 (23.1%)	1 (5.0%)	8 (16.0%)	
	Normal weight	3 (75.0%)	16 (61.5%)	19 (95.0%)	38 (76.0%)	
	Overweight	0 (0.0%)	4 (15.4%)	0 (0.0%)	4 (8.0%)	
	Diet usage					0.489
	Number of subjects	6	34	25	65	
	No	5 (83.3%)	30 (88.2%)	19 (76.0%)	54 (83.1%)	
	Yes	1 (16.7%)	4 (11.8%)	6 (24.0%)	11 (16.9%)	
	FAS					0.154
	Number of subjects	6	34	25	65	
	Lower family affluence	3 (50.0%)	9 (26.5%)	7 (28.0%)	19 (29.2%)	
	Medium family affluence	1 (16.7%)	17 (50.0%)	16 (64.0%)	34 (52.3%)	
	Higher family affluence	2 (33.3%)	8 (23.5%)	2 (8.0%)	12 (18.5%)	
	Subjective health					0.504
	Number of subjects	6	34	25	65	
	Poor	2 (33.3%)	7 (20.6%)	8 (32.0%)	17 (26.2%)	
	Good	2 (33.3%)	21 (61.8%)	14 (56.0%)	37 (56.9%)	

FAS – Family Affluence Scale; * statistically significant ($p < 0.05$) values

Compared to previous similar studies, the number of OWOB kids in the current study was higher, while the number of underweight students was lower [10, 23]. According to the World Health Organization, the number of overweight children and adolescents has increased more than twice in the last 30 years [24]. Previous studies have indicated that even up to 80% of obese adolescents will remain obese in adulthood, experiencing many comorbidities of this disease. Moreover, being obese during adolescence has a negative impact on mental health, such as altered self-image or difficulties with social functioning [25]. Even though the global problem of being underweight is decreasing, obesity is becoming more frequent in many countries than it was in the late 90s [26].

We have found that 14-year-old males underestimated their weight over three times more often than girls of the same age. Overall, girls (11 and 14-year-olds) overestimated their body weight nearly twice as much as boys of the same age, with girls aged 14 overestimating their weight by over 20% more than 14-year-old boys. According to a Polish study on adolescents aged 15 and 17, 43.9% of girls and 17.1% of boys overestimated their weight, while 9% of girls and 37.2% of boys underestimated it [6]. These findings are comparable to our study, with the noticeable propensity for females to overestimate their weight and males to underestimate it. Similar results were found in an Israeli study in which boys underestimated their body weight more frequently than girls (25.6% vs. 15.1%), and girls overestimated their weight more often than boys (27.7% vs. 15.2%) [23].

In the previously mentioned Polish study, 48.6% of all teenagers properly estimated their weight, while 61.1% of girls and 60.7% of boys did so in the current study. Furthermore, underestimating body weight was three times higher in boys than in girls, which is consistent with our findings [6].

Underestimation was particularly prevalent in the boys with normal weight and perceived underweight. In the female group, those with normal weight and perceived overweight overestimated their weight most often. According to a previous study, 48% of girls with normal weight and 50% of those underweight overestimated their body weight, which was not observed in the present study [6]. Indeed, only 3.1% of 11-year-old underweight girls and none of the 14-year-old underweight girls overestimated their weight.

We investigated the use of any diet in both age and sex groups and discovered that over one-third of boys and two-fifths of girls aged 11 who were dieting were of normal weight. This trend has also been reported in previous research, in which more than one-third of adolescent girls used a diet, despite being of normal weight [27]. Some studies have shown that dieting frequency increases with age; however, our study found statistical significance in the younger group of girls [28].

Another relevant investigation considered diet use based on weight perception and found dieting in 30% of 11-year-old and 42.9% of 14-year-old boys overestimating their weight. As previously mentioned, studies have shown that dieting is usually more common in girls and older children, especially among those who are not overweight [11, 29, 30], which may be related to the fact that adolescent girls are more dissatisfied with their bodies than boys, and is positively related to BMI [12]. Furthermore, other characteristics associated with dieting among teenagers have been investigated, including body image dissatisfaction, depression or anxiety, experiencing chronic illness, and family and environmental factors [28]. According to our findings, male adolescents and their attitudes regarding weight perception and diet should also be taken into consideration, and future research should be expanded to include this population of young boys.

In general, adolescent girls believe that being thinner would positively impact their lives, while boys see this as a negative [12]. Dieting is associated with perceived poor health by adolescents, but is also a risk factor for eating disorders [29, 31]. Other factors, such as exercising, smoking, consuming alcohol, and somatic and psychological health problems, are also associated with dieting [29, 30]. Moreover, body dissatisfaction is generally associated with unhealthy weight control behaviors and binge eating in boys and girls [32].

Some other significant factors associated with the estimation of children's body weight were parental weight assessment in the 11-year-old girls and parental or legal guardian education level in the 14-year-old female group. For 11-year-old girls who underestimated their weight, 70% of parents rated their children's weight as normal. Furthermore, all parents of children who overestimated their weight assessed their child's weight as normal. However, these results have not been compared to the actual weight of adolescents. According to a previous study, almost one-third of parents cannot correctly asses the weight of their children, with 25% underestimating and 6% overestimating [33].

Mothers and fathers of 14-year-old girls who overestimated their weight mostly had a university-level education. A previous study reported that boys who were dissatisfied with their weight were more likely to have a mother with a higher education, indicating the impact of parental education on children's weight perception and satisfaction [34].

Other characteristics not investigated in our study but found to influence teenagers' weight estimation in previous studies include family and teacher support,

which make students less likely to overestimate their weight [23]. What is interesting, adolescents from high-income families are more likely to overestimate their weight [35]. In this study, we did not find that a child's family wealth (measured by FAS) had a significant impact.

Misperceptions of body weight, on the other hand, can have an impact on teenagers' mental health in general, with body weight misperception and negative body image associated with unhealthy eating behaviors and eating disorders [4, 15]. Gu et al. [36] investigated weight-related factors and mental health problems in Chinese adolescents. Their study found that both underestimation and overestimation of body weight may result in depression, anxiety, and loneliness. Moreover, a Norwegian study discovered that misperceptions regarding adolescent weight are associated with increased anxiety and depressive symptoms [37]. In our study, we did not look at the impact of weight misperception on overall mental health, although past research has shown that it is a significant area of concern that needs further investigation.

Limitations of the study

The main limitation of this study is its relatively small sample size, as well as the fact that some of the findings are based on a small number of cases. It mostly considers individual groups of respondents, 11- and 14-year-old boys/girls, which may be at potential risk of bias. Therefore, to validate the results of this pilot study, further research on a larger group should be conducted in the future. Moreover, this is a pilot study, and our results should be considered as preliminary, requiring further research on a larger population.

In this study, we focused only on a few psychosocial factors that may influence body weight estimation. Those factors were provided by the globally applied HBSC questionnaire. Our study aimed at identifying the main factors contributing to body weight estimation. In the future, it should be tested whether there are other important factors associated with this problem. We chose questions related to body weight, diet, and basic demographic data of adolescents and their parents/legal guardians, which we considered significant.

Furthermore, according to previous research, although the Cantril Ladder is a reliable and valid instrument for measuring life satisfaction, its validity may be lower when used as a single scale. Nevertheless, reliability is assessed as high; however, this aspect should be taken into consideration [38].

CONCLUSIONS

Body weight misperception was prevalent among Polish teenagers aged 11 and 14, with boys being more likely to underestimate their weight and girls being more likely to overestimate it. Both sexes dieted despite being of a normal weight, with females being more susceptible. However, many boys who overestimated their weight used dieting.

Adolescence is a critical period for the development of many mental disorders. Understanding the impact of body weight perception may be one of the key variables in understanding mental health in this population. Parents, teachers, and medical professionals, such as doctors or nurses, should also be aware of how teenagers perceive their weight for a better approach. Furthermore, educational programs on body perception, dieting, and the physical and psychological health impact of weight assessment should be implemented in teenagers' environments. To summarize, a comprehensive understanding of adolescence and the various factors that affect young people during this period can provide valuable insight into the challenges and difficulties that may arise in adult life.

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Conflict of interest

The authors report there are no competing interests to declare.

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ORIGINAL ARTICLE

EPIDEMIOLOGY OF CORONARY ARTERY DISEASE IN PATIENTS FROM THE DISTRICT OF ŻYWIEC IN SOUTHERN POLAND

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ABSTRACT

Background. Cardiovascular diseases are currently the leading cause of premature mortality both in Poland and worldwide. Among the most severe conditions are acute cardiac events, which pose a direct threat to patients' lives and health. One of these is coronary artery disease, which predisposes individuals to myocardial infarction. Prevention relies primarily on maintaining a well-balanced diet, engaging in daily physical activity and in more severe cases, pharmacotherapy and invasive treatments.

Objective. The aim of this study was to analyze the prevalence of coronary artery disease among patients of the Cardiology Department in a hospital located in the district of Żywiec in southern Poland.

Materials and Methods. A survey study was conducted using a proprietary questionnaire consisting of three sections. The sections addressed patients' health status, their quality of life assessment. The study included 158 individuals aged 33-101, of whom only 150 met the selection criteria – being residents of the district of Żywiec. The obtained results were analyzed using correlation coefficients.

Results. Coronary artery disease was diagnosed in 41.8% (N = 66) of patients. The majority were men (N = 44). The highest proportion of the studied group were individuals aged 40 to 80 years (N = 128). A total of 40% (N = 59) of respondents were overweight, 34% (N = 50) were obese, and 26% (N = 38) had a normal body weight. The most common comorbidity was hypertension – affecting 67% (N = 101) of patients – most of whom had not experienced myocardial infarction (57%, N = 58).

Conclusions. Coronary artery disease was more prevalent among men. Arterial hypertension was the most common comorbid condition, confirming its strong association with coronary artery disease. Abnormal body weight is also a significant factor, increasing the risk of developing CHD.

Keywords: *coronary artery disease, cardiovascular diseases, diet, prevention, epidemiology, hypertension, diet-related diseases*

INTRODUCTION

Coronary artery disease (CAD) is a condition affecting the myocardium, characterized by the formation of atherosclerotic plaques within the coronary arteries [1]. Its pathophysiology is based on an inflammatory process in which lipid-laden macrophages, known as foam cells, infiltrate the vessel wall, damaging its endothelium [2]. This process activates cytokines and releases T cells. As inflammation progresses, the foam cell population increases, leading to the formation of a subendothelial plaque. A fibrous cap then develops, indicating the stabilization of the atherosclerotic plaque, followed by its calcification [3]. The progressive narrowing of the vessel lumen results in significant hemodynamic complications. Oxygen supply to cardiomyocytes becomes insufficient relative to the body's demand, leading to myocardial ischemia, which is why CAD is also referred to as ischemic heart disease (IHD) [4]. Some atherosclerotic plaques may detach from the vessel wall, releasing tissue factors and causing partial or complete occlusion of the artery's lumen [5]. Depending on the extent of the changes, CAD is categorized into stable ischemic heart disease (SIHD) and acute coronary syndrome (ACS). ACS, based on electrocardiogram findings, can be classified into non-ST elevation myocardial infarction (NSTEMI) or ST elevation myocardial infarction (STEMI). Unstable angina also falls under ACS [6]. Until the

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early 20th century, the pathogenesis of CAD remained unexplained. From the mid-20th century, the disease became the leading cause of death worldwide, peaking in the 1960s. Over time, there has been a significant decline in mortality due to heart disease, which continues to this day [7]. However, despite this progress, IHD remains a major global health concern [8]. In Poland, the first statistical analyses and epidemiological studies on CAD date back to the 1950s. These were initially local due to financial constraints. National studies assessing the prevalence of cardiovascular risk factors were conducted only in the 1990s [9]. In Poland, the increase in cardiovascular mortality continued until the early 1990s, however, the following years saw a sharp decline in cardiovascular mortality. Between 1999 and 2018, standardised death rates declined by an average of 2.8% per year among men and by 3.0% per year among women. A particularly pronounced decline in mortality from heart disease was observed in the 25-64 age range - after 2014 for women and one year later for men [10, 11]. These risk factors include hypertension, hypercholesterolemia, diabetes, obesity, physical inactivity, smoking, male gender, and family predisposition [12, 13]. The first large-scale epidemiological study conducted in Poland was the Pol-MONICA study (1983-1994), followed by another edition in 2001. Since then, Poland has actively participated in initiatives to improve public health and quality of life. Nationwide studies such as POLKARD, WOBASZ, and CINDI WHO emphasize the importance of patient education, lifestyle modifications, dietary changes, and increased physical activity to prevent cardiovascular diseases. According to data from the Institute for Health Metrics and Evaluation, in 2021, approximately 2 million people in Poland suffered from ischemic heart disease, accounting for 5.5% of the total population. The average annual incidence of coronary artery disease was between 250 and 300 new cases per 100,000 inhabitants. Men particularly those aged 40 to 55 are more likely to develop the condition. Among older individuals, however, the incidence rate is similar for both sexes. Notably, the likelihood of developing this disease increases significantly with age [14, 15]. Additionally, Ministry of Health programs, such as the National Health Plan, aim to develop early diagnosis methods for lipid disorders and improve cardiological care. These projects strive to eliminate healthcare disparities compared to other European Union countries [16]. This study aims to assess the prevalence of CAD and its risk factors among patients in Żywiec district population.

MATERIAL AND METHODS

The survey study was conducted between July and September 2024 in the Cardiology Department of the Żywiec County Hospital, following approval from the hospital director and the head of the department. The study tool was an anonymous proprietary questionnaire composed of the following sections:

1. Questions regarding patients' health status. This section included data on age, sex, body weight, height, blood pressure values, diagnosis of ischemic heart disease, hypertension, previous episodes of myocardial infarction, stroke, and past cardiac procedures. Additionally, participants were asked about the occurrence of cardiovascular diseases in their families.
2. Questions regarding patients' quality of life. The survey analyzed the presence and nature of chest pain, occurrences of dyspnea, fatigue (including its intensity), and dizziness. It also assessed whether the disease imposed limitations on work, household activities, or sports participation. Questions regarding social and interpersonal relationships were included, along with inquiries about complications following cardiac procedures, if applicable. This paper includes data on complications in patients following pacemaker implantation and vascular prosthesis placement and limitations in daily activities. Further data on this topic will be published in a separate paper.
3. Questions regarding the relationship between the disease and diet. Participants were asked whether they followed a specific diet and what type it was. Data on the use of diets will be published in another paper.

All participants in the study were informed in advance about its purpose and nature and gave their informed consent to participate. Consent was obtained orally during direct contact with patients staying in the cardiology ward. The data collected during the study were completely anonymous and did not contain any information that could identify the participants. Accordingly, no personal data were stored, and the participants' right to withdraw consent applied at the moment of their participation in the study and was clearly communicated to them.

Based on each patient's height and weight, the Body Mass Index (BMI) was calculated and interpreted according to the World Health Organization (WHO) classification [17] (Table 1). Additionally, each patient was assigned a classification within the New York Heart Association (NYHA) scale [18] (Table 2), considering their reported blood pressure values and symptoms. Blood pressure measurement was performed by qualified medical personnel using standard hospital equipment, in accordance with current clinical practice. Height and body weight were self-reported by the patients, which was noted in the methodology. Although these measurements were not

Table 1. Body Mass Index according to the World Health Organization classification [17]

BMI	Nutritional status
< 18.5	Underweight
18.5-24.9	Normal weight
25.0-29.9	Overweight
30.0-34.9	Obesity class I
35.0-39.9	Obesity class II
≥ 40	Obesity class III

Table 2. New York Heart Association functional classification [18]

Class	Description
I	No symptoms
II	Symptoms with ordinary activity
III	Symptoms with less than ordinary activity
IV	Symptoms at rest or with any minimal activity

calibrated as part of the study, the data obtained reflect typical procedures used in hospital ward conditions.

Characteristics of the study group

All study participants were patients of the Cardiology Department at the Żywiec County Hospital. The inclusion criterion was residency in the district of Żywiec. The questionnaire was administered during the patients' hospital stay. A total of 158 individuals participated in the study, including 98 men (62%) and 60 women (38%), aged 33-101 years (67.51 ± 12.12). The analysis included 150 patients, as 8 did not meet the inclusion criteria. The highest recorded BMI was 43.94, and 16 respondents (10.7%) were classified in class 4 according to the New York Heart Association.

Statistical analysis

The survey data were entered and processed using MS Excel and subsequently statistically analyzed in Statistica version 13.0 (TIBCO Software Inc.). Classical statistical measures such as mean and standard deviation were used for analysis. To assess dependence and correlation strength between variables, Cramér's V coefficient (Vc) and Phi coefficient (ϕ) were applied. The correlation strength interpretation followed these criteria: 0 – no correlation between variables, 1 – very strong correlation between components, indicating a functional relationship. If Vc or ϕ falls within the range (0; 0.3), the relationship between variables is very weak, within (0.3; 0.5), the correlation is weak, within (0.5; 0.7), the correlation is moderate, within (0.7; 0.9), the correlation is strong, within (0.9; 1), the correlation is very strong. The adopted confidence level was 95%.

RESULTS

Among all 150 respondents, the majority were male. A detailed gender distribution is presented below (Figure 1).

Among all respondents, the vast majority fell within the age range of 40 to 80 years. In contrast, the smallest group consisted of individuals below 40 years of age, which may indicate limited representation of the youngest participants within the study population. The detailed age distribution of the respondents is illustrated in the pie chart, allowing for a visual assessment of the demographic structure of the study group (Figure 2).

Among all respondents, the vast majority were classified as overweight. Approximately only 1/4 of the participants had BMI values falling within the range considered normal, indicating a relatively small

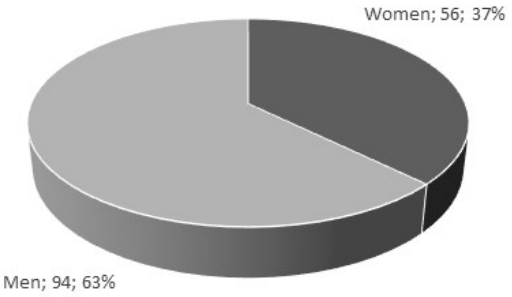

Figure 1. Participation of women and men in the study (N; %)

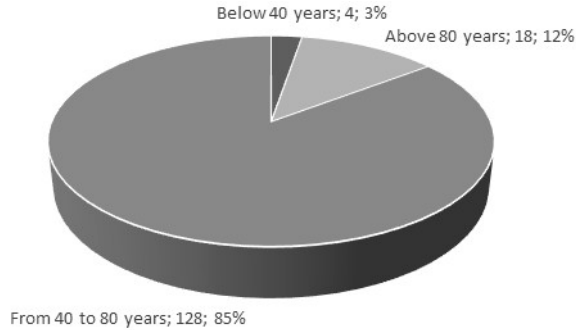

Figure 2. Age distribution of the studied patients (N; %)

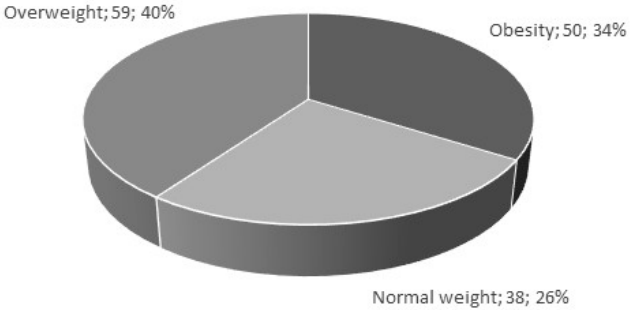

Figure 3. Distribution of Body Mass Index (BMI) among study subjects (N; %)

proportion of individuals with normative body weight in the examined sample. A detailed breakdown of body weight status is presented below, allowing for a clear assessment of body mass diversity within the study group (Figure 3).

A total of 44% (N = 66) of respondents confirmed having coronary artery disease (CAD). Among them, 22 women (14.7%) and 44 men (29.3%) reported being affected (Table 3).

Table 3. Occurence of coronary disease

Sex	Occurrence of coronary disease		
	Yes N (%)	No N (%)	I don't know N (%)
Women	22 (14.7%)	28 (18.7%)	6 (4%)
Men	44 (29.3%)	45 (30%)	5 (3.3%)
Total	66 (44%)	73 (48.7%)	11 (7.3%)

Among all surveyed participants, 36 individuals had high normal blood pressure, while 33 respondents were diagnosed with stage 1 hypertension according to European Society of Cardiology Guidelines 2021 [19]. The smallest group consisted of those with isolated systolic hypertension (N = 4) (Table 4).

Not all participants could have their BMI interpretation linked to their blood pressure category, which is why the following figure represents N = 137. Among all overweight respondents, 17 had stage 1 hypertension, while only 7 had optimal blood pressure levels. Among participants classified as obese based on BMI, 16 exhibited high normal blood pressure (Table 5).

Among all respondents without a family history of metabolic syndrome (N = 70), 41 individuals were also not diagnosed with coronary artery disease (CAD). Conversely, among those with a positive family history (N = 62) of metabolic syndrome or CAD, a majority

Table 4. Blood pressure values according to European Society of Cardiology Guidelines 2021 [19] and comparison with the results obtained in our survey for each category

Pressure value	Systolic [mm Hg]		Diastolic [mm Hg]	N	%
Optimal	< 120	and	< 80	20	14
Normal	120-129	and/or	80-84	18	13
High normal	130-139	and/or	85-89	36	23
Stage 1 hypertension	140-159	and/or	90-99	33	22
Stage 2 hypertension	160-179	and/or	100-109	16	12
Stage 3 hypertension	≥ 180	and/or	≥ 110	12	7
Isolated systolic	≥ 140	and	< 90	4	2
Lack of data				12	7

Table 5. Blood pressure values in comparison to BMI

	Optimal	Normal	High normal	Stage 1 hypertension	Stage 2 hypertension	Stage 3 hypertension	Isolated systolic
Normal weight N (%)	7 (9.6)	4 (5.5)	5 (6.9)	5 (6.9)	5 (6.9)	5 (6.9)	2 (2.7)
Overweight N (%)	7 (9.6)	8 (11)	15 (20.6)	17 (23.3)	3 (4.1)	5 (6.9)	0 (0)
Obesity N (%)	6 (8.2)	5 (6.9)	16 (21.9)	10 (13.7)	8 (11)	2 (2.7)	2 (2.7)

Table 6. Impact of family history of metabolic syndrome and/or coronary artery disease on the occurence of these conditions in the patient

Coronary heart disease	Does metabolic syndrome or coronary artery disease occur in the family?			
	No	Yes	I don't know	Total
No N (%)	41 (27.3)	20 (13.3)	12 (8)	73 (48.7)
Yes N (%)	23 (15.3)	39 (26)	4 (2.7)	66 (44)
I don't know N (%)	6 (4)	3 (2)	2 (1.3)	11 (7.3)
Total N (%)	70 (46.7)	62 (41.3)	18 (12)	150 (100)

– 39 individuals – were diagnosed with CAD. The Cramér's V correlation coefficient was 0.2310, indicating a weak correlation. The lower correlation value is significantly influenced by respondents who are unaware of whether metabolic syndrome or CAD is present in their family history (Table 6).

Among the 30 respondents (24.5%) with implanted pacemakers or vascular prostheses, 23 (83%) experienced no complications (Table 7).

Among all respondents classified as NYHA class 2 (N = 52), 25 individuals reported no limitations in daily activities. Conversely, among those classified as NYHA class 4 (N = 16), 14 individuals experienced significant limitations in performing daily tasks. The Cramér's V correlation coefficient was 0.3716, indicating a moderate correlation between NYHA classification and limitations in daily activities (Table 8).

Hypertension was diagnosed in 67% (N = 101) of all respondents. Among them, 57% (N = 58) had not experienced a myocardial infarction. In contrast, among respondents without diagnosed hypertension (N = 41), 76% (N = 31) had not suffered a myocardial infraction. The Cramér's V correlation coefficient was 0.177, indicating a weak relationship. This suggests that hypertension may be associated with myocardial infraction occurrence, but it is not a direct cause nor a guaranteed predictor of its development (Table 9).

DISCUSSION

The obtained results indicate that the majority of patients hospitalized in the cardiology ward were men. A study conducted by Suman et al. [20] explores the connection between gender and increased risk of cardiovascular diseases (CVD). The differences in CVD prevalence between men and women stem from sex, hormone levels, gene expression on X and Y chromosomes, lifestyle, diet and susceptibility to stress factors. Men are 3-4 times more likely than women to suffer ST-elevation myocardial infarction (STEMI) and non-ST-elevation myocardial infarction (NSTEMI). Additionally, ischemic heart disease (IHD) develops earlier in men than in women. Women are largely protected against CVD due to estrogens produced during the menstrual cycle, with estradiol (E2) playing a key role. By activating the estrogen receptor alpha (ER), it accelerates endothelial healing in response to injuries. E2 also promotes vasodilation and suppresses inflammation, preventing atherosclerosis development. However, the cessation of estrogen production after menopause leads to metabolic changes, contributing to diabetes and obesity. Middle-aged women develop hypertension earlier and more rapidly than men [21]. Age is another major risk factor for CAD. As aging progresses, the severity and prevalence of coronary

Table 7. Assessment of complications in patients following pacemaker implantation and/or vascular prosthesis placement

Pacemakers or vascular prostheses	Complications after implantation of pacemakers or vascular prostheses		
	No	Yes	Total
No N (%)	92 (75.4)	0 (0)	92 (75.4)
Yes N (%)	25 (20.5)	5 (4.1)	30 (24.6)
Total N (%)	117 (95.9)	5 (4.1)	122 (100)

Table 8. Impact of specific blood pressure values vs. restriction of physical activity

Occurrence of limitations in daily activities	NYHA functional classification			
	I	II	III	IV
No N (%)	36 (26.7)	29 (21.5)	9 (6.7)	2 (1.5)
Yes N (%)	13 (9.6)	23 (17)	9 (6.7)	14 (10.4)
Total N (%)	49 (36.3)	52 (38.5)	18 (13.3)	16 (11.9)

NYHA – New York Heart Association

Table 9. Comparison of the impact of diagnosed hypertension on the incidence of myocardial infarction

	Diagnosed hypertension			
Myocardial infraction	No	Yes	I don't know	Total
No N (%)	31 (20.7)	58 (38.7)	7 (38.7)	73 (48.7)
Yes N (%)	10 (6.7)	35 (23.3)	0 (0)	66 (44)
I don't know N (%)	0 (0)	8 (7.9)	1 (0.7)	11 (7.3)
Total N (%)	41 (27.3)	101 (67.3)	8 (5.3)	150 (100)

artery disease increase. Patients over 65 years old face a higher likelihood of major cardiovascular events, while those over 75 years old often suffer from multivessel CAD [22]. However, younger individuals are increasingly diagnosed with IHD [23]. Family history is also a significant independent risk factor for CHD. Research from the University of Copenhagen suggests that a first-degree relative experiencing myocardial infarction greatly increases the risk of heart attack in the patient – particularly if it occurred in the mother or sibling before age 50 [24]. According to Johns Hopkins University School of Medicine, parental CAD increases the probability of early-onset CAD in offspring, defined as a myocardial infarction before age 55. Additionally, coronary artery calcification among siblings is a stronger predictor of subclinical atherosclerosis than parental history [25]. Furthermore, individuals with early-onset CHD share poor dietary habits, low physical activity levels, and a tendency for smoking with their relatives, significantly contributing to cardiovascular disease development [26]. The majority of surveyed patients on the cardiology ward in Żywiec County Hospital suffered from hypertension. A large-scale Polish epidemiological study by Cegłowska et al. [27] describes the prevalence of hypertension in the Polish population between 2018 and 2022. In 2018, 10.8 million cases of hypertension were recorded, while in 2022, this number increased to nearly 11 million – 4.9 million men and approximately 6 million women. The highest hypertension prevalence was noted in men aged 55-59 years and women aged 50-54 years, with older age groups showing the highest recorded cases in both sexes. Hypertension is often associated with other cardiovascular diseases. According to Lewes et al. [28], 54% of strokes and 47% of ischemic heart disease cases are attributable to high blood pressure. German researchers report that hypertension predisposes individuals to myocardial infarction, angina pectoris, heart failure (systolic or diastolic), and atrial fibrillation [29]. The condition is more prevalent among individuals with overweight and obesity [30, 31]. While hypertension increases myocardial infraction risk, in this study, most hypertensive patients had not experienced an infarction. This may be due to proper medical management and patient adherence to physician recommendations. Moreover, patients are becoming increasingly aware of their health, recognizing the importance of a healthy diet, daily physical activity, a balanced lifestyle, and treatment of comorbidities [32, 33].

Limitations of the study

This study had several limitations. Firstly, it was conducted over a relatively short period (July-September 2024) with a small sample size (158 patients). Secondly, patient responses regarding specific medical conditions were subjective – some participants were unable to confirm, whether a family member had coronary artery disease or metabolic syndrome, or if they themselves had hypertension. Lastly, the analysis was carried out in a cardiology ward of a county hospital rather than a university clinic, which means fewer patients and more limited diagnostic and treatment options. Despite these limitations, this study serves as a starting point for further analyses and contributes to the epidemiological assessment of cardiovascular diseases in the Żywiec district. To reduce the incidence of coronary artery disease in the Żywiec district, it is advisable to implement comprehensive public health measures tailored to local needs. Key initiatives include offering free screening tests (blood pressure, cholesterol, glucose, and BMI), including through mobile diagnostic units that regularly visit smaller towns in the district. At the same time, it is important to carry out diverse educational activities, mainly targeting seniors, and to promote the KOS-zawał program [34, 35]. The effectiveness of these efforts can be enhanced through collaboration with local institutions such as churches, schools, and the county government.

CONCLUSIONS

Coronary artery disease remains a significant epidemiological problem in Poland. It is associated with gender, age, lifestyle, and diet, and is also inherited – especially among first-degree relatives. The analysis of the obtained results indicates consistency with previous large-scale studies, such as WOBASZ and Pol-MONICA. Ischemic heart disease affects a considerable portion of the studied population and is diagnosed more frequently in men. Early diagnosis and appropriate treatment are essential – particularly in county areas, where access to interventional cardiology units and specialized treatment options is often limited. The majority of patients were middle-aged and older adults, confirming that this group is particularly vulnerable to cardiovascular conditions. The widespread prevalence of excessive body weight among participants highlights the important role of unhealthy lifestyle factors in the development of the disease, while the frequent coexistence of arterial hypertension – even among individuals with no prior history of myocardial infarction – further confirms its strong link with the pathogenesis of coronary artery disease. The presence of multiple risk factors in individuals without previous cardiac events may reflect the effectiveness of early diagnostic efforts, but also points to the need for further strengthening of preventive strategies, especially at the local level.

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Conflict of interest
The authors report there are no competing interests to declare.

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ORIGINAL ARTICLE

ANALYSIS OF SELECTED ORGANOCHLORINE PESTICIDES IN HONEY SAMPLES FROM POLAND: A PILOT STUDY

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ABSTRACT

Background. Organochlorine pesticides (OCPs) were widely used in crop protection in the past. Due to their high chemical persistence and widespread presence in the environment, they have been classified as persistent organic pollutants (POPs). Given their toxicological properties, dietary exposure to OCPs may lead to adverse health effects in humans.

Objective. The aim of this pilot study was to analyse selected obsolete OCPs (DDT, its metabolites and isomers, as well as dieldrin and heptachlor) in honey samples and to assess the associated health risks resulting from the intake of these compounds for children and adults.

Material and Methods. The study included 79 honey samples collected from various regions of Poland. The samples were prepared using the modified QuEChERS method. The tested substances were determined in honey using gas chromatography with an electron capture detector (GC-ECD). Health risk was characterized using a deterministic method by comparing the intake of the residues from a large portion of honey with toxicological reference values. A conservative approach was used to estimate short-term exposure using 0.5 × LOQ (limit of quantification) values for substances detected at levels below the LOQ.

Results. None of the OCPs analysed were detected above their LOQs. Only in two samples, *p,p'*-DDE and dieldrin, were detected at levels above the method's limit of detection (LOD). The results indicate a negligible health risk for consumers associated with the intake of these substances from honey.

Conclusions. The results indicate that levels of tested organochlorine pesticides in honey are low. The risk associated with exposure to the analysed OCPs, at the assumed levels, through the consumption of honey available in Poland can be considered negligible.

Keywords: *honey, organochlorine pesticides, persistent organic pollutants, QuEChERS, GC-ECD*

INTRODUCTION

Honey is valued not only as a culinary ingredient but also as a natural food product with health-promoting properties [1]. It is widely regarded as a product rich in nutrients, antioxidants and enzymes, which contributes to its popularity [2, 3]. Given that honey is often consumed by children, the elderly and health-conscious individuals, it is particularly important that it remains free from contaminants. Owing to its perceived health benefits and relatively easy accessibility for the average consumer, honey enjoys great popularity and is widely consumed across most European countries [4-7]. However, honey may contain residues of active substances used in plant protection products. This results from the potential for both direct and indirect exposure of honeybees (*Apis mellifera*) to these substances, for example during the collection of pollen and nectar. Due to the possible presence of pesticide residues in honey, Regulation (EC) No 396/2005 of the European Parliament and of the Council sets maximum residue levels (MRLs) for honey to ensure an adequate level of consumer safety [8].

Among the possible contaminants in honey are organochlorine pesticides, such as DDT, dieldrin and heptachlor. These are chemical compounds that were once widely used in agriculture and their intensive use became a major source of environmental pollution [9]. Improper storage and disposal of these substances in the past further contributed to environmental contamination [10-12]. Despite being banned in the

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European Union for several decades, they are still detected in plant- and animal-derived samples [13, 14]. Organochlorine pesticides have also been identified in bodily fluids (e.g., blood) and human breast milk [15, 16]. Monitoring studies make it possible to determine current levels of these legacy contaminants in food and if necessary, revise existing MRLs. Under EU law, the maximum residue level for DDT (sum of *p,p'*-DDT, *o,p'*-DDT, *p-p'*-DDE and *p,p'*-TDE (DDD), expressed as DDT), dieldrin and heptachlor in honey and other apicultural products is set at 0.05 mg kg^{-1} (DDT) and 0.01 mg kg^{-1} (heptachlor and dieldrin) [17-19]. The use of DDT is currently restricted to malaria control, specifically for targeting *Anopheles* mosquitoes in certain African and Asian countries, where effective vector management remains essential [20].

The presence of dieldrin, DDT or heptachlor in food may adversely affect human health. The toxic effects of these compounds are associated with an increased risk of various health issues, including endocrine disruption, cancer and the nervous system disorder [21-23]. Exposure to DDT (both prenatal and postnatal) may lead to developmental disorders of the adrenal gland. Dysfunction of this hormone-producing gland can lead to disturbances in the physiological regulation of other organs and systems. This may cause various pathological processes such as abnormal functioning of the immune, reproductive and cardiovascular systems [24]. Because of their ability to biomagnify in food chains and considering their classification as human carcinogens (IARC, International Agency for Research on Cancer: dieldrin and DDT – Group 2A, heptachlor – Group 2B; Regulation (EC) No 1272/2008: all analysed substances – Carc. 2), even low-level but chronic exposure may lead to adverse health outcomes, such as increased cancer risk [25-28]. There is also growing evidence that prenatal exposure to DDT and its metabolites may increase the risk of obesity later in life [29].

The aim of this study was to quantify the levels of selected persistent organic pollutants (*p,p*'-DDE, *p,p*'-DDT, *p,p*'-DDD, *o,p*'-DDE, *o,p*'-DDD, *o,p*'-DDT, heptachlor, dieldrin) in honey and to estimate potential exposure among consumers (children and adults), as well as to characterise the associated health risk arising from the intake of above compounds with honey.

MATERIAL AND METHODS

Details of the analytical method including its validation are described elsewhere [30].

Honey

A total of 79 honey samples from various regions of Poland were used in this study (Figure 1). The samples were submitted anonymously for analysis by volunteers interested in the research. Each sample was accompanied by information on its declared botanical and geographical origin. Until analysis, all samples were stored at room temperature, away from light.

Most of the samples were nectar honeys (N = 73). In addition, three samples each of honeydew and flavoured multifloral honey were included. More than half of the analysed samples consisted of multifloral

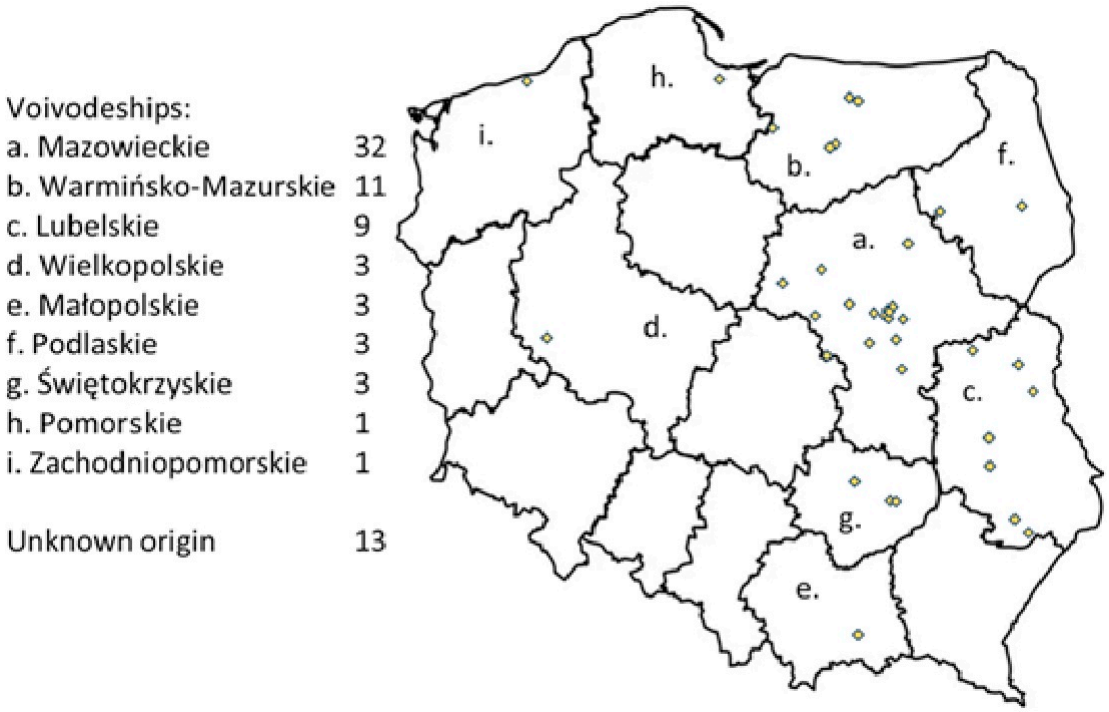

Figure 1. Declared geographical origin of the honey samples

and linden honey. The breakdown of honey types by declared botanical origin is presented in Figure 2.

Reagents

The following reagents were used in the study: acetonitrile for GC (POCH, Gliwice, Poland), *n*-hexane for pesticide residue analysis (POCH, Gliwice, Poland), QuEChERS extraction kits (Agilent, Warsaw, Poland), glacial acetic acid (BDH, Poole, UK) and *n*-dodecane (Merck, Warsaw, Poland). The following certified standards were applied: *o,p*'-DDE, *p,p*'-DDE, *o,p*'-DDD, *p,p*'-DDD, *o,p*'-DDT, *p,p*'-DDT, dieldrin and 2,2′,4,4′,5,5′-hexachlorobiphenyl (PCB 153) as an internal standard (Institute of Industrial Organic Chemistry, Warsaw, Poland) and heptachlor (Dr. Ehrenstorfer GmbH, Augsburg, Germany). All standards had a purity of > 99%.

Sample preparation

In brief, 5 g of honey was dissolved in 10 mL of water, followed by extraction with 10 mL of 1% acetic acid in acetonitrile using a commercial QuEChERS extraction kit (containing 0.5 g sodium hydrogencitrate sesquihydrate, 1 g sodium citrate dihydrate, 1 g NaCl, 4 g $MgSO_4$), vigorously shaken for 1 min. The resulting extract was centrifuged at 4000 RPM for 3 min and the supernatant was collected. A QuEChERS clean-up mixture (0.9 g $MgSO_4$ and 0.15 g PSA) was then added, vigorously shaken for 1 min and then the sample was centrifuged again at 4000 RPM for 1 min. From the resulting supernatant, 1 mL was taken and 70 µL of n-dodecane (keeper) was added, along with 10 µL of the internal standard (PCB 153 at a concentration of 1 µg mL^{-1}). The solution was then evaporated to dryness under a gentle stream of nitrogen. The residue was reconstituted in 1 mL of n-hexane and subjected to GC-ECD analysis.

Chromatography

Analysis of the OCPs in honey was performed using an Agilent 6890N gas chromatograph (Wilmington, NC, USA) equipped with a micro electron capture detector (µECD) and an Agilent 7683B autosampler (Shanghai, China). A HP-5 capillary column ((5%-Phenyl)-methylpolysiloxane) with dimensions 30 m × 250 µm × 0.25 µm was used. The oven temperature programme was as follows: 100°C (1.7 min) – 30°C min^{-1} – 210°C (0 min) – 5°C min^{-1} – 300°C (5 min). The injector temperature was set at 260°C and the detector temperature at 330°C. Helium was used as the carrier gas at a flow rate of 3.2 mL min^{-1} and nitrogen was used as the make-up gas at 60 mL min^{-1}. The injection volume was 5 µL. The limit of quantification (LOQ) was defined as the lowest validated concentration used to construct calibration curves (2.9 ng g^{-1} of honey for most analytes, except for heptachlor, for which a higher LOQ of 5.6 ng g^{-1} of honey was applied). The limit of detection (LOD) was determined to be 0.8 ng g^{-1} of honey.

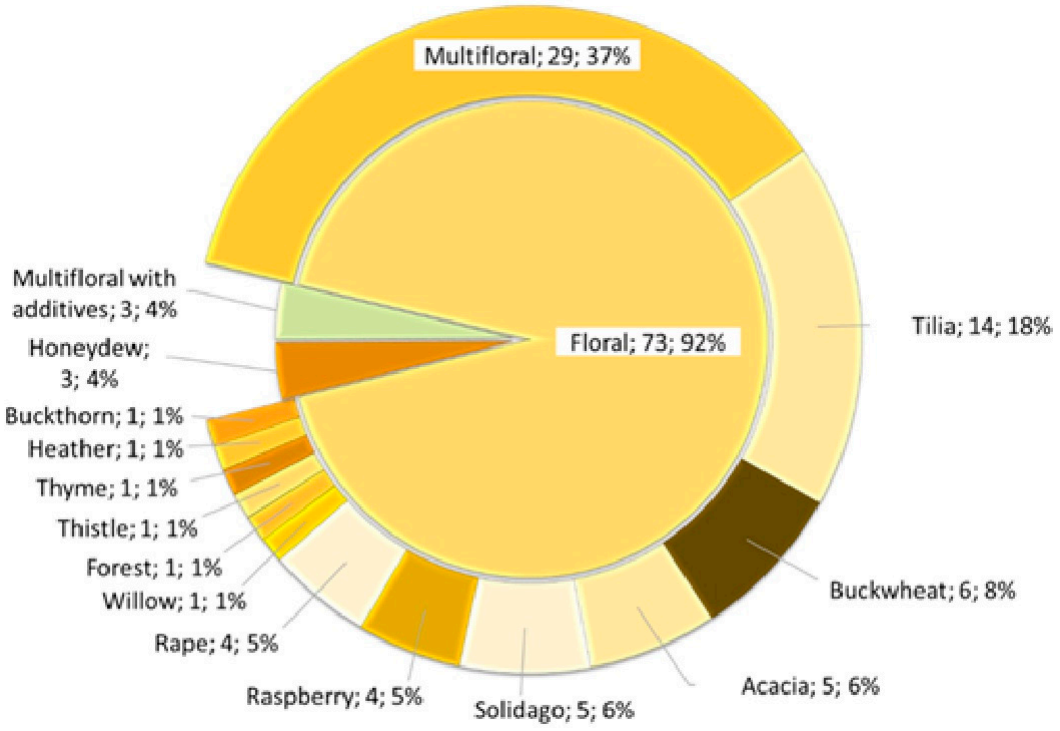

Figure 2. Declared botanical origin of the honey samples

Matrix effect

To reduce the matrix effect and improve the repeatability and reproducibility of the results, an internal standard (PCB 153) and a keeper (*n*-dodecane) were added. Additionally, due to the considerable diversity among the honey samples tested, calibration curves were prepared individually for each honey sample. These curves were obtained similarly to the method validation process by fortifying extracts with appropriate amounts of standard solution prior to solvent exchange and were determined for all the analytes studied [30].

Consumer exposure assessment

Consumer exposure and associated risk from intake of the analysed substances with honey were estimated using the EFSA PRIMo rev 3.1 model (Pesticide Residue Intake Model) [31]. The International Estimated Short-Term Intake (IESTI) was calculated, incorporating a variability factor for honey of $v = 1$ (case 1) and using the highest so-called 'large portion' of honey consumed by children and adults among all EU countries reported (the critical intake values used were respectively: 3.58 g kg^{-1} body weight for Dutch children and 1.38 g kg^{-1} body weight for Czech adults). Half of the limit of quantification value (1.45 ng g^{-1}) was assumed for detected substances in the calculations.

$$IESTI = HR \times LP \times BW^{-1}$$

where: HR – highest residue, LP – large portion and BW – body weight

Risk was then characterized by comparing the estimated intake to the toxicological reference value (TRV) specific to each substance. Intakes exceeding 100% of the TRV are considered potential health risks for consumers. For dieldrin, EFSA established an acute reference dose (ARfD) of 0.003 mg kg^{-1} bw [32]. For DDT (expressed as the sum of *o,p*'-DDE, *p,p*'-DDE, *o,p*'-DDD, *o,p*'-DDT, *p,p*'-DDD and *p,p*'-DDT), the provisional tolerable daily intake (PTDI) established by JMPR of 0.01 mg kg^{-1} bw was applied for risk characterization [33].

RESULTS

OCPs have not been found in 77 out of 79 honey samples analysed. In 2 samples, specifically a linden honey from the Warmian-Masurian Voivodeship and a multifloral honey from the Lublin Voivodeship, only dieldrin and *p,p'*-DDE were detected respectively. The levels identified were, however, below the method's limit of quantification (i.e. < 2.9 ng g^{-1}) (Table 1).

Risk assessment was conducted only for dieldrin and *p,p'*-DDE, which were detected in honey samples at levels below the method's limit of quantification. A conservative approach was applied, overestimating the potential risk. For calculations, a value of 0.5 × LOQ, i.e. 1.45 ng g^{-1} was used. The EFSA PRIMo revision 3.1 calculator was used to estimate short-term intake (ESTI) for both children and adults, based on honey consumption data for the most exposed population groups (Dutch children and Czech adults). $ESTI_{children}$ and $ESTI_{adults}$ were determined to be 5.2×10^{-6} and 2.0×10^{-6} mg kg^{-1} day^{-1}, respectively.

A negligible consumer health risk was identified in relation to a potential single (one-day) intake of dieldrin and *p,p*'-DDE with a large portion of honey. The estimated exposure for the first one did not exceed 0.2% of the ARfD for children and 0.07% of the ARfD for adults, while for the latter 0.05% PTDI for children and 0.02% PTDI for adults.

DISCUSSION

The results presented in Table 1 provide a partial overview of the contamination of honey produced and consumed in Poland with the studied organochlorine pesticide residues. Kędzierska-Matysek et al. [38], in their 2022 study based on 30 honey samples from the Lublin Voivodeship, also reported no presence of organochlorine pesticides. Similar findings regarding the presence of organochlorine pesticides in honey were obtained by Gaweł et al. [34] from research conducted between 2015 and 2017. They detected lindane and *p,p*'-DDT in only 1 out of 155 samples collected from 16 different municipalities. Likewise, Niewiadomska et al. [39], in their study on pesticide residues in animal-derived food products in 1997-2006 in Poland, including honey, did not detect any organochlorine pesticide residues in any of the 18 honey samples tested.

However, attention should be drawn to the results obtained by Kujawski et al. [35], who quantified *p,p*'-DDT in 15 out of 19 honey samples (with a maximum level of nearly 14 ng g^{-1} of honey). Other samples showed occasional presence of *o,p'*-DDD, lindane or aldrin. Similar findings were reported by Wilczyńska et. al [36], who found *p,p*'-DDT in as many as 60% of 178 honey samples collected from various regions of Poland in 2001-2002, with the highest concentration reaching 227.85 ng g^{-1}. Dieldrin and *o,p*'-DDT were detected in approximately 18% of the samples. Moreover, other OCPs were found in the tested samples, with lindane being the most frequent, detected in 63% of the samples. The presence of dieldrin, heptachlor and DDT in honey was also reported by Witczak and Ciemniak [37], who analysed OCPs in 6 types of honey from the Western Pomerania region of Poland sampled in 2008. The reported ∑DDT levels ranged from 0.05 to 0.18 ng g^{-1},

Table 1. Selected organochlorine pesticides in Polish honey

Compound	LOQ [ng g^{-1}]	Results [ng g^{-1}]	Method	No. of samples	Number (percentage) of samples with selected OCP	Ref. (year of publication)
o,p'-DDE	2.9	ND	GC-ECD	79	-	Our study
p,p'-DDE	2.9	< LOQ			1 (1.3%)	
o,p'-DDD	2.9	ND			-	
p,p'-DDD	2.9	ND			-	
o,p'-DDT	2.9	ND			-	
p,p'-DDT	2.9	ND			-	
Heptachlor	5.6	ND			-	
Dieldrin	2.9	< LOQ			1 (1.3%)	
p,p'-DDD	1	2	GC-MS/MS	155	1 (0.6%)	[34] (2019)
p,p'-DDE	1	ND			-	
o,p'-DDT	1	ND			-	
p,p'-DDT	1	ND			-	
Heptachlor	1	ND			-	
p,p'-DDT[a]	2.31	3.02-13.91	GC-MS	19	15 (78.9%)	[35] (2012)
Dieldrin	No data	1.2-5.93	GC-ECD	178	32 (18.0%)	[36] (2007)
o,p'-DDT	No data	1.5-18.66			34 (19.1%)	
p,p'-DDT	No data	1.1-227.85			108 (60.7%)	
Heptachlor	0.03	< LOQ-3.89	GC-MS	6	6 (100%)	[37] (2012)
p,p'-DDE	0.03	< LOQ-0.08			6 (100%)	
o,p'-DDD	0.03	< LOQ			6 (100%)	
p,p'-DDD	0.03	< LOQ-0.04			6 (100%)	
o,p'-DDT	0.03	< LOQ-0.06			6 (100%)	
p,p'-DDT	0.03	0.03-0.10			6 (100%)	
Dieldrin	0.03	0.06-0.10			6 (100%)	
p,p'-DDE	1	ND	GC-MS/MS	30	-	[38] (2022)
p,p'-DDD	1	ND			-	
o,p'-DDT	1	ND			-	
p,p'-DDT	1	ND			-	
Heptachlor	1	ND			-	
Dieldrin	5	ND			-	
p,p'-DDT[a]	No data	ND	GC-ECD	18	-	[39] 2008)

LOQ – limit of quantification; ND – not detected; [a] *p,p*'-DDT and metabolites expressed as *p,p*'-DDT

while dieldrin and heptachlor were found in the ranges of 0.06-0.10 ng g^{-1} and < LOQ-3.89 ng g^{-1}, respectively. The authors also measured the levels of the same compounds in rapeseed flowers and soil but did not find any correlation between the levels detected in these matrices and the OCP content in honey.

It is worth noting the findings of studies conducted in other countries, which indicate the presence of organochlorine pesticides in honey (Table 2). Yavuz et al. [40] reported the presence of dieldrin, heptachlor and DDT (including its metabolites) in nearly all of the 109 honey samples analysed from Turkey. In honey from Italy, Chiesa et al. [41] detected small amounts of DDT (and its metabolites), heptachlor and dieldrin, among others. The most frequently occurring OCP in Italian honey was endrin, which was also found at the highest concentrations. Blasco et al. [42, 43], in studies conducted on honey from Spain and Portugal, confirmed the presence of contaminants such as lindane and DDT. While lindane was found

Table 2. Selected organochlorine pesticides in honey from outside Poland

Compound	LOQ [ng g^{-1}]	Results [ng g^{-1}]	Method	Origin of honey	No. of samples	Number (percentage) of samples with selected OCP	Ref. (year of publication)
o,p'-DDE	3	< LOQ-18.6	GC-ECD	Turkey	109	109 (100%)	[40] (2010)
p,p'-DDE	2	< LOQ-23.0				109 (100%)	
o,p'-DDD	7	ND-5011.3				108 (99.1%)	
p,p'-DDD	3	ND-13.0				108 (99.1%)	
o,p'-DDT	3	ND-14.6				107 (98.2%)	
p,p'-DDT	7	ND-12.9				108 (99.1%)	
Heptachlor	7	ND-130.1				107 (98.2%)	
Dieldrin	1	ND-107.2				105 (96.3%)	
p,p'-DDE	2.55	5.4-8.8[b]	GC-MS/MS	Italy	72	24 (33.3%)	[41] (2016)
p,p'-DDD	2.74	1.9[b]				10 (13.9%)	
p,p'-DDT	2.83	5.8-15.4[b]				34 (47.2%)	
Heptachlor	2.84	4.2-6.5[b]				12 (16.7%)	
Dieldrin	3.02	3.9-4.3[b]				21 (29.2%)	
p,p'-DDT[a]	20	27-658	GC-MS	Portugal	24	10 (41.7%)	[42] (2003)
p,p'-DDE	40	186[b]	GC-ECD	Portugal	24	6 (25%)	[43] (2004)
p,p'-DDD	40	65[b]				2 (8.3%)	
o,p'-DDT	40	60[b]				1 (4.2%)	
p,p'-DDT	40	65[b]				2 (8.3%)	
p,p'-DDE	0.3	2.18[b]	GC-ECD	Spain	111	4 (3.6%)	[44] (2005)
p,p'-DDD	0.3	ND				-	
p,p'-DDT	0.6	0.45[b]				7 (6.3%)	
Heptachlor	0.1	0.17[b]				13 (11.7%)	
Dieldrin	0.3	0.34[b]				15 (13.5%)	
p,p'-DDT[a]	1	< LOQ-2.89	GC-ECD	Ukraine	104	No data	[45] 2020)
o,p'-DDE	0.05[c]	< LOD-14.3	GC-ECD	Uganda	20	No data	[10] (2021)
p,p'-DDE	0.05[c]	< LOD-0.45				No data	
o,p'-DDD	0.08[c]	< LOD-31.7				No data	
p,p'-DDD	0.07[c]	< LOD-33.9				No data	
p,p'-DDT	0.05[c]	< LOD-5.91				No data	
Dieldrin	0.1[c]	< LOD-11.0				No data	
p,p'-DDE	3.913	25.1-2697	GC-ECD	Mexico	36	6 (16.7%)	[46] (2018)
p,p'-DDD	3.913	ND				-	
p,p'-DDT	3.913	99-440.78				3 (8.3%)	
Heptachlor	3.913	24.35-2570.32				23 (63.9%)	
Dieldrin	3.913	15.72-47.06				2 (5.6%)	
DDT	0.6	1156	GC-MS	Armenia	30	No data	[47] (2020)
DDD	0.6	ND				-	
DDE	0.6	ND				-	
ΣDDT[d]	40	< LOQ	GC-ECD	Ghana	45	No data	[48] (2017)
Dieldrin	40	< LOQ				No data	
Heptachlor	40	< LOQ				No data	

LOQ – limit of quantification; ND – not detected. ND reflects how non-detection was reported in the original source (e.g. as ND, 0, – or similar). Ranges written as ND-X correspond to values in the cited studies, with ND representing non-detected or unspecified results; [a] *p,p*'-DDT and metabolites expressed as *p,p*'-DDT; [b] mean concentration; [c] Limit of detection (LOD), authors considered any result as quantifiable if it was above the LOD; [d] ΣDDT = sum of *p,p*'-DDT, *o,p*'-DDT and *p,p*'-DDE

in honey from both countries, DDT was detected only in samples from Portugal. In a later study of 111 Spanish honey samples, Herrera et al. [44] reported the presence of lindane, DDT, heptachlor and dieldrin. Some of these compounds were detected in up to 13.5% of the samples tested, with the highest levels observed for *p,p*'-DDE (93.57 ng g^{-1}). In a study of Ukrainian honey, Kasianchuk et al. [45] also found trace amounts of DDT (expressed as DDT and its derivatives) and HCH (hexachlorocyclohexane; expressed as HCH (α, β, γ isomers)) among 104 samples.

DDT, its metabolites and breakdown products are also present in honey from regions affected by malaria. In a 2021 study, Mukiibi et al. [10] focused on honey from apiaries located near a former pesticide store. They found high concentrations of organochlorine pesticides in the honey. *p,p'*-DDT, along with its metabolites and related isomers, was not only more frequently detected than other OCPs but also found at the highest concentrations, reaching up to 33.9 ng g^{-1} (for *p,p*'-DDD). Very high levels of *p,p*'-DDT and *p,p*'-DDE were also reported in honey from the Soconusco region of Mexico, known for its high malaria incidence, by Ruiz-Toledo et al. [46]. The concentrations of these compounds reached up to 440 ng g^{-1} and 2.697 ng g^{-1} of honey, respectively. This is attributed to the fact that nearly 70,000 tons of DDT were used in this region between 1957 and 2000 for malaria vector control.

An important complementary element in studies on the presence of xenobiotics in food is the assessment of the health risk resulting from their consumption. In this study, for the determined levels of dieldrin and *p,p'*-DDE, the risk associated with the intake of these substances through honey was considered negligible. Pipoyan et al. [47] focused in their study, among other things, on the risk assessment of DDT intake through the consumption of honey from Armenia. They estimated DDT intake at 0.262 mg kg^{-1} bw day^{-1}, which, according to the source they cited, does not exceed the tolerable daily intake (TDI) and therefore does not pose a non-carcinogenic risk. They also assessed the carcinogenic risk (CR), which exceeded the safe level but did not surpass the threshold of $CR > 10^{-4}$, the level considered unacceptable in risk assessment.

A different approach to risk assessment was adopted by Darko et al. [48] in their study of honey from Ghana. They determined ΣDDT, dieldrin and heptachlor at low levels, below the maximum residue limits (MRLs) established by the EU for these compounds. Consequently, they assumed that all levels below the MRL do not pose a health risk to consumers.

Honey, being a substance with low fat and wax content, should generally contain low levels of lipophilic substances. Their presence in honey is most often the result of bees bringing contaminated pollen or nectar into the hive [49]. The efficiency of various extraction techniques and the selection of appropriate analytical methods also influence the results obtained. Honey extracts often contain various compounds that interfere with the analysis and the need to use different purification techniques increases both the cost and the time required for the analysis.

One of the identified limitations of this study is the relatively high limit of quantification set during the method development. Future research should focus on improving the method presented here and include the determination of other substances from the group of persistent organic pollutants.

CONCLUSIONS

The results obtained in this study indicate that environmental levels of tested organochlorine pesticides are low. The risk associated with exposure to the analysed OCPs, specifically dieldrin and *p,p*'-DDE, at the assumed level of 0.5 LOQ, through the consumption of honey available in Poland can be considered negligible. The literature review also indicates no health threat related to the presence of trace levels of OCPs in Polish honey. At the same time, discrepancies in the results reported in the cited publications suggest the possibility of locally elevated levels of these contaminants. Verifying this assumption, however, would require more in-depth environmental studies.

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Conflicts of interest

The authors declare no conflict of interest.

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ORIGINAL ARTICLE

MAGNITUDE AND CORRELATES OF VERY LOW BIRTH WEIGHT NEWBORNS IN INDIA: INSIGHTS FROM NATIONAL FAMILY HEALTH SURVEY 2019-2021

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ABSTRACT

Background. Estimate of very low birth weight (VLBW) and low birth weight (LBW) newborns is a key maternal and child health indicator. It is often associated with higher child mortality in low-middle-income countries (LMICs), which account for 95% of the global LBW babies born annually.

Objective. This analysis aims to ascertain the occurrence and determinants of VLBW newborns in India.

Material and Methods. Data was taken from the 5th National Family Health Survey (2019-2021), which included 91,821 women aged 15-49 with a singleton pregnancy in last year, having recorded child birth weight. Information from 727 Indian districts was collected through cross-sectional design using census blocks/villages, for socio-demographic, antenatal, and reproductive variables from adult women in each household. Maternal socio-demographic, and reproductive factors were analyzed for association with VLBW birth using Chi-square tests and multivariate logistic regression using STATA 16 software.

Results. The occurrence rate of LBW babies has been 17.4% in present analysis, within which VLBW newborn constituted 1.1% – representing 6.3% of all LBW births. Key predictors for VLBW babies included maternal factors like illiteracy, anemia, underweight, prenatal tobacco use, lack of antenatal care, low economic status, high parity, female babies, and alcohol consumption during pregnancy. However, illiteracy, anemia, underweight, and prenatal tobacco use emerged as significant risks for occurrence VLBW births.

Conclusions. Most of the socio-demographic and prenatal maternal predictors for VLBW babies are amenable to reformation within existing social frame. This merits attention towards social application of preventive strategies comprehensively at grass-root level to modify the preventable risks of birth of LBW babies. There is nothing more self-explanatory and decisive than the role played by health-workers in improving antenatal care in urban slums and rural areas to reduce LBW/VLBW estimates in India.

Keywords: *India, antenatal care, very low birth weight, low birth weight, maternal-child health*

INTRODUCTION

The Global Nutritional Target (2014) proclaimed a 30% decrease in low birth weight (LBW) newborns between 2012 and 2030; however, the outcome has not been promising so far due to inadequate progress over the past two decades [1]. It is imperative to invest in primary prevention throughout the lifespan of women, especially for adolescent girls and females of child-bearing age group in the affected low-middle-income countries (LMIC) to accelerate the progress undoubtedly. The growing number of deliveries in the health-care settings and institutions in the recent years with relentless advances in the modern electronic health data communication technology generally resulted in improved quality, superiority and availability of information on LBW babies thus guiding research scholars to the reality.

LBW has been illustrated as the birth weight of a newborn less than 2500 g i.e. 2499 g or less, measured within one hour of delivery, and it continues to be one of the significant global health problems, undeniably remain as a major health burden in India [2]. Very low birth weight (VLBW) and extremely low birth weight (ELBW) babies are sub-groups of LBW neonates with birth weight less than 1500 g (1499 g or less) and less than 1000 g (999 g or less) respectively; are potentially high-risk groups with significantly high mortality and morbidity [2]. LBW is generally due to preterm delivery (short gestation less than 37 weeks), intrauterine growth restriction (IUGR), or both in the single-ton pregnancy. Advances in critical neonatal

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care, progressive management and treatment spectrum in neonatal illnesses, and easy availability of the services at the community level over the recent years, enhanced the chance of survival of both LBW and VLBW babies all over the world. However, the LBW babies are often fraught with neonatal complications like respiratory distress, septicaemia, and recurrent infective spells resulting in repeated hospitalisations with chance of development of neuro-developmental disorders like intellectual, emotional and learning disabilities along with many chronic ailments in later life viz. hypertension, dyslipidaemia and insulin resistance precipitating cardiovascular, metabolic and renal diseases in the adulthood.

Overall, the domain of LBW and its constituent subsets viz. VLBW and ELBW comprise an arduous social burden for the indigent group in LMICs culminating in compulsive financial outlay and excessive out of the pocket expenditure not merely in repeated hospitalisation but definitely in procuring improved techniques of raising these children with good nutrition, sanitation, healthy and disease free life. Low birth weight is a critical community health indicator that provides incisive analytics into several counts related to mother and child health, nutrition, healthcare delivery, and poverty [2]. It is a significant indicator for estimating the neonatal survival trend and overall health of the newborns. [3] As the birth weight of the newborn is strongly linked with the mothers' general health and nutritional status, therefore, it closely reflects the collective health status of the communities in which these children are born.

Rationale of the work validates that studying VLBW newborns is essential for improving neonatal survival, reducing healthcare costs, addressing health disparities, and safeguarding healthier long-term outcomes with quality of life for individuals and communities. It may help notify public health policymakers possibly culminating in better maternal and child health strategies locally, regionally and nationally. Early attention to cognitive impairments, developmental delays, and anticipated chronic ailments like cardiovascular, metabolic, and renal diseases among VLBW babies can help shape lifelong well-being and reduce health burden. In-depth contemplation of maternal nutrition, prenatal care, gestational lifestyle modification, and infection control may assist in preventing VLBW births and therefore, need exploration to uncover newer strategies for preventive health campaigns.

The novelty of this intent is attributed to the fact that India has a comparatively reasonable occurrence of VLBW neonates; therefore, a national appraisal of the issue is intended to underscore the significance. To date, there are not many studies available on this topic in the Indian context; therefore, attention is needed to bring out the reality to highlight the preventative strategies. Since the NFHS-5 dataset is rich and nationally representative, it would offer robust and significant opportunities for inferential analytics and geo-social insights. A composite index for quality of prenatal care using variables like number of antenatal visits, IFA (iron and folic acid) consumption, tetanus immunization, mode of delivery, and gestational complications would be a guiding link to the VLBW rates to help discern the most influential of the multiple predictors. Changes in VLBW occurrence from NFHS-4 to NFHS-5 would provide a real-time disclosure of the current state to justify the multitude of social efforts being dispensed by the national government in India. Socio-economic intersectionality due to education, economic status, and caste/tribe is likely to offer an 'Inequality Concentration Index' justifying the merit of future attention in social dimensions. The environmental health reflects in the perspective of socio-economic-literacy state may provide insight relating to availability of water-hygiene-sanitation in the context of VLBW, marking the possible need for prospective improvement.

Aim of this cross-sectional observational study is to ascertain the occurrence of VLBW babies by analysing the recent data of the 5th National Family Health Survey, India (2019-2021) along with its magnitudes and correlates in the context of consistent governmental efforts to elevate the nutritional status of women in the child-bearing age group to enhance the gestational outcome.

MATERIAL AND METHODS

Framework

The study was planned by the incumbent during March 2025 and the baseline data was acquired from the 5th National Family Health Survey report (NFHS-5), 2019-2021 published by MOHFW, GOI including comprehensive socio-demographic and economic attributes of the diversified national communities at the basic grass-root level. The NFHS-5 data acquisition was carried out in two phases. Phase-I covered 17 states and 5 Union Territories (UTs); and was completed by the NFHS team from June 2019 to January 2020. This was followed by Phase-II, which encompassed 11 states and 3 UTs, and was conducted from January 2020 to April 2021 [4, 5].

Study setting and design

This study utilized data from the National Family Health Survey (NFHS-5), conducted across India covering all 28 states and 8 Union Territories (UTs), comprising 727 districts. The survey adopted a cross-sectional design with data collection using a pretested, structured instrument administered to adult women

in each selected household. The sampling strategy followed the 2011 Census framework, with Primary Sampling Units (PSUs) defined as Census Enumeration Blocks (CEBs) in urban, semi-urban and rural areas. A two-stage stratified sampling approach was used, ensuring adequate representation across regions. To ensure sufficient sample size, PSUs with fewer than 40 households were merged with adjacent units. The Probability Proportional to Size (PPS) method guided the selection of PSUs to minimize sampling errors.

Blueprint of selection

To facilitate the easy identification of rural houses or units during subsequent phases of the survey, household mapping and listing were conducted before the census based on prominent local landmarks. To select Primary Sampling Units (PSUs) or villages, systematic random sampling was employed, including probability proportional to size (PPS) technique. The second phase included a random selection of 22 households from each PSU or village. The National Report (2021) of the NFHS-5 provides detailed and comprehensive explanations of the sampling technique, PPS calculations, and methods to minimize sampling errors. In the present analysis, 91,821 women aged 15-59 years were included. A schematic illustration of the blueprint for sample selection is presented in Figure 1.

Inclusion benchmark:

- Only children born within the last 12 months were included in order to avoid changes in maternal characteristics over time.
- Only children delivered in institutions and health facilities with birth record cards were taken into consideration in order to eliminate inaccurate birth weight measurements made at home.
- Only singleton neonates were considered because twins or triplets may affect birth weight.

Sampling technique

A two-stage stratified sampling technique was employed to select primary sampling units (PSUs), comprising villages in rural areas and census enumeration blocks (CEBs) in urban areas. Data collection for NFHS-5 was carried out by trained personnel using a comprehensive, pretested, and structured questionnaire, following the acquisition of written informed consent from all respondents. At every stage of data collection, stringent measures were taken to ensure the confidentiality of participant information. A detailed description of the sampling framework, household selection criteria, and data collection methodology is available in the published NFHS-5 report [4].

Study procedure

176,843 (24.4%) of the 724,115 women who participated in the survey reported that they had recently given birth in the 12 months preceding the health survey. Among them, 155,624 (21.5%) had delivered in hospitals or health care facilities. Of these, 154,147 (21.1%) had singleton deliveries. However, only 91,821 women (12.7%) were able to present a Hospital Birth Report Card that included a recorded birth weight, and these women were included in the final analysis for the study.

A total of 547,272 (75.5%) women with a history of childbirth in the distant past (beyond the last 12 months) were excluded, of whom 21,219 (2.9%) had home deliveries, 1477 (0.2%) had twins, 2714 (1.76%)

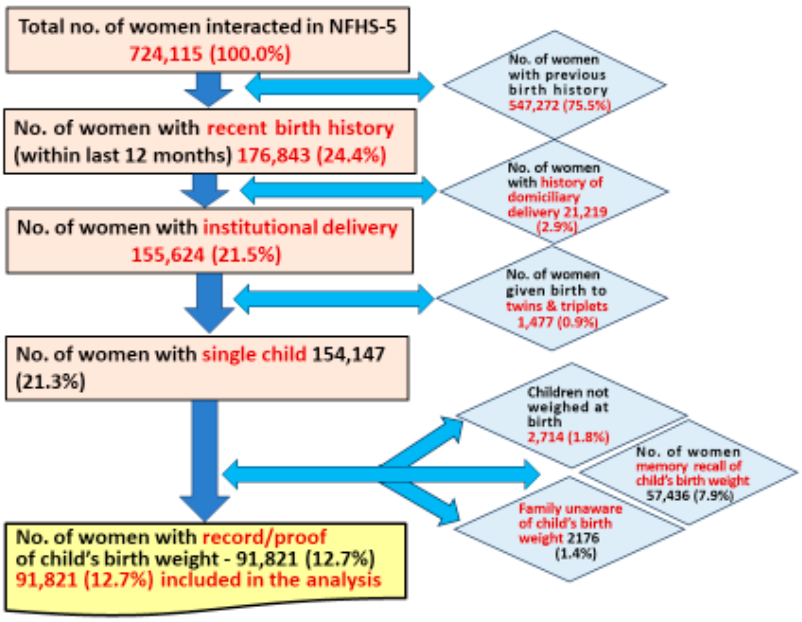

Figure 1. Blueprint of sample selection

had babies not weighed at birth, and 2136 (1.39%) did not know the exact weight of the child.

Dependent and independent variables

Newborn babies with a recorded birth weight of 1499 g or less were endorsed as 'very low birth weight' (VLBW) and the same was considered a dependable variable.

The study used a range of social correlates as independent variables, including maternal age at interview, educational level, economic status, marital status, religion, and residence. Various reproductive attributes like maternal age at birth, birth order, birth interval, complications during pregnancy as well as antecedent behaviours like smoking and alcohol consumption were taken into account as independent variables. Antenatal elements like the total no. of antenatal visits, tetanus vaccination during antenatal care (ANC), the place of childbirth, and accessibility to maternity services constituted other independent variables in the analysis. The optimum no. of ANC visits was considered to be 4 or more [6].

Various categories of maternal BMI grade, like underweight (< 18.5 kg/m²), normal (18.5-24.9 kg/m²), overweight (25.0-29.9 kg/m²), and obese (≥ 30.0 kg/m²), were analysed, studied, and derived from the data set available in the NFHS-5 record [6]. Anaemia in a pregnant woman has been considered when her blood haemoglobin level is found to be ≤ 10.99 g/dL. Mild, moderate, and severe grade of anaemia in pregnant women have been further categorised as 10.0-10.9 g/dL, 7.0-9.9 g/dL, and < 7.0 g/dL, respectively [7].

Data analysis

Descriptive statistics, including frequencies (no.), percentages, means, and standard deviations (SD) were utilized to summarize the data. Inferential statistics were applied using the *Chi*-square (χ^2) test to evaluate associations between categorical variables. All data were systematically organized and presented in tabular format. A p-value of ≤ 0.05 was considered indicative of statistical significance. Multiple logistics regression analysis was applied to ascertain the most important predictor of VLBW births.

Ethical consideration

The data utilized in this analysis were obtained from the 5th National Family Health Survey (NFHS-5, 2019-2021), which is freely available in the public domain. The dataset contains no identifiable personal information, ensuring participant anonymity. As the data are secondary in nature and have already been published, therefore, ethical clearance was not sought from any institutional review board. The original source has been duly acknowledged and cited in the present work.

RESULTS

Study coverage and participant profile

The NFHS-5 survey encompassed 636,699 households nationwide, yielding responses from 724,115 adult women and 101,839 men. For this analysis, data from 91,821 women aged 15-59 years with recorded singleton births in the preceding 12 months were included. The sample frame spanned both urban and rural PSUs, with an initial listing and mapping of households conducted to ensure systematic selection. From each PSU, 22 households were randomly chosen, adhering to Probability

Table 1. Social and demographic characteristics of study respondents

Sociodemographic traits of women participants (n = 91,821)		No. (%) of women
Age at the time of interaction	15-24 years	30,302 (33.0)
	25-34 years	49,220 (53.6)
	35-59 years	12,299 (13.4)
Residence	Urban	32,276 (35.2)
	Rural	59,545 (64.8)
Caste and tribe	Scheduled caste	22,510 (24.5)
	Scheduled tribe	11,730 (12.8)
	Other backward class (OBC)	40,224 (43.8)
	Higher caste	17,357 (18.9)
Educational status	No formal education	13,301 (14.5)
	Primary education	11,823 (12.9)
	Secondary education	45,659 (49.7)
	Higher secondary and above	21,038 (22.9)
Nutritional profile	Underweight	17,352 (18.9)
	Normal	59,523 (64.8)
	Overweight	11,722 (12.8)
	Obese	3224 (03.5)
Religion	Hindu	74,628 (81.3)
	Muslim	13,300 (14.5)
	Christian	2220 (02.4)
	Other religions	1673 (01.8)
Employment status	Never employed	77,563 (84.5)
	Currently unemployed	11,156 (12.1)
	Currently employed	3102 (03.4)
Economic class	Poorest	17,349 (18.9)
	Poorer	21,036 (22.9)
	Middle	21,036 (22.9)
	Rich	22,139 (24.1)
	Very rich	10,261 (11.2)

Proportional to Size principles (PPS) to reflect the population representation accurately.

Table 1 reflects that the majority of the women respondents belonged to 25-34 years age group (53.6%), staying in rural area (64.8%), hailing from other backward class (OBC – 43.8%), educated to secondary level (49.8), underweight (19%), following Hinduism (81.3%), never employed (84.5%), and allied to lower economic strata (41.8%).

Table 2. Low birth weight (LBW) & very low birth weight (VLBW) child birth according to sociodemographic attributes of study subjects

Sociodemographic traits		Normal birth weight (NBW)	Low birth weight (n = 16,011)		p-value
Sub-attributes (n = 91,821)		NBW ≥ 2500 g (n = 75,810) No. (%)	LBW 1500-2499 g (n = 15,001) No. (%)	VLBW ≤ 1499 g (n = 1010) No. (%)	
Age in years at delivery [No. (%)]					
15-24 years	30,301 (33.0)	24,191 (79.8)	5655 (18.7)	455 (1.5)	$\chi^2 = 334.6$ p = 0.00001 $V_C = 0.04$
25-34 years	49,222 (53.6)	41,399 (84.1)	7470 (15.2)	353 (0.7)	
≥ 35 years	12,298 (13.4)	10,220 (83.1)	1876 (15.3)	202 (1.6)	
Residence [No. (%)]					
Urban	32,276 (35.2)	26,473 (82.0)	5460 (16.9)	343 (1.1)	$\chi^2 = 2.3$ p = 0.0021 $V_C = 0.01$
Rural	59,545 (64.8)	49,338 (82.9)	9540 (16.0)	667 (1.1)	
Caste [No. (%)]					
Scheduled caste	22,510 (24.5)	18,383 (81.7)	3915 (17.4)	212 (0.9)	$\chi^2 = 82.6$ p = 0.00001 $V_C = 0.02$
Scheduled tribe	11,730 (12.8)	9473 (80.8)	2136 (18.2)	121 (1.0)	
OBC	40,224 (43.8)	33,525 (83.3)	6235 (15.5)	464 (1,1)	
Higher caste	17,357 (18.9)	14,429 (83.1)	2715 (15.6)	213 (1.2)	
Literacy standard [No. (%)]					
Illiterate	13,302 (14.5)	10,105 (76.0)	2746 (20.6)	451 (3.4)	$\chi^2 = 82.6$ p = 0.00001 $V_C = 0.02$
Primary class	11,821 (12.9)	9329 (78.9)	2280 (19.3)	212 (1.8)	
Sec. education	45,661 (49.7)	38,080 (83.3)	7335 (16.1)	246 (0.6)	
Higher sec./more	21,037 (22.9)	18,296 (86.9)	2640 (12.6)	101 (0.5)	
Nutritional status [No. (%)]					
Underweight	17,352 (18.9)	13,848 (79.8)	3051 (17.6)	453 (2.6)	$\chi^2 = 444.5$ p = 0.00001 $V_C = 0.04$
Normal	59,523 (64.8)	49,240 (82.7)	9864 (16.6)	419 (0.7)	
Overweight	11,724 (12.8)	9952 (85.0)	1665 (14.2)	107 (0.9)	
Obese	3222 (3.5)	2770 (86.0)	421 (13.1)	31 (1.0)	
Religion [No. (%)]					
Hindu	74,628 (81.3)	61,576 (82.5)	12,326 (16.5)	726 (1.0)	$\chi^2 = 126.9$ p = 0.00001 $V_C = 0.02$
Muslim	13,303 (14.5)	10,905 (81.8)	2150 (16.1)	248 (1.9)	
Christian	2218 (2.4)	1848 (83.3)	345 (15.6)	25 (1.1)	
Others	1672 (1.8)	1481 (88.6)	180 (10.8)	11 (0,66)	
Employment status [No. (%)]					
Never employed	77,564 (84.5)	63,451 (81.8)	13,216 (17.0)	897 (1.2)	$\chi^2 = 201.8$ p = 0.00001 $V_C = 0.03$
Currently unemployed	11,156 (12.1)	9693 (86.9)	1380 (12.4)	83 (0.7)	
Currently employed	3101 (3.4)	2666 (86.0)	405 (13.1)	30 (0.9)	
Economic class [No. (%)]					
Poorest	17,349 (18.9)	13,879 (80.0)	3071 (17.7)	399 (2.3)	$\chi^2 = 562.1$ p = 0.00001 $V_C = 0.05$
Poorer	21,036 (22.9)	16,946 (80.6)	3825 (18.2)	265 (1.3)	
Middle	21,036 (22.9)	17,446 (82.9)	3460 (16.5)	130 (0.6)	
Rich	22,139 (24.1)	18,659 (84.2)	3355 (15.2)	125 (0.6)	
Very rich	10,261 (11.2)	8880 (86.5)	1290 (12.6)	91 (0.9)	

Percentage calculated as per sub-groups (column-wise); χ^2 – *Chi*-square; V_C – Cramer's V coefficient

Nearly 45% of VLBW babies (above 450 of 1010) were born among young, underweight, and illiterate mothers showing statistically significant associations of moderate to weak strength (V_C 0.04-0.02) (Table 2). A striking 89% of VLBW births (897 of 1010) were borne by mothers who were never employed, while 40% (399 of 1010) occurred among those hailing from the most impoverished economic strata, both reflecting associations of moderate strength (V_C 0.03-0.05). VLBW babies from mothers of rural areas, OBC lineage, and following Hinduism showed significant but weaker associations. A large proportion of LBW

Table 3. Low birth weight (LBW) &very low birth weight (VLBW) child birth according to reproductive and antenatal attributes of study subjects

Reproductive traits		Normal birth weight	Low birth weight ,(n = 16,011)		p-value
Sub-attributes (n = 91,821)		NBW ≥ 2500 g (n = 75,810) No. (%)	LBW 1500-2499 g (n = 15,001) No. (%)	VLBW ≤ 1499 g (n = 1010) No. (%)	
ANC visits [No. (%)]					
No visit	4132 (4.5)	3006 (72.7)	1065 (25.8)	61 (1.5)	$\chi^2 = 321.6$, p = 0.00001 $V_C = 0.04$
< 4 visits	44,158 (48.1)	36,904 (83.5)	6741 (15.3)	513 (1.2)	
4 visits	43,531 (47.4)	35,900 (82.5)	7195 (16.5)	436 (1.0)	
Anaemia [No. (%)]					
Severe	2111 (2.3)	1665 (78.9)	349 (16.5)	97 (4.6)	$\chi^2 = 830.4$, p = 0.0001 $V_C = 0.07$ Z = 13.8, p < 0.0001
Moderate	26,720 (29.1)	22,083 (82.6)	4367 (16.3)	270 (1.0)	
Mild	24,608 (26.8)	20,013 (81.3)	4035 (16.4)	560 (2.3)	
Normal	38,382 (41.8)	32,049 (83.5)	6250 (16.2)	83 (0.2)	
Birth order [No. (%)]					
1	33,974 (37.0)	27,859 (30.3)	5780 (17.0)	335 (1.0)	$\chi^2 = 26.5$, p = 0.00002 $V_C = 0.01$
2/3	48,665 (53.0)	40,392 (44.0)	7715 (15.8)	558 (1.1)	
4	9182 (10.0)	7559 (8.2)	1506 (16.4)	117 (1.3)	
Birth interval [No. (%)]					
< 24 month	25,030 (27.3)	20,000 (79.9)	4722 (18.9)	308 (1.2)	$\chi^2 = 169.4$, p = 0.00001 $V_C = 0.04$
> 24 month	66,791 (70.6)	55,810 (83.5)	10,279 (15.4)	702 (1.1)	
Gender of the newborn [No. (%)]					
Male	49,378 (53.8)	41,614 (84.3)	7350 (14.9)	414 (0.8)	$\chi^2 = 242.3$, p = 0.00001 $V_C = 0.05$
Female	42,443 (46.2)	34,196 (80.6)	7651 (18.0)	596 (1.4)	
Pregnancy complications [No. (%)]					
No	21,119 (23.0)	17,619 (83.5)	3302 (15.6)	198 (0.9)	$\chi^2 = 17.3$, p = 0.0001 $V_C = 0.01$
Yes	70,702 (77.0)	58,191 (82.3)	11,699 (16.6)	812 (1.1)	
Caesarean section [No. (%)]					
No	67,304 (73.3)	55,706 (82.8)	10,892 (16.2)	706 (1.0)	$\chi^2 = 10.9$, p = 0.004 $V_C = 0.01$
Yes	24,517 (26.7)	20,104 (82.0)	4109 (16.8)	304 (1.2)	
Iron-folic acid supplement [No. (%)]					
No	9184 (10.1)	7347 (80.0)	1725 (18.8)	112 (1.2)	$\chi^2 = 46.8$, p = 0.00001 $V_C = 0.02$
Yes	82,637 (89.9)	68,463 (82.8)	13,276 (16.1)	898 (1.1)	
Tetanus injection [No. (%)]					
No	3765 (4.1)	3049 (81.0)	671 (17.9)	45 (1.1)	$\chi^2 = 6.8$, p = 0.03 $V_C = 0.01$
Yes	88,056 (95.9)	72,761 (82.6)	14,330 (16.3)	965 (1.1)	
Use cigarette/tobacco [No. (%)]					
Yes	2556 (2.8)	2055 (80.4)	430 (16.8)	71 (2.8)	$\chi^2 = 69.2$, p = 0.00001 $V_C = 0.03$
No	89,265 (97.2)	73,755 (82.6)	14,571 (16.3)	939 (1.1)	
Consume alcohol [No. (%)]					
No	91,454 (99.6)	75,526 (82.6)	14,925 (16.3)	1003 (1.1)	$\chi^2 = 7.7$, p = 0.02 $V_C = 0.01$
Yes	367 (0.4)	284 (77.4)	76 (20.7)	7 (1.9)	

Percentage calculated as per sub-groups (column-wise); χ^2 – *Chi*-square; V_C – Cramer's V coefficient; Z – Cochran Armitage trend test for VLBW trend

babies were born to mothers from younger age groups, scheduled caste communities, and those who had never been employed. Similarly, factors like low economic status, undernutrition, and rural residence showed significant associations with occurrence of LBW births.

Table 3 shows that large proportion of mother who did not avail the antenatal visits at all, gave birth to statistically significant percent of LBW babies (26%). Severely anaemic mothers had the significant LBW rate (17%). Tobacco use and alcohol consumption among mothers resulted in significantly higher percent of LBW babies in the measures of around 17% and 21% respectively. Higher birth order (16%) and shorter birth interval (19%) among mothers were also important determinants for LBW babies. Large percentage of mothers with gestational complications, caesarean section, no iron supplementation, and lack of TT vaccination contributed significantly in the birth of around 17-19% of the LBW babies.

Severe anaemia among mothers accounted for significant occurrence of VLBW babies (4.6%) along with a statistically significant graded trend according to the categories of anaemia. Maternal tobacco use and alcohol consumption were associated with significantly higher rates of birth of VLBW babies, approximately 2.8% and 1.9% respectively. The absence of antenatal care, female sex of the newborn, higher birth order, short inter-pregnancy intervals, and lack of iron supplementation were all significantly associated with the birth of VLBW babies, with occurrence rates ranging from 1.5% to 1.2% in the respective groups. Gestational complication, caesarean section and lack of anti-tetanus shot were also found significantly associated with VLBW occurrence.

Regional occurrence of LBW and VLBW births

Rural areas consistently report higher LBW and VLBW percentages across all regions compared to urban areas (Figure 2). The highest LBW occurrence is seen in Central rural India (20.7%), while the lowest is in Northeast urban sector (10.8%). VLBW prevalence shows a similar trend with rural areas slightly exceeding urban in every region. The rural-urban gap is most evident in the Central and West regions, indicating implication of local factors and influences.

A combination of socio-demographic and maternal reproductive correlates observed significantly associated with an increased risk of both LBW and VLBW in newborns is depicted in (Table 4 and Figure 3). Among these, certain determinants emerge as particularly influential like illiteracy (3.42), anaemia (3.36), undernutrition (3.11), tobacco use (2.41) lack of antenatal care (1.98), and economic status (1.85) reflecting significant risks for birth of VLBW babies. Risk prediction for LBW babies included lack of antenatal care (1.36), anaemia (1.28), economic status (1.25), illiteracy (1.21), short birth spacing (1.18), young age maternity (1.15), and lack of iron supplement (1.14). Analysis indicates the weightage of risks are neither equal nor universal for LBW and VLBW occurrence.

DISCUSSION

Global and Indian trends of LBW – VLBW

Around the world, 14.6% of the neonates are born with low birth weight (LBW), constituting 25 million cases every year; 95% of that occurs in LMICs, with South Asia collectively sharing for 52% of the total burden [8]. Data analysis from the National Family

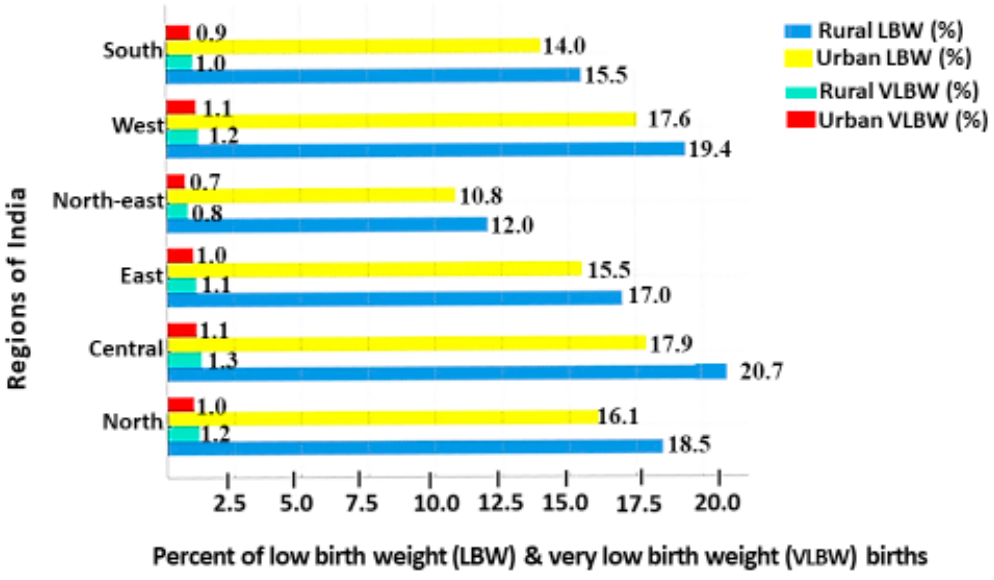

Figure 2. Region wise percentage of LBW and VLBW births

Table 4. Adjusted Odds Ratios (AOR) and 95% CI for socio-demographic and reproductive predictors of low birth weight (LBW) & very low birth weight (VLBW)

Predictor	Category	LBW AOR (95% CI)	p-value	VLBW AOR (95% CI)	p-value
Age at delivery	15-24 years	1.15 (1.09-1.22)	< 0.001	1.95 (1.75-2.15)	< 0.001
Caste	Scheduled tribe	1.10 (1.04-1.18)	< 0.001	1.28 (1.08-1.48)	0.02
Literacy	Illiterate	1.21 (1.11-1.32)	< 0.001	3.42 (3.21-3.63)	< 0.001
Nutritional status	Underweight	1.08 (1.02-1.14)	0.01	3.11 (2.90-3.32)	< 0.001
Economic class	Poorest	1.25 (1.17-1.34)	< 0.001	1.85 (1.69-2.01)	< 0.001
ANC visits	No visits	1.36 (1.27-1.46)	< 0.001	1.98 (1.77-2.19)	< 0.001
Anemia	Severe	1.28 (1.15-1.43)	< 0.001	3.36 (3.22-3.50)	< 0.001
Tobacco use	Yes	1.12 (1.01-1.23)	0.03	2.41 (2.22-2.60)	< 0.001
Iron supplement	No	1.14 (1.07-1.22)	< 0.001	1.18 (1.07-1.29)	0.04
Birth interval	< 24 months	1.18 (1.12-1.26)	< 0.001	1.29 (1.11-1.47)	0.006

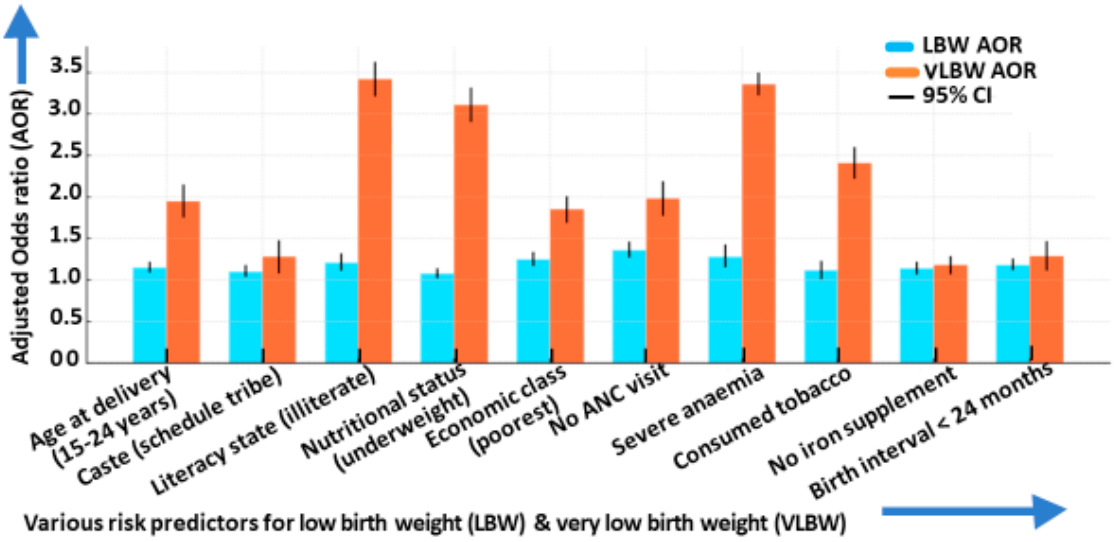

Figure 3. AOR of low birth weight (LBW) and very low birth weight (VLBW) according to the socio-demographic predictors

Health Survey (NFHS) in India exhibited a decline in LBW load from 22% in 2005-2006 (NFHS-3), to 17.5% in 2015-2016 (NFHS-4) [9]; however, this was not enough to achieve the desired 30% fall in LBW burden by 2030 [1]. Studies from the recent past depicted an occurrence of very low birth weight (VLBW) neonates during NFHS-4 (2015-2016) has been 1.2% which is significantly high, a cause of concern and imperative for forecasting further interventions to plummet the accompanying morbidity and mortality [10]. Regional work in Theni district of Western Tamil Nadu unveiled that LBW accounted for 16.3% of neonates and just above 1% of the new born babies were VLBW. Based on the trend analysis, the proportion of LBW babies born has steadily amplified since 2018 with an insignificant dip in 2022, while that of VLBW babies has consistently spiked since 2018 [11]. CDC US documented LBW and VLBW births as 8.6% and 1.36% of the total babies born in 2022 respectively indicating an upward swing for both [12]. The proportion of LBW babies born in England has been 7.2% in 2022, an increase from 2021 (6.8%); however, it remained unchanged at around 7.4% between 2011 and 2018. Percent of VLBW babies born in England has been 1% in 2022 and remained stable since 2020. Birth of LBW and VLBW babies has been higher in deprived sectors being 9.2% and 1.3% respectively against 5.6% and 0.8% in the developed areas of United Kingdom [13].

Intersecting social axis for LBW and VLBW risk

The present analysis reveals crucial sociodemographic and maternal health determinants associated with the occurrence of LBW and VLBW babies in the study population. The striking over-representation of young women aged 25-34 years

(53.6%), residing in rural areas (64.8%), belonging to OBC category (43.8%), educated up to secondary level (50%), unemployed (81%), and economically disadvantaged (42%) align with national demographic trends, where indigent and marginalized communities often exhibit poor gestational outcome due to limited access to the healthcare and social support services intended for expectant as well as prospective mothers [5]. Consequently, the crucial intersection of poverty, limited education, caste-based disparities, and rurality emerges as a powerful axis along which maternal and neonatal vulnerabilities are reproduced.

The analysis discerned that the burden of LBW among the representative Indian population during the study tenure of 2019 to 2021 stood at a notable 17.4%, within which VLBW newborns constituted 1.1% – representing 6.3% of all LBW births, resonating harmoniously with the patterns observed in parallel scholarly investigations on NFHS-4 data further reaffirming the persistence of this public health concern [10, 11]. Rural areas consistently reflected higher LBW and VLBW percentages across all regions compared to urban areas. The highest LBW occurrence is seen in Central rural India, while the lowest is in North-east urban sector. Beyond the clinical implications, it highlights the limited progress in addressing maternal and neonatal health disparities as well as calls for renewed and targeted interventions in maternal health care to curb the intergenerational cycle of poor gestational outcome.

Imprint of maternal disadvantage on birth weight

The finding of the disproportionate concentration of VLBW births borne by young, illiterate, and underweight mothers aligns with an extensive body of literature emphasizing the critical influence of maternal age, educational attainment, and nutritional status as key determinants of adverse neonatal outcomes. Younger maternal age and lack of formal education have been consistently associated with diminished awareness and utilization of antenatal care services, alongside inadequate nutritional practices [14, 15]. Moreover, maternal undernutrition evidenced by a considerable prevalence of underweight women represent a formidable public health challenge in rural India, is akin to the findings of the current analysis. Such nutritional deficiencies are strongly implicated in intrauterine growth restriction, thereby increasing the likelihood of both LBW and VLBW deliveries [16]. These findings underscore the urgent need for targeted interventions that address the intersecting vulnerabilities of youth, illiteracy, and malnutrition among pregnant women in resource-constrained environments. A tripartite strategy encompassing enlightened education, tailored adolescent maternal care, and community engagement stands paramount in augmenting antenatal cognizance, nutritional prudence, and equitable healthcare access among the expectant mothers.

A substantial majority of VLBW births have been reported among the unemployed mothers, indicating a strong and significant association that emphasizes the impact of socioeconomic disadvantage on gestational outcomes aligning with the current findings. Unemployed women, particularly in rural contexts, often lack financial autonomy and face barriers in accessing quality health services, resulting in delayed or inadequate ANC [17]. Furthermore, the pronounced concentration of VLBW births (40%, 399 of 1010) among mothers from the poorest households reinforces the existing evidence that economic hardship restricts access to adequate nutrition and timely medical care, thereby exacerbating the risk of adverse birth outcomes [18].

Beyond biology: grip of social stratification on neonatal health

Rural residence, identity of OBC, and Hinduism have been moderately associated with VLBW, albeit with comparatively smaller effect sizes. These demographic characteristics often intersect with entrenched structural determinants – such as social marginalization, limited geographical accessibility, and systemic deficiencies within healthcare infrastructure that collectively influence adverse maternal and neonatal health outcomes. A recent work highlighted significant caste and regional disparities in the utilization of maternal and child healthcare services in India, noting that individuals from disadvantaged social groups, including OBCs and rural residents, face substantial barriers in accessing complete healthcare [19]. Similarly, a recent review reflected that rural residence and belonging to socially backward castes are consistently linked to lower utilization of maternal health services, further exacerbating health inequities [20].

Invisible barriers and structural shadows – unseen hand of disparity

The patterns of LBW births closely echo those observed for VLBW occurrence, particularly among socioeconomically vulnerable groups. Women who are younger, unemployed, and economically disadvantaged consistently exhibit surged rate of LBW births, highlighting the critical intersection of age, employment status, and income with gestational outcomes and consequences [20]. Statistically significant associations between LBW and its determinants such as maternal undernutrition, low socioeconomic status, and rural residence have been consistently documented across South East Asia. These variables are salient contributors to

intrauterine growth restriction and preterm delivery. Although effect sizes remain modest in the present analysis, the consistency and directional alignment of these associations elucidate the compounded disadvantage experienced by rural, socioeconomically marginalized, and vulnerable undernourished women as reflected by other scholars [21, 22]. Of particular concern is the disproportionately high concentration of LBW births, borne by the women belonging to the Scheduled Castes (SC); this finding is especially salient in the Indian context, where SC communities continue to face entrenched social exclusion, economic marginalization, and systemic blockades to access basic healthcare services [23]. The persistent caste-based inequities in maternal and neonatal health outcomes are well-documented and can be attributed to a combination of historical disadvantage and contemporary institutional neglect. Scholars have argued that caste, in conjunction with gender and economic class, constitutes a fundamental axis of stratification that determines access to healthcare resources, nutritional adequacy, and exposure to environmental risks during pregnancy [24]. These intersecting inequalities manifest not only in differential axis to antenatal care, but also portray disparities in health literacy, autonomy in health decision-making, and exposure to psychosocial stressors – all of which contribute cumulatively to adverse birth outcomes [19].

The silent burdens: unmet antenatal needs and maternal anaemia

The most salient determinant discerned in the analysis was the absence of antenatal care, that resonates with an expansive corpus of contemporary research underlining the indispensable role of ANC in safeguarding maternal-fetal health. A recent systematic review revealed that women who did not attend any ANC visits had a 54% higher risk of delivering LBW neonates compared to those who had at least one ANC visit [25]. Similarly, a retrospective study demonstrated that inadequate ANC – defined as fewer than four visits or initiation after the first trimester – was associated with increased odds of LBW [26]. Through timely surveillance of gestational progress, judicious management of obstetric complications, and optimization of maternal nutrition, ANC emerges as a linchpin in mitigating intrauterine growth restriction thereby curtailing the risk of LBW and VLBW outcomes.

Severe maternal anemia was another strong contributor to LBW and VLBW, showcasing a clear gradient correlation with the severity of anemia – analogous to consistent findings by many scholars. Severe maternal anemia stands as a formidable determinant of adverse neonatal outcomes, notably LBW and VLBW babies. Empirical evidence from a recent study in India, reveals that severe anemia in pregnant women is significantly associated with increased risks of preterm birth and LBW, with the risk intensifying in correlation with the severity of anemia. Specifically, the study found that women with severe anemia had higher odds of delivering LBW infants compared to non-anemic counterparts [27]. Anemia during pregnancy compromises oxygen transport to the fetus, leading to intrauterine growth restriction and preterm birth, both of which are direct causes of LBW and VLBW newborns. These findings accentuate the imperative of routine hemoglobin monitoring and the administration of iron-folic acid supplementation throughout pregnancy. The World Health Organization advocates for daily supplementation with 60 mg of elemental iron and 500 µg of folic acid as part of standard antenatal care to mitigate the risks associated with maternal anemia [28].

Toxic choices from womb to world

Maternal substance use during prenatal period, particularly tobacco and alcohol remains a significant determinant of adverse gestational outcomes, notably LBW and VLBW that is similar to the findings of the current intent [29, 30]. Tobacco exposure impairs fetal development via placental insufficiency and fetal hypoxia; nicotine and carbon monoxide induce vasoconstriction, compromising uteroplacental perfusion and nutrient transfer to foetus. Likewise, alcohol traverses the placenta and accumulates in amniotic fluid, disrupting cellular differentiation and organogenesis contributing to growth restrictions and increasing the risk of LBW and VLBW [31]. Concomitant use of both substances, tobacco as well as alcohol, exacerbates these effects, highlighting the imperative for integrated maternal health interventions [32]. This evidence potentiates the imperative for nuanced public health policy that seamlessly embeds maternal substance use prevention within the broader continuum of reproductive care. Strategic community engagement, regulatory oversight of substance marketing, and equitable access to support services must converge to arrest the intergenerational toll of LBW and VLBW occurrence.

Birth order, intervals, and neonatal risk

Higher birth order and short birth intervals (BIs) are significantly associated with increased risks of LBW and VLBW in the present work; and commensurate with annotation from NFHS-4 indicating around 12% of births occurred within six months of a previous pregnancy resulted in 19.4% of LBW babies. This is notably higher compared to the 16.0% observed in births with BIs of 18-23 months [33]. The compounded effect of higher birth order and short birth intervals

places additional strain on maternal resources and reduces physiological recovery time between pregnancies, thereby elevating the risk of adverse birth outcomes [33]. Recent studies have reported that mothers who consumed fewer than 100 IFA tablets or received fewer than two TT (tetanus toxoid) injections had 1.2 times higher risk each of delivering LBW and VLBW babies resonating similarly with the findings of the present analysis [33]. These findings highlight the critical role of comprehensive antenatal care, including adequate IFA supplementation and TT vaccination, in enhancing pregnancy outcomes.

Influence of neonatal sex and obstetric factors on birth weight

Interestingly, the female sex of the newborn found modestly associated with LBW and VLBW occurrence in this research; and is consistent with previous research indicating that male foetuses tend to exhibit a slightly higher in-utero growth trajectory [6, 34]. This increased growth potential may lower the likelihood of male newborns being classified as LBW or VLBW compared to their female counterparts [35]. Gestational complications and caesarean deliveries have been consistently associated with LBW and VLBW newborns, pointing towards the clinical management strategies often employed in high-risk pregnancies. These associations, however, should not be interpreted as causal; rather, they reflect underlying maternal or fetal conditions – such as preeclampsia, intrauterine growth restriction (IUGR), or fetal distress – that necessitate medical intervention [34, 36]. Moreover, a retrospective cohort study demonstrated that aesarean delivery was associated with lower neonatal morbidity in VLBW infants, suggesting that the mode of delivery is often a response to pre-existing complications rather than a direct cause of low birth weight [37]. Therefore, while these associations are evident, they primarily reflect the underlying conditions prompting medical intervention rather than indicating a direct causal relations.

Complex risk differentials

A complex interplay of socio-demographic and maternal reproductive factors significantly elevates the risk of both LBW and VLBW births. Key contributors to VLBW include maternal illiteracy (AOR: 3.42), anaemia (AOR-3.11), tobacco use (AOR-2.41), lack of antenatal care (AOR-1.98), and low economic status (AOR-1.85), reinforcing findings from global studies [6]. For LBW, moderate risks are observed with limited antenatal care, anaemia, economic status, and illiteracy – factors commonly reported in LMICs [38]. These patterns highlight that risk intensity is neither uniform nor universal for LBW and VLBW. The differential strength and nature of these risks highlight the necessity for stratified prevention strategies that distinguish the aetiologies of LBW and VLBW, mitigating them as diverse group of risks.

Compound vulnerabilities vs. social consumption of health

The short and long term ramifications of LBW/VLBW neonates substantially amplify healthcare-related social expenditure, particularly in impoverished and socioeconomically vulnerable communities. In the immediate term, LBW/VLBW newborns are disproportionately afflicted by recurrent childhood morbidities such as ARI (acute respiratory infection), diarrheal diseases, pneumonia, PEM, and septicaemia. Over time, these children often endure a pernicious cycle of malnutrition and infection that may extend to adulthood, culminating in a heightened susceptibility to chronic non-communicable diseases including adult-onset insulin resistance, type-2 diabetes mellitus, CHD, and obesity. The advent of advanced treatment modalities and neonatal care technologies, has markedly escalated the cost of nurturing and sustaining LBW/VLBW babies – imposing a significant financial burden on already strained household resources. Although healthcare utilization patterns may appear comparable between LBW/VLBW and NBW neonates, the former invariably incur higher out-of-pocket expenditures owing to their increased vulnerability to illness. Indeed, annual healthcare costs related to common childhood morbidities among LBW children have been observed to exceed those of NBW counterparts by nearly 13%. This reality imposes an urgent and compelling imperative: the seamless integration of anticipatory prevention and robust primary healthcare into the very fabric of community life – particularly at the grassroots – where lies the transformative potential to mitigate, if not preclude, the avoidable risks associated with VLBW and to safeguard the delicate promise of life from its very inception.

Strengths of the study

The paramount distinction of this scholarly endeavour lies in its exceptionally large and meticulously curated sample, derived through a scientifically rigorous and methodologically sound sampling framework – ensuring an unparalleled degree of national representativeness. The estimation of birth weight is relied upon meticulously documented maternal records, a methodological refinement that likely confers superior precision and fidelity in capturing the true magnitude of the burden across the diverse socio-geographic spectra of rural and urban India. Furthermore, as the data emanate from authoritative records duly accredited by health centres and hospitals, their authenticity, reliability, and overall

evidentiary integrity may be regarded as exemplary and beyond reproach.

Limitations of the study

As an inherently cross-sectional inquiry, this study is limited in its capacity to infer definitive causal relationships or establish the temporality of associations observed. Moreover, the analysis did not incorporate a range of critical socio-environmental determinants intimately linked with VLBW/LBW, including water quality, sanitation, kitchen hygiene, maternal dietary practices, and the extent of psychosocial support accessible to mothers – factors which may exert a profound and multifaceted influence on neonatal outcomes. A further limitation arises from the reliance on self-reported data for several variables, rendering the findings vulnerable to considerable recall error and social desirability bias, particularly in relation to culturally sensitive behavioural risk factors such as tobacco and alcohol consumption. These methodological constraints, while not uncommon in large-scale epidemiological research, italicize the necessity for future studies with more comprehensive and rigorously controlled data to illuminate the complex aetiology of VLBW/LBW with greater clarity and empirical precision.

CONCLUSIONS

Approximately one in every six women in India gives birth to either LBW or VLBW infant, with the burden disproportionately borne by illiterate women from impoverished and socially marginalized communities. This inequity reveals a deeply entrenched nexus between LBW/VLBW and pivotal social determinants – most notably maternal literacy, chronic undernutrition, and economic deprivation. Alarmingly, the prevalence of LBW has shown minimal attenuation over recent years, despite the Government of India's unwavering commitment and steadily escalating investments in nutritional supplementation and food security initiatives targeting underserved populations. This troubling persistence signals a pressing need for the innovation and deployment of a more incisive, integrative, and empirically grounded nutritional support framework – tailored to the physiological and socio-economic realities of expectant mothers. Within this, critical public health endeavour, the time-honoured trios of state benevolence – manifest in transformative initiatives such as the Integrated Child Development Services (ICDS), the Janani Suraksha Yojana (JSY), and the Janani Shishu Suraksha Karyakram (JSSK) – stand not merely as bureaucratic instruments, but as luminous beacons of promise and catalytic agents of social upliftment. To actualise the potential of these interventions, a renewed emphasis on strategic implementation, inter-sectoral synergy, and community engagement is indispensable. Notably, the sustained surge in institutional deliveries, coupled with remarkable strides in digital health communication, has cast a spotlight on the quality and worth of LBW data – offering an unprecedented opportunity to anchor evidence-based, precision-targeted interventional research within the realities of public health practice.

Conflict of interest

The author declares no conflict of interest.

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ORIGINAL ARTICLE

BONE DENSITY AND IMPLEMENTATION OF RECOMMENDATIONS FOR DAIRY PRODUCTS CONSUMPTION AND PHYSICAL ACTIVITY IN WOMEN: A PILOT STUDY

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ABSTRACT

Background. Diet and lifestyle are key factors of osteoporosis prevention, and their synergistic interaction can significantly affect the condition of the skeletal system in women.

Objective. The aim of the study was to assess bone density and its relation with the implementation of recommendations regarding the consumption of dairy products and physical activity in young women.

Material and Methods. The study included 27 Caucasian women female participants aged 22-44 years (menstruate, non-menopausal). Dual energy X-ray beam absorptiometry (DEXA – Dual Energy X-Ray Absorptiometry; Lunar Prodigy camera) was used to assess bone density and indices as BMD (Bone Mineral Density), T-score and Z-score at the lumbar spine (L1-L4) and the femoral neck. Dairy intake was determined using the food frequency method for 4 subgroups: milk, fermented dairy drinks, rennet cheese and cottage cheese. The following criteria were used to assess compliance with the recommendations: for dairy intake at least 2 times per day, for physical activity at least 3 times per week.

Results. Recommendations for dairy intake or physical activity were followed by 33% and 74% of the women, respectively, both recommendations were followed by 26% of the women. Women meeting both recommendations had the highest median total BMD of 1.25 g/cm² (Q25-Q75: 1.20-1.34) and T-score of 1.70 (1.20-2.60). In women meeting only one recommendation, total BMD was 1.18 g/cm² (1.13-1.23) and T-score was 1.00 (0.50-1.50). The lowest values were found in women not meeting any of those recommendations, with total BMD of 1.14 g/cm² (1.07-1.19) and T-score of 0.60 (0.10-1.10).

Conclusions. Implementing both recommendations, namely for dairy intake and physical activity seems to be more effective for bone mineral density than following just one recommendation. In contrast, infrequent consumption of dairy products and low physical activity are associated with the risk of reduced bone mineral density in young women.

Keywords: *women, physical activity, osteoporosis, dairy products, bone*

INTRODUCTION

Osteoporosis is a systematic metabolic bone disease characterized by reduced bone density and abnormal bone structure, which leads to an increased risk of fractures [1, 2] Currently, about 32 million people worldwide suffer from osteoporosis, of which 25.5 million are women, who are more vulnerable to this problem due to bone loss after menopause [2]. In Poland in 2022, the number of patients was about 2.1 million, and cases of osteoporosis were more common in women - they accounted for 1.7 million of this group [3]. The increasing prevelance of this disease, especially in developed countries, where the average life expectancy is high, has the serious consequencies not only for affected individuals but also on the health system [2, 4]. In Europe, the annual costs of treatment of osteoporotic fractures are significant and depend on the level of development of national healthcare systems. The highest costs of osteoporotic fractures per person in 2019 were recorded in Switzerland (403 euros) and Denmark (251 euros), while the lowest were in Romania (13 euros) and Poland (18 euros) [2].

The standard method for measuring BMD (Bone Mineral Density) is the DXA (Dual Energy X-ray Absorptiometry) densitometry test. This test enables precise assessment of changes in bone density and identification of people at increased risk of fractures [2, 4]. DXA results enable not only precise diagnosis of the disease, but also an assessment of treatment effectiveness, which is particularly important in preventing further fractures [2, 5]. Currently, diagnostics

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and therapy for osteoporosis treatment are focused on a detailed assessment of the individual risk of fractures, which also requires collecting information on dietary and non-dietary risk factors for bone fractures [2].

It has been shown that dietary factors for bone factors play an important role in preventing osteoporosis. Adequate dietary calcium intake contributes to increased bone mineral density, especially during periods of intensive growth, such as childhood and adolescence [5]. These periods are crucial for the development of peak bone mass (PBM), nevertheless PBM can be still achieved by the end of the third decade of. Achieving higher BMD is an important preventive factor in the development of osteoporosis later in life, as higher BMD correlates with a lower risk of fractures and bone loss in adulthood. In adulthood, after reaching PBM, the role of dietary factors such as dairy products is less important. Nevertheless, calcium intake is still important, as it contributes to slowing the rate of bone loss, especially in group of older adults and postmenopausal women, in whom the decline in estrogen levels accelerates the process of bone demineralization [5, 6]. Higher BMD values were shown to be associated with normal serum vitamin D levels, which highlights the importance of the synergistic effects of calcium and vitamin D in bone formation [7, 8]. These mechanisms include increased calcium absorption in the gastrointestinal tract, stimulation of bone matrix mineralization, and regulation of bone resorption processes by osteoclasts. Furthermore, vitamin D deficiencies in populations with different levels of dairy product consumption may lead to reduced efficacy of these products in maintaining optimal bone health [9, 10]. In addition, vitamin K_2 plays a crucial role in proper calcium metabolism, osteoblast activation, and prevention of vascular calcification, and thus should also be considered as an important factor in maintaining bone health [11].

Physical activity is an important non-dietary factor in prevention of osteoporosis. According to the World Health Organization (WHO) guidelines, it should include strength and resistance exercises, especially in adults [12]. WHO recommends a minimum of 150 minutes of moderate-intensity physical activity per week, which strengthens the skeletal structure by increasing the mechanical forces acting on bones and stimulating osteogenesis. This mechanism is well explained by Frost's mechanostat theory, which posits that bone tissue adapts its mass and structure to habitual mechanical loading, increasing bone formation in response to higher strains and reducing bone mass when loads are insufficient [13, 14]. Regular physical activity in children, adolescents, and premenopausal women has been shown to improve BMD, particularly at weight-bearing skeletal sites such as the lumbar spine and hip [15]. Evidence consistently indicates that weight-bearing, high-impact, and resistance exercises are the most effective types of activity for maintaining and improving bone health, while sedentary behavior and insufficient activity are major risk factors for bone loss and osteoporosis development [15].

Diet and lifestyle are key factors of osteoporosis prevention, and their synergistic interaction can significantly affect the condition of the skeletal system. It is particular important in the female population, among whom the incidence of osteoporosis is higher than in men. The aim of the study was to assess bone density and its relation with the implementation of recommendations regarding the consumption of dairy products and physical activity in adult females.

MATERIAL AND METHODS

Study participants

Volunteers were recruited from July-August 2023 at the Warsaw University of Life Sciences, Poland. The participants were 27 apparently healthy Caucasian females aged 22-44 years who menstruate before menopause living in a big city. The inclusion criteria were: (1) age 20-50 y; (2) intake of dairy products; (3) no contraindications to DXA testing (recently administered gastrointestinal contrast or radionuclides; pregnancy; scoliosis, which may affect spine measurements; severe degenerative changes or fracture deformity in the measurement area; implants, hardware, devices, or other foreign material in the measurement area; the inability to attain the correct position or remain motionless for the measurement) [16]; (4) menstruating regularly; (5) normal body weight (BMI 18.5-24.99); (6) the lack of endocrine disorders and other disorders that could decrease BMD (e.g.: chronic renal failure, rheumatoid arthritis and other inflammatory arthritides. gastrointestinal malabsorption); (6) consent to participate in the study. The exclusion criteria included: (1) current vitamin D supplementation lasting at least 1 month; (2) using multivitamin preparations; (3) using hormone therapy; (4) using oral glucocorticoids; (5) smoking; (6) regular alcohol consumption (several times a week or every day). This study complied with the ethical guidelines of the Declaration of Helsinki. The study was approved by the Ethics Committee of the Institute of Human Nutrition Sciences, Warsaw University of Life Sciences, Poland (Resolution No. 39/2021), and informed consent was obtained from all participants.

Data

Dairy products intake

A Dietary Habits and Nutrition Beliefs Questionnaire (KomPAN®) [17] was used to assess the frequency of consumption of four dairy subcategories: milk, fermented milk products, cottage cheese, and

other types of cheese. All participants were asked to record their habitual frequency of consumption for each subgroups within the last twelve months according to the following categories: '1 – never or almost never', '2 – 1-3 times per month', '3 – once a week', '4 – several times a week', '5 – once a day', '6 – a few times a day'. According to KomPAN® [17], the consumption frequency of each subcategory was recoded into daily frequency: 0, 0.06, 0.14, 0.5, 1, and 2, respectively for 1., 2., 3., 4., 5., and 6. category. Then, all four daily frequencies were summed up and compared with Polish Food Based Dietary Guidelines [18]. A daily frequency of dairy products consumption equaled 2 or more was considered as meeting the dietary guidelines.

Physical activity

All participants were asked the question: 'How often do you engage in physical activity during the week?', and could choose one out of seven categories: '1 – never or almost never', '2 – once a week', '3 – twice a week', '4 – three times a week', '5 – four times a week', '6 – five times a week', '7 – 6-7 times a week'. The question description indicates that it refers to activity lasting at least 60 minutes of moderate or vigorous intensity. The physical activity undertaken at least 3 times a week was considered as meeting the WHO recommendations for adults [12].

Anthropometrics and bone density

Height (H) was measured with a portable stadiometer with the head in the horizontal Frankfurt plane and recorded with a precision of 0.1 cm (SECA 220, Hamburg, Germany), and weight to the nearest 0.1 kg using electronic scales. Body mass index (BMI) was calculated as weight/height^2 (kg/m^2) and was interpreted according to WHO recommendations [19]. Using dual energy X-ray absorptiometry (DXA) method (a densitometer: GE Lunar Prodigy, software version 1.31), fat content (% and centiles), Visceral Adipose Tissue (VAT), Subcutaneous Adipose Tissue (SAT), and Bone Mineral Density (BMD) at the lumbar spine (L2-4), femoral necks, whole body were measured. The densitometer was calibrated daily, and effective radiation dose for total body scan was 0.5 μSv, for lumbar spine – 0.7, and dual femur – 1.35 μSv [20]. Study participants were instructed not to take calcium supplements for 24 hours before the test, to fast for at least 12 hours, and to wear comfortable, loose-fitting clothing, avoiding metal elements such as zippers. Each woman was asked if there was a possibility of pregnancy. During the measurement of the lumbar spine, it was checked whether it was correctly positioned – the 12th rib and the iliac crest were visible on the image and whether the L4-L5 intervertebral disc was in line with the iliac crest. During the measurement of the femurs, the leg angle was adjusted so that the femoral shaft was in line with the vertical central axis of the image. Among the DXA results, the whole body, hips and lumbar spine BMD were used for further analysis. According to official position of International Society for Clinical Densitometry [21], to determine the occurrence of low bone density in adults younger than age 50, a Z-score of -2.0 or lower is defined as 'below the expected range for age' and a Z-score above -2.0 is 'within the expected range for age.' We also used T-score results, taking into account the WHO international reference standard. The WHO defines T-scores as follows: greater than or equal to -1.0: normal; between -1.0 and -2.5: low bone mass; less than or equal to -2.5: osteoporosis; less than or equal to -2.5 plus fragility fracture: severe osteoporosis [16].

All measurements were performed under strictly standardized conditions (room temperature 22°C, air humidity 45%) by one well-trained researcher (dietitian), using the same device in order to avoid inter-observer and inter-device variability.

Statistical analysis

By combining two classifications, namely meeting the dairy products recommendations (yes/no) and meeting the physical activity recommendations (yes/no), the subjects were finally classified into 3 groups: meeting the both recommendations for dairy products AND physical activity (Dairy AND PA), meeting either dairy OR physically activity recommendations (Dairy OR PA), meeting neither dairy NOR physical activity recommendations (Neither Dairy NOR PA). Categorical data are presented as *n* and percentage (%), while quantitative data are presented as median, lower and upper quartile as well as arithmetic mean and standard deviation. As all quantitative variables were not normally distributed according to the Shapiro-Wilk test, the Kruskal-Wallis test was applied to compare the three groups of women. We also calculated the effect size for the Kruskal-Wallis test (Eta Squared, η^2). For all analysis, the significance level was set at 0.05. The statistical analyses were performed using STATISTICA software (version 13.0 PL; StatSoft Inc., Tulsa, OK, USA; StatSoft, Krakow, Poland).

RESULTS

The mean age of participants was 33.5 ± 6.4 years. On average women consumed dairy products 1.2 times/day, more often as milk and fermented products like yogurts and kefirs, while less often as cottage cheese and other types of cheese (Table 1). On average, they spent 3 hours a week on physical activity lasting at least 60 minutes of moderate or vigorous intenssity.

Both, median and mean values of BMI were in the range of normal weight body, nevertheless the fat content equaled 33% in the whole population, exceeding the reference values for women (Table 2). According to BMI, only 50% of women had normal weight, while 33% had excessive body weight, mostly overweight (Table 3).

Only 33% of women met the recommendations for consuming the dairy products at least twice a day and almost 74% met the recommendations for being physically active for at least 180 minutes a week (Table 3). Meeting both recommendations was found only among 26% of women.

Nutritional status and bone density parameters according to meeting the recommendations for dairy products consumption and/or physical activity are presented in Table 4 and Table 5. For all analyzed variables related to body composition and fat content no significant differences were found among three groups of women (Table 4). None of the woman was at risk of osteoporosis. On the contrary, total BMD and T-score differed significantly in the population (Table 5). Women meeting both recommendations had the highest median total BMD of 1.25 g/cm² (Q25-Q75: 1.20-1.34) and T-score of 1.70 (1.20-2.60). In women meeting only one recommendation, total BMD was 1.18 g/cm² (1.13-1.23) and T-score was 1.00 (0.50-1.50). The lowest values were found in women not meeting any of those recommendations, with total BMD of 1.14 g/cm² (1.07-1.19) and T-score of 0.60 (0.10-1.10). Although for Z-score such significant differences were not detected, a similar tendency as for total BMD and T-score can be observed. Calculated η^2 indicated a large effect size for total BMD (0.31) and T-score (0.31), while medium effect size for Z-score (0.08).

Three women had low bone mass and two of them did not meet any of the recommendations, while the third woman met the recommendations for physical activity but not for dairy products consumption.

Table 1. Characteristic of women according to dairy products consumption [daily frequency] and physical activity [hours/week]

Variable	Me (Q25; Q75)*	X ± SD**
Dairy products in total:	1.20 (0.78; 2.14)	1.52 ± 0.99
Milk	0.50 (0.00; 1.00)	0.48 ± 0.57
Fermented dairy	0.50 (0.14; 0.50)	0.46 ± 0.35
Cottage cheese	0.14 (0.06; 0.50)	0.32 ± 0.41
Other types of cheese	0.14 (0.14; 0.50)	0.26 ± 0.20
Physical activity	3.00 (3.00; 4.00)	3.15 ± 1.75

*Me (Q25; Q75) – median, lower and upper quartile;

**X ± SD – mean and standard deviation.

Table 2. Characteristics of nutritional status of women

Variable	Me (Q25; Q75)*	X ± SD**
BMI [kg/m²]	20.9 (19.3; 26.0)	23.0 ± 4.6
Fat %	33.5 (24.2; 38.6)	32.7 ± 8.3
Fat %, centile	65.0 (28.0; 78.0)	58.0 ± 28.9
VAT	18.0 (6.0; 62.0)	39.8 ± 43.9
SAT	120.0 (57.0; 226.0)	140.2 ± 105.7
BMD Total [g/cm²]	1.19 (1.13; 1.24)	1.19 ± 0.08
T-score	1.10 (0.50; 1.60)	1.11 ± 0.81
Z-score	1.00 (0.60; 1.70)	1.16 ± 0.81

*Me (Q25; Q75) – median, lower and upper quartile;
**X ± SD – arithmetic mean and standard deviation;
VAT – Visceral Adipose Tissue;
SAT – Subcutaneous Adipose Tissue;
BMD – Bone Mineral Density.

Table 3. Characteristics of women according to BMI categories and meeting the recommendations for dairy consumption and physical activity (PA)

Variable	n	%
BMI [kg/m²]		
Underweight (< 18.5)	4	14.8
Normal weight (18.5-24.9)	14	51.8
Overweight (25.0-29.9)	7	25.9
Obesity (≥ 30.0)	2	7.4
Meeting the recommendations for dairy products (yes)	9	33.3
Meeting the recommendations for PA (yes)	20	74.1
Meeting the recommendations for both dairy products and PA (yes)	7	25.9

DISCUSSION

Our study showed that bone mineral density (BMD) was dependent on the combined effect of regular consumption of dairy products (at least twice daily) and compliance with the recommended time of physical activity, which was at least 180 minutes per week. Women meeting only one of these recommendations (regarding dairy consumption or physical activity) were characterized by lower BMD and T-score values. These results are consistent with other studies, which confirmed that higher BMD values depend on several coexisting factors, including physical activity and consumption of milk and dairy products, especially as a good source of highly bioavailable calcium and protein [8, 10, 22, 23, 24].

Adequate intake of calcium, vitamin D and dairy products may contribute to improving peak bone mass in adolescents, counteract bone loss in postmenopausal

Table 4. BMI and body fat according to meeting recommendations for dairy products and physical activity (PA) in women

Variable		Meeting the recommendations			Kruskal-Wallis test p-value
		Yes Dairy AND PA n = 7 (26%)	Yes/No Dairy OR PA n = 16 (59%)	No Neither Dairy NOR PA n = 4 (15%)	
BMI [kg/m^2]	Me (Q25; Q75)*	23.4 (19.7; 29.8)	20.3 (19.1; 25.0)	25.0 (21.6; 27.7)	0.3583
	X ± SD**	24.7 ± 5.4	22.1 ± 4.2	24.7 ± 4.5	
Fat %	Me (Q25; Q75)	36.2 (24.2; 41.3)	31.7 (27.8; 38.2)	35.9 (27.9; 43.4)	0.5776
	X ± SD	34.6 ± 8.7	32.0 ± 7.3	35.7 ± 10.2	
Fat %, centile	Me (Q25; Q75)	77.0 (28.0; 88.0)	63.0 (35.0; 76.0)	75.5 (44.5; 89.5)	0.4291
	X ± SD	65.9 ± 28.2	55.4 ± 26.7	67.0 ± 34.0	
VAT	Me (Q25; Q75)	41.0 (5.0; 47.0)	14.0 (5.0; 62.0)	57.0 (8.5; 117.5)	0.5426
	X ± SD	42.6 ± 46.4	33.7 ± 39.5	63.0 ± 63.9	
SAT	Me (Q25; Q75)	157.0 (57.0; 275.0)	91.0 (58.0; 222.0)	145.0 (89.5; 237.5)	0.5139
	X ± SD	182.6 ± 133.1	182.6 ± 133.1	163.5 ± 120.3	

*Me (Q25; Q75) – median, lower and upper quartile; **X ± SD – mean and standard deviation; VAT – Visceral Adipose Tissue; SAT – Subcutaneous Adipose Tissue.

Table 5. Bone density parameters according to meeting recommendations for dairy products and physical activity in women

Variable		Meeting the recommendations			Kruskal-Wallis test p-value
		Yes Dairy AND PA n = 7	Yes/No Dairy OR PA n = 16	No Neither Dairy NOR PA n = 4	
BMD Total [g/cm^2]	Me (Q25; Q75)*	1.25 (1.20; 1.34)^a	1.18 (1.13; 1.23)^b	1.14 (1.07; 1.19)^b	0.0074
	X ± SD**	1.27 ± 0.07	1.18 ± 0.07	1.13 ± 0.07	
T-score	Me (Q25; Q75)	1.70 (1.20; 2.60)^a	1.00 (0.50; 1.50)^b	0.60 (-0.10; 1.10)^b	0.0073
	X ± SD	1.87 ± 0.66	0.95 ± 0.68	0.50 ± 0.71	
Z-score	Me (Q25; Q75)	1.90 (0.80; 2.20)	1.00 (0.60; 1.60)	0.85 (-0.10; 0.90)	0.1337
	X ± SD	1.67 ± 0.79	1.11 ± 0.67	0.40 ± 0.93	

*Me (Q25; Q75) – median, lower and upper quartile; **X ± SD – arithmetic mean and standard deviation; BMD – Bone Mineral Density; ^{ab} – values not sharing the same superscript are significantly different, $p < 0.05$.

women and reduce the risk of developing osteoporosis in old age [8, 25]. Dairy products, consumed at least twice a day, provide essential nutrients such as calcium, vitamin D and protein, which support the building and regeneration of bone tissue [7, 9, 24, 25]. In addition, dairy products, particularly cheese, also provide vitamin K_2, which plays an important role in calcium metabolism, osteoblast activation, and prevention of vascular calcification, complementing the effects of calcium and vitamin D on bone health [11]. Consumption of dairy products during childhood and adolescence has the most beneficial effect on skeletal health and development [8], while their consumption in adulthood brings moderate benefits [8, 24]. The relationship between a high-protein diet (HPD) and bone health remains a topic of debate. Studies conducted on rats subjected to diets with varying protein content for three weeks have shown that HPD has only a marginal effect on indicators related to bone metabolism. In contrast, other analyses suggest that diets with moderate to high protein content, combined with an appropriate exercise regimen, may lead to an increase in bone mineral density (BMD) and influence cortical bone structure; however, they do not cause significant changes in bone turnover markers in obese rats [26].

In our own studies, it was shown that women most often consumed milk and fermented products, such as natural yogurt and kefir, once a day. The least frequently declared consumption of cottage cheese and other cheeses. Similar results were obtained in studies conducted among Polish women with an average age of 34, living in urban areas [27]. In this group, 30% of women declared daily consumption of milk, 18% of yogurts, 17% of cheeses, and only 7% of buttermilk

and kefir. Fermented milk products are particularly important due to the content of probiotic strains, which can affect bone metabolism regardless of the energy, protein or calcium supplied [23]. Many studies have shown that fermented milk products contributed to a increase in BMD and decreased bone turnover in women of different ages [8, 9]. However, it is worth noting that the level of dairy consumption among Polish women remains lower than recommended in the context of osteoporosis prevention. Studies in Western and Northern European populations report daily dairy consumption among 30-50% of women, with the highest rates in Scandinavian countries and the lowest in Mediterranean regions [8]. Autors of this review also highlighted that regular intake of yogurt and kefir is associated with significantly higher BMD at the lumbar spine and femoral neck and with lower bone resorption markers. Similarly, Rizzoli [9] noted that consuming at least three servings of fermented dairy products per day can reduce the risk of osteoporotic fractures by 20-30% compared to consuming less than one serving per day. In the context of the Polish population, however, the situation appears less favorable. Ratajczak et al. [23] emphasized that the average intake of milk and dairy products among adult Polish women remains below recommended levels for osteoporosis prevention, particularly in postmenopausal women. Kalkwarf et al. [28] also demonstrated in an American cohort that high milk consumption during childhood and adolescence was associated with higher BMD and a lower risk of osteoporotic fractures in adulthood, although intake declined substantially with age, with only about one-third of adult women reporting regular dairy consumption.

Our findings align with this trend of insufficient intake. In our study group, only 33% of women reported consuming dairy products at least twice daily, while in Kozirok's study [27] approximately 42% of Polish women aged 20-49 reported drinking at least one glass of milk daily. These results highlight a significant gap between evidence-based recommendations and actual dietary behaviors, underlining the need for public health efforts to promote regular consumption of fermented dairy products in this population.

Another important aspect is the type of diet used by the study participants and supplementation of the diet with calcium or consumption of products enriched with this ingredient. In recent years, there has been a significant change in lifestyle and diet structure towards a high-sugar, high-fat or high protein diet [25]. A high-sugar diet negatively affects bone mineral balance, which has been confirmed in many studies. In turn, the impact on bones of a vegetarian diet, intermittent fasting or a calorie-restricted diet as a weight loss strategy has not yet been thoroughly studied or is controversial [29]. Promoting a balanced diet can significantly contribute to reducing the occurrence of osteoporosis. A well-balanced diet, healthy eating habits, effective nutrition strategies, and regular physical activity are the foundations of maintaining human health [25], which was also confirmed in a meta-analysis [8]. In adults, no significant differences in BMD were observed between those using calcium-rich foods and those taking calcium-containing dietary supplements. However, dairy products appear to be more beneficial for maintaining or building bone mass than fortified beverages such as sweetened drinks or soy drinks [8]. This superiority of dairy products over supplementation or fortification may be explained by the complex nutrient matrix of dairy, which provides not only calcium but also high-quality protein, phosphorus, bioactive peptides, and fat-soluble vitamins such as vitamin D and K_2, resulting in synergistic effects that cannot be achieved with isolated calcium supplementation alone [8, 11, 25, 29]. Furthermore, calcium from dairy products is better absorbed, and regular dairy intake is associated with improved overall diet quality and adherence to healthy dietary patterns, both of which are beneficial for bone health [25]. A narrative review also highlighted that individuals relying solely on calcium supplementation might not achieve the same reduction in fracture risk as those consuming dairy as part of a balanced diet [29]. These findings underscore the importance of encouraging the consumption of dairy products as part of a comprehensive nutritional strategy for osteoporosis prevention.

Physical activity exceeding 180 minutes per week contributes to improving trabecular microstructure and increasing overall bone density in the hip and other body regions. Regular physical exercise increases BMD and reduces the frequency of falls by increasing muscle mass [30]. In addition, physically active young people have higher levels of lean body mass, which is a strong predictor of bone mass [31]. In turn, BMI affects the mechanical load on bones, which can stimulate their adaptation and strengthening, which is responsible for biomechanical factors. Our own studies have shown that women who met both recommendations regarding physical activity and dairy product consumption had higher BMD values. Study results clearly indicate that the type of physical activity is crucial for bone mass/bone density, and bone mass gains can be optimized through mechanical loading using high-impact exercises such as walking, stair climbing, jogging, Tai Chi, and multi-component exercises that combine different methods (aerobics, strengthening, progressive resistance, balance, and dance) [14]. According to Kopiczko et al. [14] physical activity, especially sports training, specifically exercises such as throwing, is essential for proper bone mineralization in women, and

athletic training after the age of 40 can help eliminate the risk of developing osteoporosis.

Health policy should include comprehensive strategies for the prevention and treatment of osteoporosis in people of all ages. Deepening knowledge about the connections and molecular mechanisms between dietary patterns and bone health may provide a basis for developing more effective dietary strategies that will contribute to improving the health of the skeletal system. Moreover, healthy dietary patterns promoted by parents, guardians, and the school environment, along with encouragement of regular physical activity, play an important role in consolidating the habit of daily consumption of dairy products and an active lifestyle, thus supporting the development of proper health behaviors from an early age.

Strengths and weaknesses of the study

Strengths of the study:

The study demonstrates significant methodological advantages, such as the use of a food frequency questionnaire (FFQ), with particular emphasis on the consumption of milk and dairy products. Additionally, declared physical activity, use of dietary supplements, bone mineral density (BMD) and anthropometric tests were taken into account, which allows for a comprehensive assessment of the relationships between the variables studied. Conducting preliminary pilot studies and detailed analysis of the results allowed for the identification of key areas requiring refinement within the main studies. An advantage is also the age of the women studied, which is the premenopausal period, as there is a lack of studies in this group and the literature data is fragmentary.

Weaknesses of the study:

One of the main weaknesses of the study is the insufficient sample size, which limits the possibility of generalizing the results to a wider population. To increase the homogeneity of the group, prematurity, low birth weight, and childhood rickets should also be added as exclusion criteria in future studies. In addition, the lack of detailed data on the amount and type of dairy products consumer is a significant limitation in the precise analysis of their impact on bone health. There was also a lack of information regarding baseline calcium intake and vitamin D status in the body. In addition, there were no questions regarding the type of diet used, as well as the consumption of dairy products during childhood and adolescence, which are crucial for shaping peak bone mass.

Moreover, in future study, more recommended tools should be used to assess physical activity, as IPAQ, and information on type of physical activity should be collected.

However, as this was a pilot study, the obtained results provided valuable indications as to which elements should be considered and refined in the design of the proper studies.

CONCLUSIONS

Implementing both recommendations, namely for dairy intake and physical activity seems to be more effective for bone mineral density than following just one recommendation. In contrast, infrequent consumption of dairy products and low physical activity are associated with the risk of reduced bone mineral density in young women.

Conflicts of interest

The authors declare no conflict of interest.

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ORIGINAL ARTICLE

THE STATE OF MOTHERS' KNOWLEDGE ABOUT INFANT FEEDING

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ABSTRACT

Background. The correct nutrition of infants is crucial for their proper mental and physical development, as well as for adequate metabolic programming. Programming is the influence of environmental factors, including nutrition, during critical periods of early development (including fetal life and the first years of life) on the risk of disease in adulthood.
Objective. The aim of the study was to investigate the level of knowledge of mothers on infant feeding.
Material and Methods. The study involved 1100 mothers of different ages who were active in online groups interested in maternity and infant feeding. The inclusion criterion for the study was having a child born between 2021 and 2023. The study used a CAWI (Computer-Assisted Web Interview) method and the survey was conducted in November 2024.
Results. It was shown that most of the mothers surveyed had very good knowledge of infant feeding. A good level of knowledge was recorded among younger mothers of children under 6 months of age, with primary/high school education and living in rural areas.
Conclusion. It is recommended to provide more detailed information on expanding the diet of infants after 6 months of age, e.g. on the labels of foods dedicated to children.

Keywords: *mothers, knowledge, feeding, infants, breastfeeding*

INTRODUCTION

The first and best food for the baby is breast milk, which has proven health benefits and is considered the gold standard in infant nutrition [1, 2]. It has nutritional and immunological properties, supporting the normal physical, emotional and intellectual development of infants. Breastfeeding reduces the risk of many diseases, both during breastfeeding and later in life. Among these diseases, the following are distinguished: low risk of leukaemia, lymphoma, Crohn's disease and reduces the risk of sudden infant death. Breastfeeding has many benefits for the mother, including reducing the risk of breast cancer. It is also likely to reduce the risk of allergic diseases, overweight and obesity, type 1 and 2 diabetes and hypertension [3, 4].

All organisations concerned with infant feeding, such as the World Health Organisation (WHO), the European Society for Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) and the American Academy of Paediatricians (AAP), recommend exclusive breastfeeding for the first six months of a child's life [1]. After the six-month period, breast milk feeding should be continued if both mother and baby want it. But the infant's diet should be expanded with new products as breast milk becomes insufficient to cover the needs of the developing organism [5]. According to ESPGHAN, it is recommended to start dietary expansion after the infant is 17 weeks old, but no later than 26 weeks of age [6]. It is important to introduce a new food, e.g. cereal or egg, into the diet one at a time and monitor the baby's health. In the traditional method, the baby is fed with a spoon, starting with creamy foods and then introducing foods that require biting. In another method, called BLW (Baby Led Weaning), the use of spoons and purees is omitted, offering food that the child can grasp, chew and consume [5, 7]. According to the recommendations of the Polish Society of Gastroenterology, Hepatology and Child Nutrition (PTGHiZD), this method should be implemented from the seventh month of child's life [1]. During the expansion of the diet with the BLW method, the principle of single introduction of new foods and observation also applies. The child must not be left unattended during meals because of the possibility of

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choking. Another method of feeding infants takes into account the principle' the parent/carer decides when and what the child eats, while the child decides how much to eat' [8]. The above principle and the BLW method promote the child's independence and motor development.

Aim of the study

The aim of the study was to investigate the level of knowledge of mothers on infant feeding.

MATERIAL AND METHODS

Study design and settings

A survey to analyse women's knowledge on infant feeding was conducted in November 2024 in Poland, using the CAWI (Computer-Assisted Web Interview) technique. A total of 1,100 women participated in the study, gathered in online social media groups with a profile related to motherhood and infant diet. The inclusion criterion for the study was: being a mother, having a baby in 2021-2023. The study was conducted using a proprietary survey questionnaire, consisting of two parts: the first part concerned socio-demographic data (including age, number of children had, baby's gender place of residence, education) and the second part included 14 questions on knowledge about infant nutrition. Knowledge was assessed on the basis of correct answers, awarding 1 point for each answer. A maximum of 14 points could be obtained. The level of knowledge was assessed on the basis of the criteria:

- less than 25% of correct answers (0-3.5 points) – inadequate knowledge,
- 25-50% of correct answers (3.6-7.0 points) – satisfactory knowledge,
- 50-75% of correct answers (7.1-10.4 points) – good knowledge,
- 75%+ of correct answers (10.5-14 points) – very good knowledge.

Statistical analysis

Statistical analysis was performed using the Statistica v.13.3. (TIBCO Software Inc. USA). The distribution of variables was analysed using the Shapiro-Wilk test. To compare the level of infant feeding knowledge of the study mothers with their sociodemographic parameters, Kruskal-Wallis tests and post hoc test (distribution different from normal distribution) were performed. The significance level was taken at $p < 0.05$.

RESULTS

Participants

The largest group were mothers aged between 26 and 32 (54.9%) and the smallest were women over 40 (3%). The average age of the mothers surveyed was 30.1 years. The majority of women in the survey lived

Table 1. Characteristics of respondents (N = 1100)

Variables		N	%
Age [years]	19-25	185	16.8
	26-32	604	54.9
	33-39	278	25.3
	40 and above	33	3.0
Education	primary/vocational	44	4.0
	secondary	286	26.0
	higher	770	70.0
Place of residence	rural areas	336	30.6
	city up to 50,000	274	24.9
	city over 50,000	490	44.5
Number of children	1	895	81.3
	2	163	14.8
	3 and more	42	4.0
Baby's gender	boy	564	51.3
	girl	536	48.7
Child's age	0 - ≤ 6 months	140	12.7
	> 6 - ≤ 12 months	521	47.4
	> 1 year and older	439	39.9
Total		1100	100.0

N – number of observations

in cities with more than 50,000 inhabitants (44.5%), and one third lived in rural areas. The majority of female respondents (70%) had a university education and 26% had a secondary education. The remaining mothers declared primary or vocational education. More than 80% of the women surveyed had one child and 15% had two children. The remaining respondents had three or more children. There were slightly more mothers of boys (564) than girls (536) among the respondents. Most women had children aged > 6-12 months (47.4%) (Table 1).

Questionnaire

Table 2 (part 1) shows the percentage of infant feeding responses given by mothers. About 61.4% agreed with the statement that breast milk is better digested than modified milk. A large group of women, i.e. 87.1% knew that breastfeeding should last for 6 months. Almost the entire group of mothers agreed that the infant should be fed on demand. About 92.6% of the respondents believed that a woman should feed for as long as the baby and the mother want. Breast milk has nutritional, immunological and nourishing properties, 63.9% of the respondents agreed with this statement. About half of the women (48.9%) agree that there is no set order in which new products should be added to the infant's diet. Almost all mothers (94.6%) stated that infant food cannot be salted.

Table 2 (part 2) shows further responses of the surveyed women on infant feeding. Approximately

Table 2. Assessment of mother' knowledge about infant nutrition (Questions/Answers), part 1

Questions/Answers	N	%
Is it true that breast milk is better digested than formula milk?		
True	675	61.4
False	106	9.6
I don't know	319	29.0
Do you know how long a baby should be fed exclusively with breast milk?		
For a period of 5 months	20	1.8
For a period of 6 months	958	87.1
For a period of 7 months	38	3.5
I don't know	84	7.6
Is it true that babies should be fed on demand?		
True	1089	99.0
False	6	0.5
I don't know	5	0.5
Is there a specific time until which a baby should be breastfed?		
Up to 6 months	16	1.5
Up to 1 year	59	5.4
As long as mother and child want	1019	92.6
According to paediatrician recommendations	6	0.5
Which milk has nutritional. immunological and trophic properties?		
Formula milk	7	0.6
Breast milk	703	63.9
Formula and breast milk	390	35.5
What products do we start expanding our baby's diet with?		
Vegetables	555	50.5
Fruits	6	0.5
Grain products	1	0.1
There is no set order for introducing products into a child's diet	538	48.9
Can you add salt to your food when expanding your diet?		
Yes	8	0.7
No	1040	94.6
Sometimes	52	4.7

N – number of observations

Table 2. Assessment of mother' knowledge about infant nutrition (Questions/Answers), part 2

Questions/Answers	N	%
Should an infant be given water to drink in the first six months of life?		
Yes	42	3.8
No	926	84.2
Sometimes	122	11.1
I don't know	10	0.9
What drinking water is recommended for babies?		
Highly mineralized water	22	2.0
Medium mineralized water	21	1.9
Low mineralized/spring water	915	83.2
I don't know	142	12.9
When should you introduce allergenic products such as eggs, gluten, nuts into your diet?		
From the beginning of expanding the diet	950	86.4
After the end of one year	116	10.5
After the end of two years	4	0.4
I don't know	30	2.7
Can children under 1 year old eat honey?		
Yes	15	1.4
No	1055	95.9
I don't know	30	2.7
What set of products can be given to a child only after the age of 3?		
Beef and pork	35	3.2
Goose and duck	50	4.5
Sausages, hot dogs, cold cuts	1001	91.0
Lamb and rabbit	14	1.3
What color vegetables are recommended first when expanding your diet?		
Red	76	6.9
Green	595	54.1
Yellow	65	5.9
I don't know	364	33.1
Is it true that when expanding the diet using the BLW method, the parent feeds the child, for example, with a spoon?		
True	76	6.9
False	958	87.1
I don't know	66	6

N – number of observation

84.2% of the mothers stated that infants should not be fed with water for the first 6 months of life. Spring water or low mineralised water is recommended for infants after the age of 6 months, 83.2% of the mothers surveyed thought so. Furthermore, the majority of women (86.4%) confirmed that allergenic foods (e.g. eggs) should be introduced from the beginning of the expansion of the diet. The majority (95.9% of women) agreed with the statement that honey should not be given to infants before the age of 1 year. Almost the entire surveyed group (91% of mothers) stated that sausages and cold cuts should not be given to infants until the age of 3 years. Half of the respondents (54.1%) knew that green-coloured vegetables should be the first to be given to infants when expanding their diet. The majority of the women surveyed (87.1%) knew what the BLW method was for expanding the diet of infants and it does not refer to spoon feeding of food.

Knowledge vs. sociodemographic parameters

The average number of points obtained by the female respondents was 11.3 points, which classified their knowledge at a very good level (more than 75% correct answers). The majority of 664 (60.3%) female respondents scored between 11 and 13 points. The lowest scores (3 points) were obtained by 2 respondents

and the maximum score (14 points) was obtained by 10% of the respondents (114 women).

Age appeared to be one of the factors influencing the level of knowledge (Table 3). Women over 25 years of age had very good knowledge about infant feeding (above 11 points) compared to younger respondents. Education had a similar effect on knowledge levels. Respondents with higher education scored better for knowledge (11.6 points) than those with secondary education (10.7 points) and primary or vocational education (9.6 points). Place of residence also influenced the survey results. Women living in cities with more than 50,000 inhabitants scored higher for knowledge of infant feeding (above 11.3 points) than those from smaller towns or rural areas (Table 3). The age of the child was another factor that influenced the survey results. Women who had children older than 6 months showed better knowledge of infant feeding (11.4 points) compared to mothers of younger children (10.5 points) (Table 3). The number of children had and the gender of the child did not influence the level of knowledge on infant feeding among the mothers surveyed.

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DISCUSSION

Childhood, especially infancy, is a key life stage where health knowledge and behaviours, including those related to nutrition, are formed. The transmission of appropriate dietary patterns has an important impact on the child's health throughout life. Parents', and especially mothers', knowledge of infant feeding is an indispensable part of shaping their eating habits [9].

Table 3. Mean scores on infant feeding knowledge of the mothers studied according to sociodemographic parameters

Variables		Points		Test K-W p-value
		Mean	SD	
Age [years]	19-25	10.5[a]	2.2	0.0006
	26-32	11.5[b]	1.8	
	33-39	11.3[b]	1.9	
	40 and above	11.2[b]	2.3	
Education	primary/vocational	9.6[a]	2.6	< 0.0001
	secondary	10.7[b]	2.1	
	higher	11.6[c]	1.8	
Place of residence	rural areas	10.9[a]	1.9	< 0.0001
	city up to 50,000	11.3[b]	2.0	
	city over 50,000	11.5[b]	2.0	
Number of children	1	11.3[a]	1.9	0.2987
	2	11.4[a]	2.0	
	3 and more	10.8[a]	2.4	
Baby's gender	boy	11.3[a]	1.9	0.7184
	girl	11.3[a]	2.0	
Child's age	0 - ≤ 6 months	10.5[a]	2.4	0.0003
	> 6 - ≤ 12 months	11.4[b]	1.9	
	> 1 year and older	11.4[b]	1.9	
Total		11.3	1.9	

SD – standard deviation; test K-W – test Kruskal-Wallis; a, b, c – differences statistically significant for post hoc test at $p < 0.05$; a, a – no statistically significant differences for post hoc test at $p < 0.05$

In the study conducted, the knowledge of the mothers interviewed regarding infant feeding was at a very good level. Łukasik and Berek [10] investigated the knowledge of child nutrition in a group of 70 parents of children hospitalised in the infant ward at the Paediatric Hospital in Bielsko-Biała. More than half of the respondents in this study believed that their knowledge of child nutrition was sufficient, and the Internet was the main source of information. It was shown that 57.1% of the women fed their child naturally at least until the first six months of life. Approximately 45.7% of respondents used both home-prepared and ready-made certified meals for infant feeding.

The basis of infant nutrition in the first year of life is breast milk, which ideally meets the needs of the developing body. Breastfeeding has both short-term and long-term health benefits, which have been repeatedly confirmed in the literature. Breast milk provides infants with essential immunity, active nutrients and pro biotics to promote growth and safeguard intestinal microbiota. As evidenced by reports from the United Nations and some studies on neonatal deaths caused by nutritional problems annually, breast milk is closely linked to infant health. Furthermore, some research has shown that non-breastfed infants have a higher risk of major diseases compared to those who are breastfed [11]. Mulcaire-Jones and Scanlon [12] also highlight in their study, that the first thousand days of life, composing the 270 days of pregnancy and the first two years (730 days) of life, is at once a critical and vulnerable time for human development. Breastfeeding can reduce stress for both the infant and mother, imparting the child mother bonding and can literally be called 'packed with love'. Breastfed children are more likely to achieve full intellectual potential and can ultimately perform better in later life. Breastfeeding has advantages for mothers in terms of birth spacing and decreased incidence of breast and ovarian cancer [13].

In a study by Zielińska et al. [14] involving a group of 446 mothers aged 18-42 years, it was observed, similarly to the present study, that women with vocational education and living in the countryside scored lower on knowledge of infant feeding than those with higher education or living in cities. Mekebo et al. [15], in a study from Ethiopia involving 566 infants with their mothers, found that 83% of them used breastfeeding for 6 months of the child's life. In this study exclusive breastfeeding practice among under-6 month infants was significantly associated with place of residence and maternal educational level.

In total of 676 healthy mothers living in Bangkok, whose most recent child was between 6 and 18 monthsold, were recruited in Topothai's et al. [16] study. Although the benefits of breastfeeding are widely recognized, only 14% of mothers in Thailand exclusively breastfed their children during the first six months of their lives in 2019, which dropped from 23% in 2016.

An interesting study was a randomised trial conducted by Rapson et al. [17], which looked at starting infants on complementary feeding with vegetables only. It showed that infants who started their dietary expansion with vegetables consumed more spinach and broccoli than infants in the control group. The authors of the study concluded that giving vegetables as the first food promotes higher vegetable intake in later months of life, which may be an effective strategy to increase the amount of vegetables in children's diets. Similarly, in this study, mothers (50.5%) indicated vegetables as a product that should be introduced into the diet of infants after 6 months of life. The current recommendations do not specify the order in which individual product groups should be introduced into the diet of infants after 6 months of age. However, in order to help mothers make the right choice, manufacturers of food products for infants and young children should include detailed and understandable information on expanding their diet on the product packaging. Another study by Issa et al. [18] found that more than half of the parents gave water to their infants as early as between three and four months of age.

Mastalerz-Kozubek et al. [19] study showed that at least half of the Polish and majority of the Austrian mothers, especially of the older toddlers, did not follow the recommendations about avoiding salt use during the first years of children's life. Even though the prevalence of the use of added sugar was lower, those results are also disconcerting, especially as the use of sugar, like salt, should be limited in children's nutrition. Furthermore, the obtained results revealed that the use of added salt, sugar, or both salt and sugar in the toddlers' diet was associated with multiparity and lower maternal age.

The objective of Bournez et al. [20] study was to describe the frequency of use of added sugar, salt, and fat during the complementary feeding period and the associated infant caregiving practices in France. In conclusion, it was showed that the use of added sugar and salt occurred early in life, but the frequency of their use remained relatively low. The use of added fat also occurred early and was more frequent than the use of added sugar and salt, but approximately 35% of the infants never received added fat during their complementary feeding period. The authors' promoted the current recommendation should be enhanced, taking into account the fact that the use of these added ingredients seems to be related to maternal habits or culinary practices.

Breastfeeding is still popular, and there is a large amount of easily accessible public information on the

benefits of breastfeeding for both women and children. Women's awareness in this area is also growing, forcing baby food manufacturers to intensify their promotional activities in order to keep up with the latest knowledge on feeding children after 6 months of age. Nonetheless, promotion and marketing of breastmilk substitutes are thought to be the supplementary hurdle for breastfeeding. Exposure of individuals to this strategic marketing led to reduced breastfeeding initiation and duration, irrespective of the country. Moreover, the consumption of these infant formulas is rising day by day because of key drivers such as the increasing number of working mothers, rising cases of malnutrition, a concern about infant nutrition and the growing income of the middle class [21, 22].

CONCLUSIONS

Having offspring is a person's top priority in life. For many parents, a healthy child who develops well and grows harmoniously is the main goal. Preparing for the role of a parent also includes acquiring knowledge about his or her nutrition from the first day of life. It is recommended that more accurate information on expanding the diet of infants after 6 months is provided. Producers of food dedicated to infants and young children should also be helpful in this regard. Nutritional information on product packaging should be precise and understandable to caregivers.

Conflict of interest

The authors declare no conflict of interest.

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ORIGINAL ARTICLE

OBESITY AND ASSOCIATED RISK FACTORS AMONG WOMEN OF REPRODUCTIVE AGE IN MOROCCO

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ABSTRACT

Background. Obesity is a major global health concern growing in every region and affecting millions of people worldwide. It has become a pandemic. In 2022, 1 of 8 people in the world were living with obesity and more than half of the world's population will be overweight or obese by 2035 leading to a total economic impact of US$ 4.32 trillion.

Objective. This study aims to update data on the prevalence of overweight and obesity and the associated socio-demographic and economic factors in women of reproductive age (WRA) in Morocco.

Material and Methods. A total of 2,172 women aged 18 to 49 years, representing all regions of Morocco, were enrolled. Socio-demographic and economic data as well as anthropometric measurements, specifically height, weight and waist circumference were collected.

Results. Based on body mass index (BMI), 30.3% of women were classified as overweight and 27.8% as obese. However, based on specific predictive equation of body composition for Moroccan population, 61.6% of women showed excess of fat (mass fat ≥ 35%). Age and household-index were positively correlated to the prevalence of obesity and excess body fat, whereas education was inversely correlated to the prevalence of obesity and excess fat. In addition, urban area and being married seem to play a positive role in the increase of obesity rate.

Conclusion. The prevalence of excess body fat is high among WRA in Morocco. This prevalence was impacted by age, education level, household-index, marital status and urban area. These factors highlight the complexity of addressing obesity and the need for comprehensive strategies that consider sociodemographic and economic factors.

Keywords: *overweight, obesity, excess body fat, women, sociodemographic and economic factors*

INTRODUCTION

Women are currently among the most affected by the nutritional transition, shifting from undernutrition to overweight and obesity, especially in emerging economies [1, 2]. While, obesity is a major global health concern growing in every region and affecting millions of people worldwide. According to the World Health Organization (WHO), obesity has become a pandemic. In 2022, 1 of 8 people in the world were living with obesity [3]. According to World Obesity Federation, more than half of the world's population will be overweight or obese by 2035 leading to a total economic impact of US$ 4.32 trillion [4]. Furthermore, excess weight and obesity contribute significantly to the global disease burden, accounting for 2.4 million deaths and 70.7 million disability-adjusted life years (DALYs) among women [5].

During the 75th session of the World Health Assembly (WHA75), new global guidelines for the prevention and management of obesity throughout the life cycle were officially adopted. Alongside this, the assembly endorsed the 'Acceleration Plan to STOP Obesity', a joint initiative of WHO and United Nations

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International Children's Emergency Fund (UNICEF) aimed at supporting Member States in implementing these recommendations. Also, this support is adapted to each country's unique needs and priorities and includes the development of monitoring and reporting systems [6]. Furthermore, an adequate nutritional status serves as a reflection of the general welfare of a population. Ensuring the sufficient nutritional status of women hold a significance not only for their own well-being and enhanced work capacity but also for the vitality of their descendants' health [7].

In Morocco, the last National Survey on Common Risk Factors for NCDs reports that 53% of adults are overweight or obese, with 20% classified as obese. Women are disproportionately affected, with 29% experiencing obesity compared to 11% of men [8]. Unfortunately, the pandemic will not stop at this point, by 2030, the World Obesity Atlas estimates that in Morocco 9.94 million women will be overweight. Obesity prevalence will account for 46% leading to a total economic impact of US$5.589 million with an impact on Gross Domestic Product (GDP) of 3.5% [4]. To stop and control this pandemic, Morocco, like many other countries has been, for over three decades, actively combating all forms of malnutrition including obesity, as defined by the WHO, which describes malnutrition as deficiencies, excesses or imbalances in a person's intake of energy and/or nutrients [9]. This commitment has been reinforced through the endorsement of various international declarations and resolutions. In response, the Ministry of Health (MH) has developed and implemented multiple nutrition-focused health programs over the years, significantly contributing to the improvements of the nutritional and health status of the Moroccan population. As part of this ongoing effort, the MH has launched a comprehensive and integrated National Nutrition Programme, aligned with the National Nutrition Strategy and in full accordance with international commitments [8].

On the other hands, different method can assess obesity by using index such as BMI or excess of fat such as bioelectrical impedance analysis (BIA), dilution isotope, dual-energy X-ray absorptiometry (DXA), densitometry, etc. However, these methods either have significant limitations or they are expensive and technically complex, making them less practical for large-scale use, particularly in low-resource settings [10]. As a result, there is a growing need for valid, simple, and cost-effective techniques suitable for routine practice and epidemiological studies, especially in developing countries. To address this, several researchers have developed predictive equations based on conventional methods such as BIA and anthropometry [11, 12]. In our study, we employed a validated anthropometric-based prediction equation developed by El Kari et al. [13] in 2023 to assess the nutritional status of WRA in Morocco. Therefore, the objective of the present study was to evaluate the prevalence of obesity and the impact of socio-demographic and economic risk factor among WRA using both BMI and excess fat.

MATERIAL AND METHODS

Study design and population

This research was conducted within the framework of the National Nutrition Survey organized by the Moroccan MH and implemented nationwide across all 12 regions of Morocco. The survey employed a probability sampling method proportional to population size, as recommended by the WHO [14], and included 180 sampling clusters. Within each cluster, households were randomly selected using a count sheet prepared the day prior to the survey. A systematic sampling technique was applied to select 20 households per cluster, ensuring equal probability for each.

In total, 3,118 households were surveyed, with 60.4% located in urban area and 39.6% in rural area. In each selected household, one WRA, aged 18 to 49 years, was eligible for inclusion if present at the time of the visit. In households with multiple eligible participants, one WRA was selected by the supervisor of the field team using a random draw based on Kish's table [15]. A total of 110 women were excluded from the study, including those under 18 or over 49 years of age; those with chronic or severe illnesses requiring hospitalization or medical treatment; those suffering from severe malnutrition requiring nutritional rehabilitation; those with physical or mental disabilities; and those presenting with fever, diarrhea, respiratory infections, or other acute infections. During a household visit, the study's objectives were explained to the family, and signed informed consent was obtained from each participating woman prior to data collection.

Ethical approval

The survey protocol was validated by a Technical and Steering Committee comprising representatives of all concerned Institutions (MH, Universities, CHU, HCP) then the protocol was approved by the National Ethics Committee for Biomedical Research in Rabat under the refence 321/17.

Socio-economic assessments

A questionnaire consisting of 12 questions, including both open-ended and closed-ended types, was employed to collect pertinent socio-demographic and economic information. This face-to-face survey encompassed details such as age, residence area,

marital status, educational level, household-index. The latter is a score assigned to households on the basis of the number and type of goods owned, and housing characteristics such as the source of water supply, sanitary facilities and flooring materials, etc. These scores are generated using principal component analysis. The quantiles of household-index are constructed by assigning the household score to each woman in the same household, and dividing the distribution into 3 equal categories, each representing 1/3 of the population. The household-index allows us to compare the economic well-being of one woman against another within the study population. It does not define poverty in the country or the studied population.

Anthropometric measurement

Trained healthcare professionals conducted anthropometric measurements following the established WHO protocol and using calibrated instruments [16]. These measurements were taken with minimal attire and without footwear. Body weight was determined with precision to the nearest 0.1 kg utilizing an electronic scale (Seca GmbH and Co. KG). Height was measured to the nearest 0.1 cm using a stadiometer (Seca GmbH and Co. KG). Body Mass Index (BMI) was computed by dividing weight in kilograms by the square of height in meters (kg/m^2) and was employed to categorize nutritional status as follows: underweight ($< 18.5\,kg/m^2$), normal weight ($18.5\text{-}24.9\,kg/m^2$), overweight ($25.0\text{-}29.9\,kg/m^2$), and obese ($\geq 30.0\,kg/m^2$) [17].

Waist circumference (WC) was also measured using a tape measure (Seca 201) to the nearest 0.1 centimeter. The WC was used to class the studied population to different classes of risk of health problems related to abdominal obesity. Based on Han's and Lean's [18, 19] data, the following classification was considered: less than 80 cm: low risk of health problems related to abdominal obesity, between 80 and 88 cm: moderate risk of health problems related to abdominal obesity, more than 88 cm: high risk of health problems related to abdominal obesity.

Estimation of excess fat

For body composition assessment a newly developed Anthropometric-Based Prediction Equation (ABPE) was used [13]. One of the independent variables introduced is body volume (BV). Following Fricke's model, which views the body as a suspension of cells in an electrolyte solution and as a conductive cylinder [20, 21], BV was calculated using the formula for the volume of a cylinder, where V represents the volume, S is the area of the cylinder's base, and H is the cylinder's height. The height was considered as the body's height, and for area calculation, the radius was assumed to be the height/9. Thus, the anthropometric prediction equation of total body water (TBW) used in this study is TBW (kg) = -5.249 + 107.502 BV (l) + 0.289 weight (kg) + 2.015 sex (male: 1, female: 0) [13].

The estimation of fat-free mass (FFM) in kilograms was derived from TBW, taking into consideration that FFM incorporates age- and sex-specific values of hydration factors [22]. Subsequently, the calculation of fat mass (FM) in kilograms was performed by determining the difference between body mass and FFM. Additional variables were computed, including fat mass percentage (FM%), FFM index (FFMI) = FFM/height^2 (kg/m^2), and FM index (FMI) = FM/height^2 (kg/m^2). Different cut-off points were used to define obesity according to the FM%. In fact, for women < 40 years, excess of fat was defined as FM% > 35% [23]. For subjects aged 40-49 y, the excess of fat was when FM% > 40% [24].

Statistical analysis

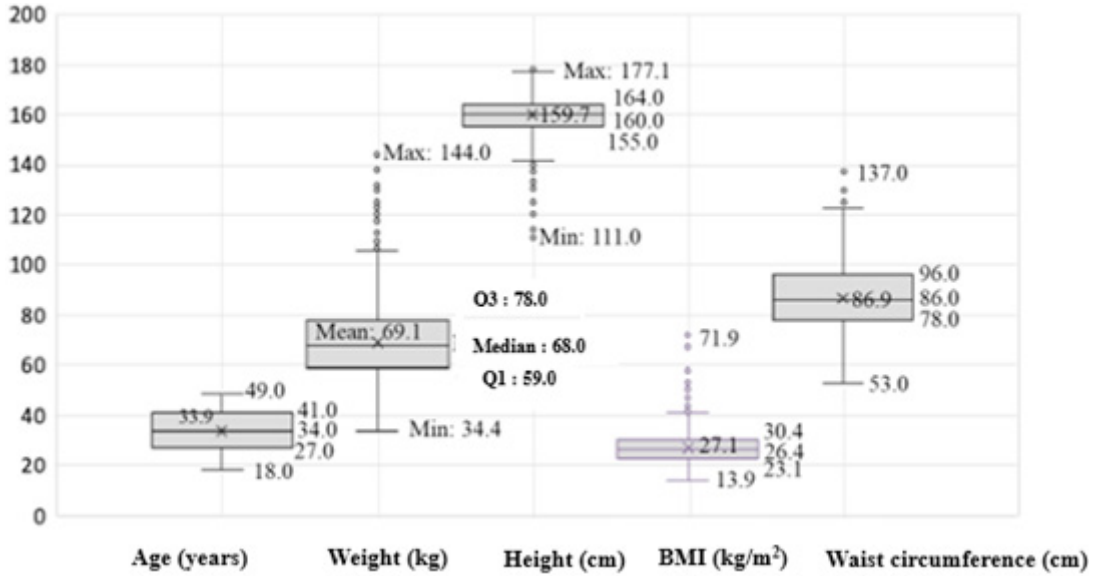
Data were analyzed using IBM SPSS version 21.0. The Kolmogorov-Smirnov test was used to evaluate the normally distributed variables, which are presented as means ± SD, and non-normally distributed variables are presented as median (inter-quartile range (IQR)). Nominal variables are presented as a proportion and 95% confidence interval. A *Chi*-square test was used to test independence between nominal variables. t-test was used to examine the difference in normally distributed variables. A p-value of < 0.05 was considered as statistically significant.

To improve representativeness and obtain more accurate results, weighting factors were calculated to adjust the means and prevalence taking into account the differences between the sample studied and the target population. The weights were calculated on the basis of the demographic characteristics of the sample and the target population. To study the impact of different risk factors, multivariate analysis based on multiple regression was used.

RESULTS

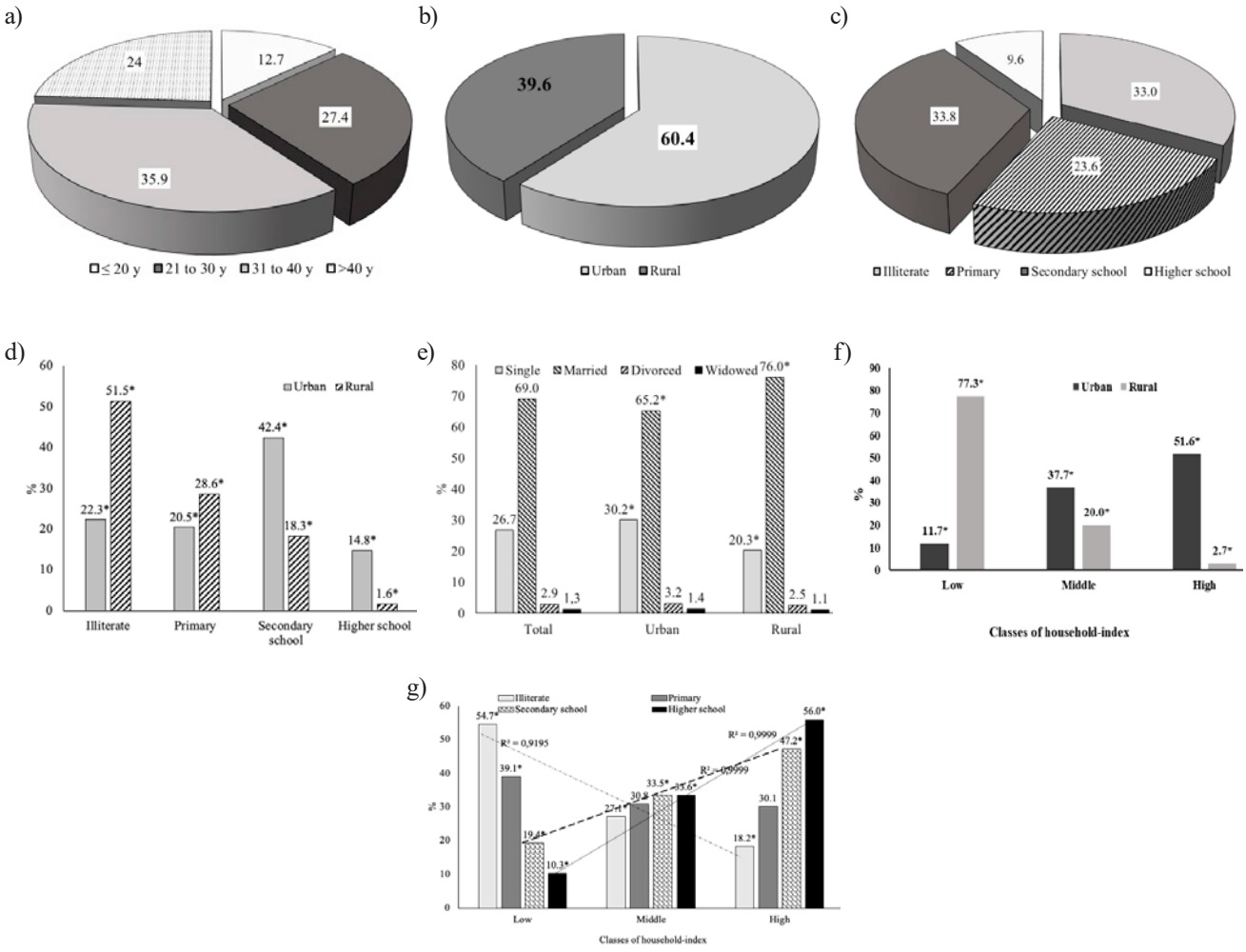
Description of the population

This research enrolled a cohort of 2.172 women aged 18 to 49 years. Their average age was 33.9 ± 8.5 years (Figure 1). Participants aged 20 years or younger, 21 to 30 years, 31 to 40 years, and over 40 years represented 12.7%, 27.4%, 35.9%, and 24.0%, respectively (Figure 2.a). A proportion of 60.4% lived on urban area (Figure 2.b) and the illiteracy represented 33% (Figure 2.c), with a predominance in rural area (51.5%) in comparison to urban area (22.3%) (Figure 2.d). Most of women were married (69%), the single women account for 26.7% (Figure 2.e).



Results are presented as mean ± SD, median (interquartile at Q1:25% and Q3:75%), minimum and maximum

Figure 1. Age and anthropometric characteristics of participants



Values are presented as percentage; p-values were determined using *Chi*² test ; * represents a significant difference ($p < 0.05$)

Figure 2. Socio-demographic and economic characteristics of participants; a. Age group distribution of the study population, b. Distribution of the study population by area of residence, c. Literacy levels of the study population, d. Literacy rates by area of residence, e: Marital status distribution of the study population, f. Household index distribution by area of residence, g. Relationship between household index and education level

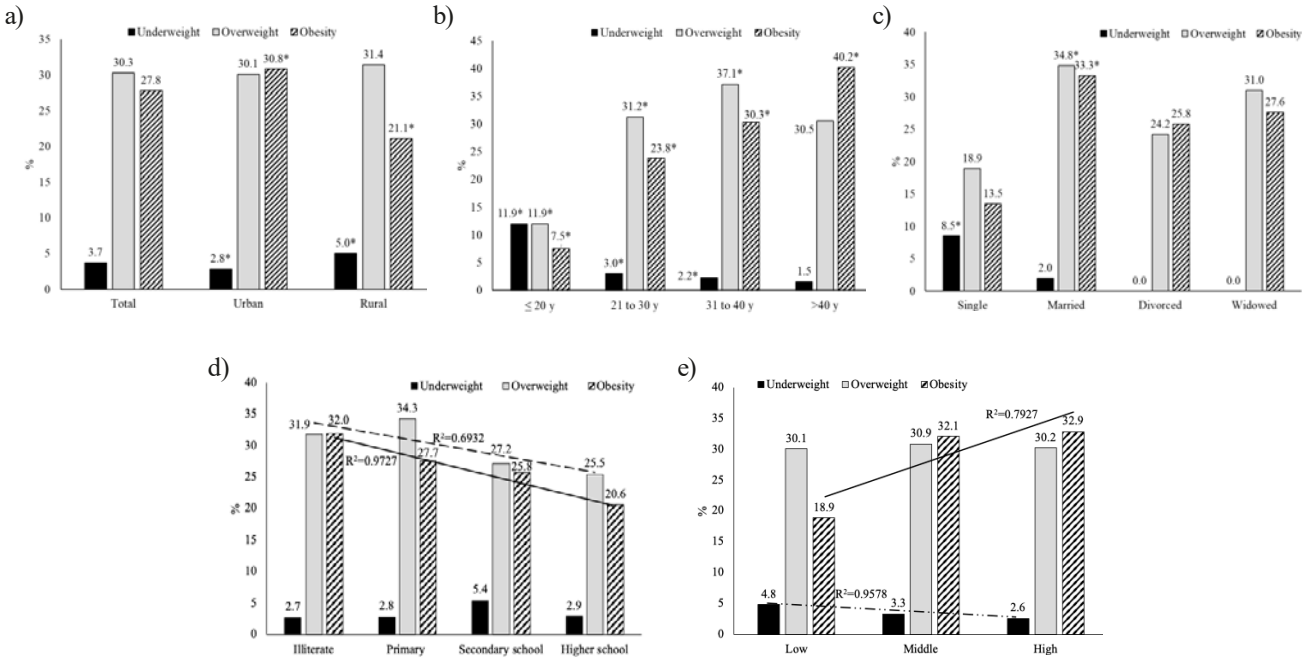
According to household-index, 77.3% and 2.7% of women in rural area belonged to the low and high index class, respectively. While in urban area, 11.7% and 51.6% belonged to the low and high index class, respectively (Figure 2.f). Furthermore, a relationship was observed between the household-index and the education level where more women were educated, more they belonged to the high index class, whereas more women belonged to the low index class, more illiterate they were (Figure 2.g). For anthropometric measurements, the mean of weight was equal to 69.1 ± 14.4 kg, 159.7 ± 7.1 cm for the height, the mean of BMI was equal to 27.1 ± 5.8 kg/m^2 and the mean of waist circumference was equal to 86.9 ± 12.8 cm (Figure 1).

Underweight, overweight and obesity

Using BMI, it was found that 3.7% of WRA were underweight, while 58.1% had an excess of weight, of whom 30.3% were overweight and 27.8% were obese (Figure 3.a). According to the residence area, the results showed that in urban areas, the prevalence of underweight, overweight and obesity were equal to 2.8%, 30.1% and 30.8%, respectively. In rural areas, these percentages were equal to 5.0%, 31.4% and 21.1%, respectively (Figure 3.a). This indicates that obesity was significantly higher in urban areas ($p < 0.001$), whereas the prevalence of underweight was significantly higher in rural areas ($p < 0.01$). Regarding the effect of age on the prevalence of weight problem, it was observed that the older the women, the less underweight they were and the more overweight they were ($R^2 = 0.719$ for underweight, and 0.5316 and 0.9665 for overweight and obesity, respectively; Figure 3.b). The prevalence of underweight decreased from 11.9% in women 20 and younger to 1.5% in women over 40, while the prevalence of excess of weight increased from 19.4% in women under 20 to 70.7% in women over 40 (Figure 3.b). The same observation was made when studying the relationship between household-index and nutritional status. In fact, the higher the women's household-index, the lower the number of women suffering from underweight and the higher the number of obese women (R^2 was 0.9578 in the case of underweight and 0.7927 in the case of obesity) (Figure 3.e).

However, the level of education had an inverse effect on the prevalence of excess of weight, because the higher the level of education, the fewer women were overweight ($R^2 = 0.6932$) and obese ($R^2 = 0.9727$) (Figure 3.d). Furthermore, the highest prevalence of overweight and obesity was observed among married women (34.8% and 33.3%, respectively), while the highest prevalence of underweight was observed among single women (8.5%) (Figure 3.c).

In order to obtain more precise results on the nutritional status of these women, this study also assessed their body composition. The average of TBW was 31.8 ± 5.1 kg, while the average of FFM was



Values are presented as percentage; p-values were determined using *Chi*^{2} test ; * represents a significant difference ($p < 0.05$)

Figure 3. Prevalence of malnutrition among WRA according to socio-economic and demographic factors; a. Nutritional status distribution among WRA, by area of residence, b. Relationship between age and nutritional status among WRA, c. Relationship between marital status and nutritional status among WRA, d. Relationship between literacy and nutritional status among WRA, e. Relationship between household index and nutritional status

Table 1. Body composition and excess body fat

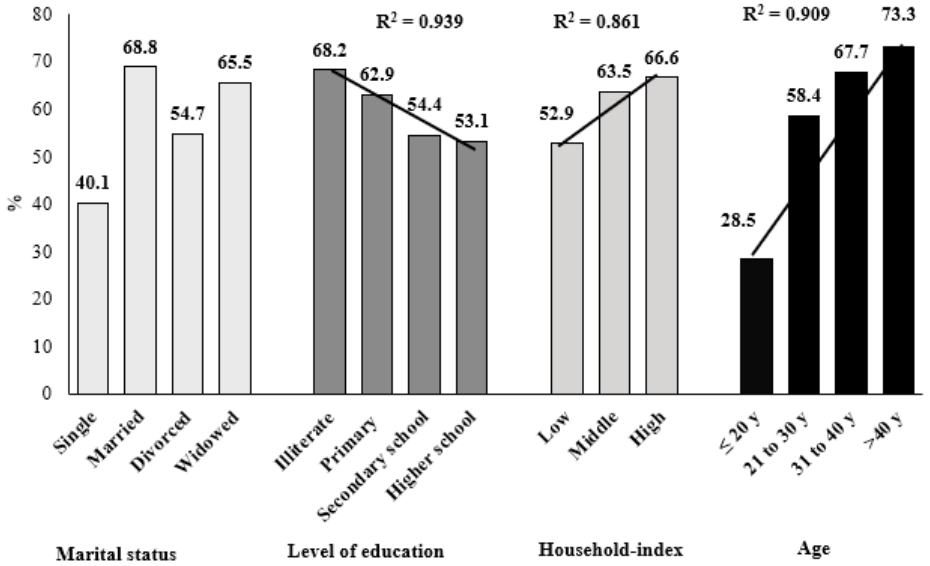
Body composition	Total N = 2172	Urban N = 1312	Rural N = 860	p-value
TBW (kg)	31.8 ± 5.1	32.1 ± 5.2	31.3 ± 5.1	0.5351
FFM (kg)	43.3 ± 7.1	43.8 ± 7.1	42.6 ± 6.9	0.3606
FM (kg)	25.7 ± 8.4	26.6 ± 8.7	24.3 ± 7.8	0.0005
FM%	36.5 ± 5.5	37.1 ± 5.5	35.6 ± 5.5	1
FFMI (kg/m^2)	16.9 ± 2.2	17.1 ± 2.3	16.6 ± 2.0	0.008
FMI (kg/m^2)	10.1 ± 3.6	10.5 ± 3.8	9.6 ± 3.2	0.0003
FM% ≥ 35% (%95 CI)	61.6 (59.5; 63.7)	64.4 (61.8; 67.0)	54.5 (51.2; 57.9)	< 0.001

Results are presented as means ± SD or proportion (%) (95% confidence interval); p-values were determined using t test in the case of means and *Chi*^{2} test in the case of %; TBW – total body water; FFM – fat free mass; FM – fat masse, FM% – fat mass percent, FFMI – fat free mass index; FMI – fat mass index

43.3 ± 7.1 kg, and the average of FM, FM%, FFMI and FMI were 25.7 ± 8.4 kg, 36.5 ± 5.5%, 16.9 ± 2.2 kg/m² and 10.1 ± 3.6 kg/m², respectively. In addition, the prevalence of women with excess body fat was 61.6% (Table 1).

The comparison between the urban and rural areas showed that there was no significant difference in terms of the means of TBW, FFM compartments and the FM%, although these compartments were slightly higher in the case of urban women than in rural women. In addition, the FM, FFMI, FMI and the prevalence of women with excess body fat (64.4% vs. 54.5%) were significantly higher in urban women than in rural women (Table 1). Looking at the prevalence of excess fat in relation to marital status, level of education, household-index and age, it showed that as the level of education increases, the prevalence of excess fat decreases ($R^2 = 0.939$). However, as age and level of household-index increase, so does the prevalence of excess fat, with a R^2 equal to 0.909 and 0.861, respectively (Figure 4).

However, according to marital status, single women had the lowest prevalence (40.1%), while married women had the highest (68.8%) (Figure 4), the difference is statistically significant ($p < 0.0001$). Furthermore, it was observed that 85.0% of women with excess fat were at risk of developing health problems associated with abdominal obesity, given that these women had a WC above 80 cm. Those with a high risk (WC > 88 cm) of developing health problems associated with abdominal obesity represented 58.5% (Figure 5). The comparison between the two residence areas showed that there are more women with excess fat related to health problems risk associated to abdominal obesity in urban area (60.9%) than in rural area (53.7%) ($p < 0.0002$).



Values are presented as percentage; p-values were determined using *Chi*^{2} test; * represents a significant difference ($p < 0.05$)

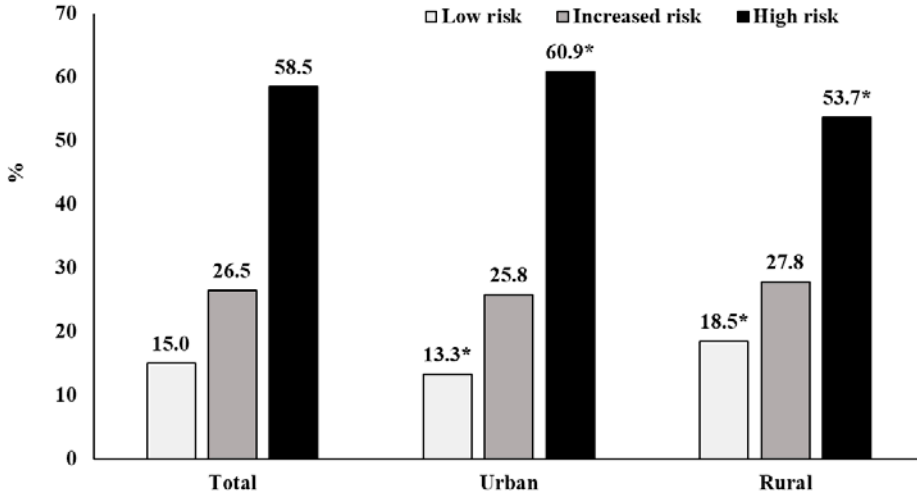
Figure 4. Prevalence of excess fat among WRA according to socio-economic and demographic factors

For a more in-depth analysis of the relationship between body fat and risk factors such as age, place of residence, level of education, marital status and well-being index, a multivariate analysis based on multiple regression was performed (Table 2). The results showed that the model's R^2 was 0.147, meaning that the studied factors were responsible for 14.7% of the variation in fat mass. However, among the studied factors, age was the most significant predictor, with fat mass increasing by 1.8 kg between age groups. Marital status and place of residence also had significant effects of approximately 1.3 kg, but in opposite directions: progressing from one level of marital status to another was associated with a 1.3 kg increase in fat mass, while moving from urban to rural areas corresponded to a 1.3 kg decrease. Additionally, the household well-being index had a positive effect, with fat mass increasing by 1.1 kg for each level of improvement. In contrast, educational level did not have a statistically significant impact on fat mass ($p = 0.150$) (Table 2).

DISCUSSION

Despite the fact that Morocco has made great efforts to reduce and control obesity in the Moroccan population, its prevalence continues to increase [25]. It increased from 6.4% in 1984 to 29% in 2017 [25, 26]. It is well known that obesity and overweight are characterized by an accumulation of fat in the body, and their definitions are very often based on BMI, which is closely associated to total body fat, but which has also shown an important limitation in terms of differentiating between FFM and FM [27-30]. Thus, the objective of the present study was to determine the prevalence of overweight and obesity using both BMI and excess fat and to study their relationship to socio-demographic and economic risk factor among WRA in Morocco.

In the current study, 35.9% of the WRA were aged between 31 and 40, 69% were married and a third of the women were illiterate, with a predominance in rural areas (51.5%). In the latter, 77.3% of women belonged to the lowest household-index class, which may have an impact on women's health status, given that people with a higher level of education and favorable living conditions tend to be more aware of good health conditions and to have better knowledge of how to maintain it [31]. Although low socioeconomic status (SES) is linked to a higher risk of various diseases regardless of health behaviours [32], studies



Values are presented as percentage; p-values were determined using *Chi*^{2} test; * represents a significant difference ($p < 0.05$)

Figure 5. Prevalence of health problems risk associated to abdominal obesity among obese women

Table 2. Multiple regression model between fat mass as dependent variable and risk factors as independent variables.

Model	Unstandardized ß	Std. Error	t	p-value
Constant	16.7	1.4	12.284	0.000
Age	1.8	0.2	8.760	0.000
Household-index	1.1	0.3	4.094	0.000
Marital status	1.3	0.5	4.748	0.000
Residence area	-1.3	0.5	-2.855	0.004
Education level	-0.3	0.2	-1.441	0.150

Std. Error – Standard Error

have shown that a significant part of health disparities related to SES can be explained by differences in health behaviours between socioeconomic groups [33]. As women enter adulthood and begin forming partnerships and starting families, the SES of their household and partner increasingly influences their health. Marriage, in particular, is often associated with protective effects against various health conditions [34]. In recent decades, the health benefits associated with marriage appear to have become more pronounced. It was initially believed that this trend was driven by declining marriage rates among individuals with lower levels of education and delayed marriage among those with higher education [35]. However, data from the United States [36] and Norway [37] suggest that shifts in the educational composition of married individuals have played only a minor role in the widening health disparity. While a recent meta-analysis involving over 7 million participants found that being unmarried was associated with a higher risk of stroke and mortality in men compared to women [34], other meta-analyses have reported no significant gender differences in the protective effects of marriage on cardiovascular disease (CVD) risk [38].

Regarding the assessment of nutritional status based on BMI, it revealed that 30.3% of women are classified as overweight, while 27.8% were obese. This is roughly in line with the 2017-2018 national survey on common risk factors for non-communicable diseases (NCDs) [25] which showed that the prevalence of excess of weight among women aged over 18 was 63.4% of which 29% were obese. Similarly, the study by Barich et al. [39] on a subsample of Moroccan women aged 19 to 49 showed that 34.3% of women were overweight and 22.7% were obese. In Bangladesh, overweight and obesity rate increased from 24% in 2014 [40] to 32% in 2017 [41]. Another study in Dar es Salaam, Tanzania, found that 27.8% and 22.6% of WRA were overweight and obese, respectively [42]. Also, in various countries in the Middle East and North and South Africa, obesity rates among women have exceeded 30% [43]. The factors behind developing overweight and obesity are varied, multifaceted and can interact with each other in complex ways, making it challenging to address overweight and obesity. They can be categorized as environmental factors (*unhealthy diet:* consuming high-calorie, high-fat, and high-sugar foods and drinks; *food marketing*: aggressive marketing of unhealthy foods, especially to children; *urbanization*: changes in lifestyle and diet associated with urbanization), lifestyle factors (*poor eating habits*: skipping meals, eating on the go, and consuming large portions; *lack of physical activity*: insufficient exercise and physical activity and sedentary lifestyles; *stress*: chronic stress can lead to overeating and weight gain; *sleep deprivation*: lack of sleep can disrupt hormones that regulate hunger and fullness), socioeconomic factors (*low socioeconomic status*: limited access to healthy food options and safe spaces for physical activity; *food insecurity*: limited access to nutritious food, leading to reliance on high-calorie, high-fat foods; c*ultural factors*: cultural norms and values that promote overeating or unhealthy eating habits), medical factors (hormonal imbalances, medications, sleep disorders etc.), genetic factors, pregnancy without forgetting ageing [3, 44-48].

In addition, excess weight appears to be particularly high in urban areas in Africa [49], which was confirmed in this study, as the prevalence in urban areas is significantly higher than in rural areas. Furthermore, it seems that women's level of education has an inverse impact on the prevalence of obesity, indicating that the more educated women are, the less obese they are. On the other hand, women's age and the household-index level have a positive impact on the prevalence of overweight/obesity, since the older they are or the higher their household-index level, the more obese and the fewer underweight they are. Additionally, the problem of overweight/obesity can also be associated to other problems of nutritional deficiency, leading to a double burden of malnutrition at national, household or individual level [50-52].

To estimate excess body fat in the studied population, we used an anthropometric equation developed for the Moroccan population and published in 2023 to assess body composition [13]. In fact, equations for predicting body composition based on anthropometric measurements or bioelectrical impedance analysis tend to be population-specific; applying them to other populations can therefore lead to systematic errors and inaccurate estimates [53, 54]. By applying this equation to the population of WRA, it was observed that the prevalence of excess body fat was 62%, with a disparity according to the residence area, showing that urban areas had more women with excess fat than rural areas.

In addition, the use of multivariate analysis based on multiple regression showed that the age, the marital status and the household-index were factors favoring a positive increase of the excess body fat whereas moving from an urban to a rural area reduces body fat. This confirms the impact of socio-economic factors such as asset-index and access to resources (supermarkets in urban area), which influence access to processed foods, and also the impact of demographic factors such as age, gender, marital status and ethnicity on malnutrition in its various forms [55-57]. From another point of view, the impact of the five risk factors studied in this study represents 14.7% of the global variation of fat mass thus revealing that other factors are more responsible for the rise in obesity among Moroccan women such as diet and inactivity.

A resent publication in July 2025 suggested that between increased caloric intake and reduced energy expenditure, cited as development-related contributors to the obesity crisis, dietary intake plays a far greater role than inactivity in the elevated prevalence of obesity [58].

Furthermore, it seems that by using BMI or excess body fat in the Moroccan women population of reproductive age, we obtained a high degree of similarity in the results, thus confirming the positive relationship between BMI and body fat. This makes BMI useful for population screening for obesity rather than diagnostic measure of it [59].

CONCLUSIONS

In summary, our study underscores the pressing need for targeted public health interventions to address the continue rising rates of overweight and obesity among women of reproductive age in Morocco. These interventions should consider socio-economic factors, educational levels, and urbanization trends as a part of a comprehensive approach that takes into account these multiple factors are often necessary to promote healthy weight management.

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Conflict of interest
The authors declare no conflict of interest.

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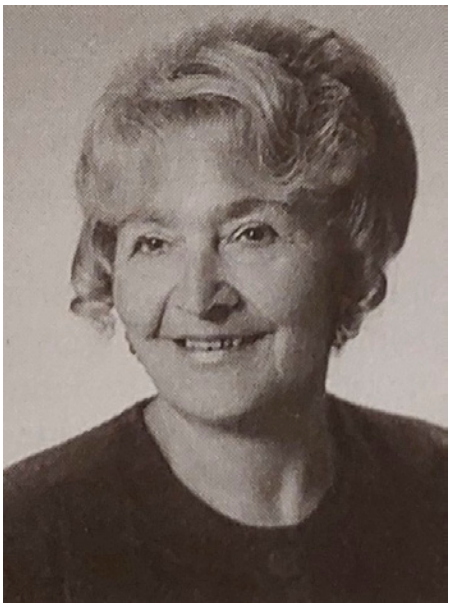
PAMIĘCI PROFESOR DR HAB. DANUTY PALUT

(1931-2025)



W dniu 7 marca 2025 roku zmarła prof. dr. hab. Danuta Palut, długoletni pracownik Zakładu Toksykologii i Oceny Ryzyka Zdrowotnego Narodowego Instytutu Zdrowia Publicznego – Państwowego Zakładu Higieny w Warszawie, wspaniały naukowiec, bez reszty oddana pracy naukowej w Instytucie.

Profesor Danuta Palut była absolwentką Wydziału Chemii Uniwersytetu Warszawskiego, który ukończyła w 1955 r. Bezpośrednio po studiach rozpoczęła pracę w Państwowym Zakładzie Higieny (obecna nazwa Narodowy Instytut Zdrowia Publicznego – PZH PIB) w Warszawie, w którym pracowała przez ponad 40 lat, aż do przejścia na emeryturę. Do tego czasu Instytut ten był jej jedynym miejscem pracy, w którym realizowała swoje naukowe pasje i zdobyła wszystkie możliwe stopnie naukowe: dr nauk przyrodniczych (1966), dr hab. (1974) i tytuł naukowy profesora zwyczajnego (1992).

Najwcześniejsze publikacje naukowe Profesor Palut pochodzą z początku lat sześćdziesiątych. Ale najistotniejsza praca z punktu widzenia Jej dalszego rozwoju naukowego, opublikowana w 1968 r. w czasopiśmie naukowym „Roczniki Państwowego Zakładu Higieny" dotyczyła otrzymywania insektycydu bromofos znakowanego radioaktywnym bromem. Wiadomo, że taka substancja stanowi nieocenione narzędzie służące toksykologom do badań metabolizmu, dystrybucji narządowej i wydalania substancji szkodliwych z organizmu. Jej późniejsza rozprawa habilitacyjna „Badania mechanizmów detoksykacyjnych insektycydów fosforoorganicznych i karbaminianowych" stanowiła kontynuację tej tematyki skupiając się na badaniu mechanizmów detoksykacyjnych insektycydów, w tym właśnie bromofosu znakowanego radioaktywnym bromem.

Po habilitacji główne fascynacje naukowe Profesor Palut skoncentrowały się wokół mechanizmów rakotwórczości indukowanej substancjami chemicznymi i modeli eksperymentalnych, za pomocą których usiłowała wyjaśnić procesy biologiczne leżące u podstaw hepatokancerogenezy, łącznie z rolą mutagenezy w tym procesie. Tej tematyce poświęciła większość swoich zainteresowań naukowych do końca swojej pracy zawodowej. W badaniach inicjowanych przez Profesor Palut udało się wykazać przydatność dwustopniowego modelu hepatokancerogenezy inicjowanej czynnikami genotoksycznymi i częściową hepatoktomią do oceny potencjalnych promotorów raka wątroby. Pozwoliło to na sformułowanie wniosku, że proliferacja hepatocytów może być potencjalnym markerem promotorów raka wątroby o niegenotoksycznym podłożu. Na tym etapie autor niniejszego wspomnienia miał zaszczyt współpracować z Panią Profesor, czego wynikiem były wspólne publikacje.

Nikt z naszego zespołu naukowego nie miał najmniejszych wątpliwości, że Profesor Danuta Palut była wzorem naukowca.

Profesor Palut była naukowcem w pełnym znaczeniu tego słowa. Pracownicy, którzy mieli przywilej z nią współpracować, nie mieli żadnych wątpliwości, że treścią Jej życia było rozwiązywanie problemów naukowych w drodze eksperymentu. Często odnosiliśmy wrażenie, że dla Profesor Palut definiowanie hipotezy badawczej było najważniejszym etapem całego procesu naukowego, a dyskusje o nowych koncepcjach Pani Profesor zwykła była prowadzić nie tylko podczas seminariów, ale właściwie przy każdej nadarzającej się okazji.

Dorobek naukowy Profesor Danuty Palut obejmuje ponad siedemdziesiąt oryginalnych prac naukowych w czasopismach krajowych i zagranicznych, takich jak Toxicology, Pharmacology and Toxicology, Carcinogenesis, Journal of Applied Pharmacology and Toxicology.

Profesor Palut prowadziła szeroką działalność naukową współpracując z licznymi ośrodkami w kraju i zagranicą. Jako stypendystka Światowej Organizacji Zdrowia przebywała na stażach naukowych na Uniwersytecie Releigh w Północnej Karolinie, USA oraz w Food and Drug Administration w Waszyngtonie, a zdobytą tam wiedzę wykorzystywała w swojej pracy badawczej dzieląc się nią z innymi naukowcami.

Była promotorem licznych prac doktorskich, autorką opinii i ekspertyz naukowych oraz przetłumaczyła tom 65 „Butanole – 4 izomery" w serii naukowej Environmental Health Criteria, wydawanej przez Światową Organizację Zdrowia, który w wersji polskiej został wydany przez Państwowy Zakład Wydawnictw Lekarskich (PZWL).

Profesor Palut była również cenioną recenzentką licznych manuskryptów nadsyłanych do czasopism naukowych krajowych i zagranicznych, prac doktorskich i rozpraw habilitacyjnych.

Była członkiem Rady Naukowej Państwowego Zakładu Higieny oraz innych instytutów naukowych, a także redaktorem Działu Toksykologii i Oceny Ryzyka zdrowotnego w czasopiśmie naukowym „Roczniki Państwowego Zakładu Higieny" (Annals of the National Institute of Hygiene).

Za wybitne osiągnięcia naukowe otrzymała indywidulaną Nagrodę Ministra Zdrowia i Opieki Społecznej oraz kilkukrotnie, cenioną w środowisku naukowym, nagrodę im. Ludwika Rajchmana. Była także członkiem wielu towarzystw naukowych, w tym Polskiego Towarzystwa Toksykologicznego, Europejskiego Towarzystwa ds. Mutagenów Środowiskowych i Polskiego Towarzystwa Genetycznego.

Oprócz prowadzonych badań naukowych uczestniczyła w działalności dydaktycznej Instytutu prowadząc liczne seminaria, wykłady i szkolenia dla pracowników Państwowej Inspekcji Sanitarnej.

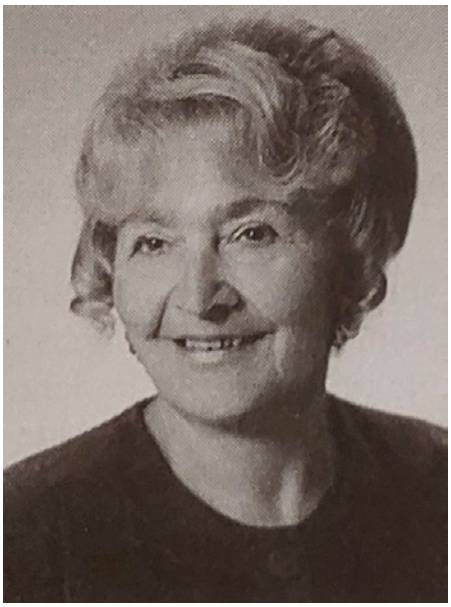
Dla nas, pracowników Zakładu Toksykologii i Oceny Ryzyka Zdrowotnego, była osobą o szlachetnym sercu, ciepłą, życzliwą, tryskającą humorem, na której wsparcie wszyscy, zwłaszcza młodsi pracownicy, zawsze mogli liczyć. Cechowała ją duża wrażliwość na sprawy ludzkie. Wśród swoich zainteresowań wymieniała muzykę, malarstwo i podróże.

Pani Profesor Danuta Palut pozostanie na zawsze w pamięci pracowników naszego Instytutu.

Prof. dr hab. Jan Krzysztof Ludwicki

IN MEMORIAM: PROFESSOR DANUTA PALUT

(1931-2025)



Professor Danuta Palut, PhD, a long-time employee of the Department of Toxicology and Health Risk Assessment at the National Institute of Public Health – National Institute of Hygiene in Warsaw, passed away on 7 March 2025. A great scientist, she was utterly devoted to scientific work at the Institute.

Professor Danuta Palut graduated from the Faculty of Chemistry at the University of Warsaw in 1955. Immediately after her studies, she began working at the National Institute of Hygiene (now the National Institute of Public Health – NIH NRI) in Warsaw, where she worked for over 40 years until her retirement. Until then, this Institute was her only place of work, where she pursued her scientific passions and earned all possible scientific degrees: Doctor (1966), Doctor habilitated (1974) and the title of full Professor (1992).

Professor Palut's earliest scientific publications date back to the early 1960s. But the most important work from the point of view of her further scientific development, published in 1968 in the scientific journal 'Roczniki Państwowego Zakładu Higieny' (Annals of the National Institute of Hygiene) concerned the preparation of the insecticide bromophos labelled with radioactive bromine. Such a substance is known to provide an invaluable tool for toxicologists to study metabolism, organ distribution and excretion of harmful substances from the body. Her subsequent postdoctoral thesis, 'Studies on the detoxification mechanisms of organophosphorus and carbamate insecticides', continued this theme by focusing on the study of the detoxification mechanisms of insecticides, including radioactive bromine-labelled bromophos.

After her habilitation, Professor Palut's main scientific fascinations focused on the mechanisms of chemical-induced carcinogenesis and the experimental models with which she attempted to explain the biological processes underlying hepatocarcinogenesis, including the role of mutagenesis in this process. She devoted most of her scientific interests to this topic until the end of her career. In studies initiated by Professor Palut, it was possible to demonstrate the usefulness of a two-stage model of hepatocarcinogenesis initiated by genotoxic agents and partial hepatectomy for the evaluation of potential promoters of liver cancer. This allowed us to conclude that hepatocyte proliferation could be a potential marker of non-genotoxic liver cancer promoters. At this stage, the author of this memoir was privileged to collaborate with the Professor, resulting in joint publications. No one on our scientific team had the slightest doubt that Professor Palut was a real scientist.

Professor Palut was a scientist in the full sense of the word. Employees who had the privilege of working with her had no doubt that the essence of her life was solving scientific problems through scientific experimentation. We often had the impression that, for Professor Palut, defining a research hypothesis was the most important stage in the entire scientific process, and she used to discuss new concepts not only during seminars, but practically at every opportunity.

Professor Danuta Palut's scientific output includes over seventy original scientific papers in national and international journals such as Toxicology, Pharmacology and Toxicology, Carcinogenesis, Journal of Applied Pharmacology and Toxicology.

She has carried out a wide range of scientific activities collaborating with numerous centres at home and abroad. As a scholarship holder of the World Health Organization, she was on scientific internships at the University of Raleigh in North Carolina, USA and the Food and Drug Administration in Washington, D.C., and she used the knowledge gained there in her research work by sharing it with other scientists.

She has been the supervisor of numerous doctoral theses, authored scientific opinions and expert reports and translated volume 65 'Butanols – 4 isomers' in the Environmental Health Criteria scientific series published by the World Health Organisation, which in Polish version was appeared in the State Medical Publishing House (PZWL).

She was also a valued reviewer of numerous manuscripts submitted to national and international scientific journals, doctoral theses and postdoctoral dissertations.

Since 1987, she was editor of the Toxicology and Health Risk Assessment section of the scientific journal 'Roczniki Państwowego Zakładu Higieny' (Annals of the National Institute of Hygiene) and was a member of the Scientific Council of the National Institute of Hygiene and other scientific institutes.

For her outstanding scientific achievements, she received the individual Award of the Minister of Health and Social Welfare and the Ludwik Rajchman Award, valued in the scientific community, several times. She was also a member of many scientific societies, including the Polish Society of Toxicology, the European Society for Environmental Mutagens and the Polish Genetic Society.

In addition to her scientific research, she participated in the teaching activities of the Institute by giving numerous seminars, lectures and trainings for the staff of the State Sanitary Inspectorate.

For us, the staff of the Department of Toxicology and Health Risk Assessment, Professor Danuta Palut was a person with a noble heart, warm, kind and sparkling with humour, whose support everyone, especially junior staff, could always count on. She was characterised by a great sensitivity to human affairs. Among her interests were music, painting and travel.

Professor Danuta Palut will always be remembered by the staff of our Institute.

Professor Jan Krzysztof Ludwicki, PhD

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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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5. The Editorial Office reserves the right to make editorial corrections to the manuscript that do not influence the substantive content of the article, without prior notification to the author.

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Abstract should not exceed more than 300 words. The original research article should consist of the following sections: Background, Objective, Material and Methods, Results, Discussion and Conclusions. The abstract of a review article does not need to be divided into sections.

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.

Review article should include: Introduction/Background, Conclusions, Acknowledgements, Conflict of interest and References. The remaining section titles depend on the topic of the article.
Introduction/Background should contain the scientific rationale and the aim of the study or in the case of a review the purpose of the article. Only references directly related to the paper should be cited.

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on the approval by a local Ethics Commission. In the case of clinical studies in humans that they have been performed with the ethical standards according to the Helsinki Declaration.

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Discussion should emphasize the new and important aspects of the results and a comprehensive interpretation of the results obtained against the background of results obtained by other authors. Quotations should be restricted to those with immediate relevance to the author's findings.

Conclusions should be stated in points or descriptively and should be logically connected with the aims stated in the introduction. Statements and conclusions not derived from own observations should be avoided. If a hypothesis is proposed it must be stated clearly.

Acknowledgements. One or more statements should specify: (1) persons who contributed substantially to the study but cannot be regarded as authors, such as technical assistants, statisticians, data collectors etc. Their assistance should be acknowledged for the sake of transparency. It must be clear that they are not responsible for the final version of the article. The consent of all the persons named in the acknowledgements must be obtained; (2) all sources of financial and material support, which should specify the nature of the support. The recommended form is: "This work was supported by …….: (name of the organization, project number etc.)".

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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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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.

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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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