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REVIEW ARTICLE

ORTHOREXIA NERVOSA – THE BORDER BETWEEN HEALTHY EATING AND EATING DISORDERS

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ABSTRACT

The term *orthorexia nervosa* (ON), presented in 1997 in Yoga Journal by Dr. Steven Bratman, sheds new light on the view on healthy eating habits. He showed that persistent thinking about nutrition does not necessarily have to be associated with anorexia or bulimia, and may turn into something so far unknown - obsessive control over the healthiest eating style, resulting in numerous self-imposed restrictions and in the long run, without appropriate therapy, leading to the deterioration of the current state of health. Orthorexia can have many consequences not only on mental health, but also on physical health. For this reason, the development of standard diagnostic and classification criteria for orthorexia nervosa is a priority. The problem of eating disorders should be the subject of epidemiological research, which will take into account demographic, cultural and socio-economic conditions appropriate for a given population, and will also take into account the pressure of factors related to the food market.

Key words: *orthorexia, orthorexia nervosa, eating disorders, nutrition, health*

STRESZCZENIE

Termin *ortoreksja nervosa* (ON), przedstawiony w 1997 roku na łamach Yoga Journal przez dr Stevena Bratmana, rzuca nowe światło na kwestię zdrowych nawyków żywieniowych. Wykazał on, że uporczywe myślenie o odżywianiu nie musi być związane z anoreksją czy bulimią, a może przerodzić się w coś dotychczas nieznanego - obsesyjną kontrolę nad najzdrowszym stylem odżywiania, skutkującą licznymi samoograniczeniami, a w dłuższej perspektywie, bez odpowiedniej terapii, prowadzącą do pogorszenia obecnego stanu zdrowia. Ortoreksja może mieć wiele konsekwencji nie tylko dla zdrowia psychicznego, ale także dla zdrowia fizycznego. Z tego powodu opracowanie standardowych kryteriów diagnostycznych i klasyfikacyjnych dla orthorexia nervosa jest priorytetem. Problem zaburzeń odżywiania powinien być przedmiotem badań epidemiologicznych, które będą uwzględniały warunki demograficzne, kulturowe i społeczno-ekonomiczne właściwe dla danej populacji, a także będą brały pod uwagę presję czynników związanych z rynkiem żywności.

Słowa kluczowe: *ortoreksja, orthorexia nervosa, zaburzenia odżywiania, żywienie, zdrowie*

INTRODUCTION

When talking about eating disorders, most of the attention is usually focused on two of them - (AN) and bulimia nervosa (BN). Undoubtedly, the fact that society's education on this type of disorder is progressing deserves praise. Often, however, educators themselves do not realize that they can be directed in exactly the opposite direction, i.e. overly healthy eating.

The term orthorexia nervosa (ON) appeared for the first time in 1997 in the work of Dr. Steven Bratman „In the claws of healthy food" (*Health Food Junkie*) [7]. The doctor wrote it based on his past experiences with the radical diet. According to the World Health Organization (WHO), this is an unhealthy, exaggerated focus on a healthy diet. The question of whether it should be treated as a separate disease entity, an eating disorder or an obsessive-compulsive disorder (OCD) remains a controversial issue [8, 24].

SYMPTOMS OF ORTHOREXIA

People with orthorexia are obsessive about their diet, devoting a large part of their time to it [21]. They pay above-average attention to the quality of food, raw materials and sources from which it comes - they check that vegetables and fruit have not been

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in contact with pesticides, dairy or meat has not been obtained from animals that have been given hormones or antibiotics, or whether the food contains additives such as preservatives or artificial dyes [15]. They fear diseases that could develop as a result of eating poor-quality, in their opinion unhealthy products, and therefore spend a great part of their time deepening their knowledge of healthy eating and go to extremes related to it. Some people refrain from taking whole groups of products, for example, completely excluding dairy products, gluten, simple sugars and even all carbohydrates from their diets. It happens that radical restrictions on the consumed groups of products over time lead to a state of malnutrition, gradual weight loss and deterioration of general health [21]. There are no studies on the effects of long-term untreated orthorexia nervosa, but its health effects are expected to be similar to those seen in anorexia nervosa, i.e. they may develop into osteoporosis, anemia, metabolic acidosis, hyponatremia or bradycardia. [6, 27].

Orthorexia does not even spare the social life of people affected by it - often meals prepared in restaurants and by other people do not meet the standards imposed by them, and therefore refuse to eat them. Sometimes they also criticize the diet of the people around them, considering their nutrition to be the best for health [21].

DIAGNOSIS CRITERIA

There are no officially accepted criteria for the diagnosis of orthorexia [10]. It is still not included in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) which is a classification of mental disorders issued by the American Psychiatric Association, or the International Statistical Classification of Diseases and Related Health Problems (ICD-10). ORTO-15 questionnaires are usually taken into account [5], BOT (*Bratman's Orthorexia Test*) [15] and EHQ (*Eating Habits Questionnaire*) [10].

Due to the lack of clearly indicated diagnostic criteria, it is difficult to define the scale of this phenomenon in the world. Various studies show that the risk of orthorexia may affect from 1% to as much as 57.6% of the population, depending on the study group and adopted diagnostic criteria [1, 11, 13, 17, 19]. In 2019, a study by *Łucka* et al. [24] was published, which showed that out of a group of 864 respondents, as many as 240 people (27.7%) were at risk of developing orthorexia nervosa. It also noted a significant relationship between the risk of eating disorders, examined using the EAT-26 questionnaire, and the suspicion of orthorexia resulting from the completed ORTO-15 forms [24], which suggests that it is another eating disorder and not a separate disease entity or an obsessive-compulsive disorder (OCD).

RISK FACTORS OF ORTHOREXIA

Orthorexia is a relatively new entity, therefore the factors predisposing to its development remain the subject of numerous studies [35]. Due to the multifactorial nature, complexity and heterogeneity of this disorder, they are conditioned by many factors: individual, because biological, and socio-cultural [14]. The disease often begins innocently, and behaviors to improve physical condition and reduce the risk of disease can motivate a healthy diet. Orthorexia begins when planning, buying and preparing meals is dominated in daily activities [20, 23]. Different conclusions about the relationship between age and ON risk can be drawn from different works. According to some of them, young people are the most vulnerable, while others indicate that there is no relationship between age and orthorexia [31]. The issue of gender and predisposition to HE also remains debatable, however, researchers tend to believe that it is not related to this unit [8, 26, 31]. Interestingly, it has been noticed that perfectionists are more likely to suffer from orthorexia [29].

Among the nutritional factors, some studies indicate that vegans and vegetarians are more likely to develop ON than those on a basic diet [5, 9, 25]. Taking into account various branches of vegetarianism, the highest risk of orthorexia was observed in lacto-vegetarians [12].

According to *Strahler* et al., among people predisposed to ON, a large proportion were people following the Mediterranean diet [32], which was recognized by the U.S. News & World Report monthly as the healthiest diet in 2022. It was noticed that keeping the caloric balance also influences the higher risk of orthorexia [9, 31, 32]. A relationship has been found between the history of weight loss in the past and an increased likelihood of ON [5, 31]. Research by *Parra-Fernandez* et al. from 2018 suggests that people dissatisfied with their body more often suffer from ON [30]. Researchers are also looking for a relationship between orthorexia and the field of study or work. Some studies suggest that employees of sectors related to health and nutrition and students of related fields of study, such as dieticians or students of medicine, are particularly vulnerable [2, 33], but some studies did not find such a relationship [1, 26]. However, the studies conducted so far indicate that the most important risk factor for orthorexia is the present or past eating disorders, such as bulimia and anorexia [3, 8, 18]. The work of *Turner* and *Lefevre* shows that the risk of orthorexia is much more common among social media users, especially Instagram [34]. People using this platform were more likely to develop ON. Similar observations about orthorexia and the use of social media were made by *Yılmazel* [36]. It can

therefore be concluded that social media, especially those rich in profiles focusing on the topic of healthy eating, contribute to the creation of inappropriate eating habits.

TREATMENT OF ORTHOREXIA AND THE ROLE OF DIETICIANS

As with diagnostics, there are no standards for the treatment of orthorexia nervosa. Considering the available literature, it can be assumed that the therapy of orthorexia should be similar to the protocols adopted in the case of other eating disorders, such as anorexia nervosa (AN) and bulimia nervosa (BN), due to their similarity - in each of these units, the patient's mind focuses on nutrition, but in In the case of orthorexia nervosa, the interest in nutrition is not caused by the desire to improve the appearance, but the diet.

The therapeutic team should consist of a psychotherapist, dietician and physician, especially when ON contributed to the state of malnutrition and deterioration of health. Individual or group psychotherapy and treatment of orthorexia complications are important [28]. The physician may consider introducing pharmacotherapy, eg. olanzapine, which has an antipsychotic effect [27]. Treatment of patients with a high degree of malnutrition and metabolic complications should be in the hospital. According to the protocol proposed in 2015 by *Kove*n and *Wabry*, a physician dealing with orthorexia should be familiar with the treatment of refeeding syndrome [22].

In the treatment of orthorexia nervosa, the main task of a dietician is nutritional education and correction of incorrect eating habits resulting from the disorder [8]. If malnutrition is diagnosed, nutritional treatment should follow the pattern of anorexia nervosa and begin with a modified consistency diet - liquid, semi-liquid or mush. Gradually, one should strive to achieve a diversified diet, covering the patient's energy needs [28].

There is no doubt that nutritionists should update their knowledge of nutrition in line with scientific achievements, which is included in the sixth point of the promise of the Dietician's Code of Professional Ethics of the Republic of Poland. It should be borne in mind that one of the symptoms of orthorexia nervosa is the constant desire to broaden one's knowledge about food and nutrition and related fields [21]. For this reason, the competences of a dietitian working with a patient suffering from ON can be constantly tested and even questioned by the patient. Certainly, in addition to knowledge about nutrition, knowledge of human physiology, food production technology, psychology and even food law will be useful.

Knowledge about the methodology of conducting research, the ability to spot inaccuracies and mental errors can help the patient realize that some of the scientific research referred to is of low quality and should be approached with a distance. A dietitian should be able to explain in an accessible way what is supported by current scientific knowledge in the context of nutrition. Only when the patient believes in the broad knowledge of this subject of the person with whom he works, can we talk about starting some of the proper therapy.

It is worth for a dietitian in the process of nutritional education to focus on the topic of groups of products that a person with orthorexia has stopped consuming. It is good to make an inventory of all products or methods of thermal processing that are excluded from the diet. Introducing them back to the menu should be done gradually, after the patient has been properly prepared. If the patient raises the topic of side effects of consuming certain products, it should be factually presented why moderate consumption may bring more tangible benefits than risks.

CONCLUSIONS

Considering the available literature sources, it can be concluded that the contribution of a dietician to the treatment of orthorexia nervosa may be one of the key factors determining the success or failure of treatment. Current knowledge about nutrition and broadly understood health, presented to the patient in a substantive and accessible way, is a very important element of the therapy. The problem of ON, its appropriate classification and epidemiology, risk factors, diagnosis and treatment protocol should be the subject of further research. Only on their basis will it be possible to develop effective prevention programs as well as diagnosis and therapy schemes for this disease.

Conflict of interest statement
The authors declare no conflict of interest.

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ORIGINAL ARTICLE

POSITION STATEMENT OF THE POLISH ACADEMY OF SCIENCES COMMITTEE HUMAN NUTRITION SCIENCE ON THE PRINCIPLES FOR THE NUTRITION OF CHILDREN AGED 1–3 YEARS*)

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ABSTRACT

The Position Statement on the principles of nutrition for children aged 1-3 years emphasizes that proper nutrition of children at this age determines their optimal psychometric development and has beneficial effects on the process nutritional programming, which reduces the risk of diet-related diseases in adulthood. Continued breastfeeding in the post-infancy period, together with the proper introduction of complementary foods, supplies all the nutritional needs of the child. A varied selection of food products is important to balance out the diet of a child in the context of energy and nutrient needs. Attention should be paid to products not recommended for frequent consumption, due to the possibility of the early development of improper eating habits that can lead to undesirable health consequences. Due to the potential risk of deficiency, adequate intake of iron, iodine, calcium and vitamin D, as well as of n-3 PUFAs (which is often insufficient) should be provided. Adequate dietary energy and protein intake protects children against protein–energy undernutrition and is crucial for their proper growth and development. An important element in the assessment of the development of children involves monitoring their nutritional status and physical development by systematically measuring their body weight and length/height and analyzing their weight gain. It is necessary to diagnose the causes of being underweight/overweight in children. Physical activity (such as outdoor walks, plays, and games) and healthy sleep hygiene are recommended. Physical activity, an adequate number of hours of sleep, and the quality of sleep in early childhood may improve immunity, reduce the risk of excessive weight gain, and consequently reduce the risk of obesity later in life. Other issues discussed include the functioning of the digestive system as one of the determinants of the nutrition of young children, basics of proper nutrition, risk of nutrient deficiencies and development of proper eating habits in early childhood.

Key words: *nutrition, children aged 1-3 years, nutrition guidelines, nutrients*

*) This Position Statement is also published in the Polish language in Standardy Medyczne/Pediatria 2022;19(3):287-302.

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This update and modification of the guiding principles for the nutrition of children aged 1–3 years is a response to the publication of updated nutritional guidelines, recent international reports by experts, and the published findings of population studies on the comprehensive assessment of the nutritional status and diet of children and adolescents, including the research conducted in Poland under the framework of the National Health Program in 2016–2020 and the overall situation of the COVID-19 pandemic [*Dewey* et al. 2021, *Kułaga* et al. 2021, *Wądołowska* et al. 2021, DGA USA 2020, *Beluska-Turkan* et al. 2019, *Weker* et al. 2019].

The position on this issue currently adopted by the Committee on Human Nutrition Science, Polish Academy of Sciences is based on the nutritional guidelines for children aged 1-3 years developed by the Expert Group appointed by the National Consultant in Pediatrics in 2012 [*Dobrzańska* et al. 2012], as well as other reliable guidelines and reports drafted by leading scientific societies, reputable institutions, and teams of experts, including the European Society for Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN), the American Academy of Pediatrics (AAP), the European Food Safety Authority (EFSA), and the World Health Organization (WHO). Therefore, a group consisting of experts [members of the Task Force for Children and Adolescents Nutrition of the PAS Committee on Human Nutrition Science and consultants in the field of pediatrics – Prof. *Hanna Szajewska*, MD, and Prof. *Mieczysława Czerwionka-Szaflarska*, MD] was formed to develop nutritional recommendations for children aged 1–3 years with respect to the aforementioned documents and the possibility of their adoption/adaptation in Polish conditions.

Overall, the following recommendations, presented in 14 points, were drafted based on position papers put forward by leading scientific societies in the field of nutrition, a thorough review of the current literature on the nutrition of children in the post-infancy period (1–3 years of age), and the results of scientific research in this area conducted in Poland.

PRINCIPLES FOR THE NUTRITION OF CHILDREN AGED 1–3

Proper nutrition during the first 1,000 days of life [prenatal, infancy, and post-infancy periods] is crucial for optimal physical and mental development. In children aged 1–3 years, proper nutrition continues to have beneficial effects on nutritional programming, which reduces the risk of diet-related diseases in adulthood.

Breastfeeding and its continuation in the post-infancy period, together with the proper introduction of complementary foods, supplies all the nutritional needs of the child, except for vitamin D. As yet, no upper age limit to the duration of breastfeeding has been established.

In the second year of life, some younger children may manifest a feeding pattern similar to the infant and/or transitional diet. For reasons related to the need for proper development of oral motor skills [chewing and biting food], care should be taken to ensure an adequately varied texture of foods/dishes in the diet. Proper oral hygiene of the child is likewise important.

Adherence to the proper organization of meals influences the development of proper eating behaviors in children. Breakfast is the first meal, which a child should receive at an appropriate time. Subsequent meals should be evenly distributed throughout the day, with attention being paid to responsive feeding, or positive interactions between the child and the parent/caregiver during feeding.

In the nutrition of children, a varied selection of foods/products is important to balance out the diet in the context of energy and nutrient needs. The WHO recommends the consumption of natural, fresh, local, and low-processed foods of high nutritional and hygienic (microbiological) quality. Such foods should be a source of complete protein, *n*-3 and *n*-6 polyunsaturated fatty acids (PUFAs), complex carbohydrates and dietary fiber, vitamins and minerals, and other important nutrients, including bioactive compounds with beneficial effects on the body. Especially noteworthy are fresh vegetables, vegetables pickled in brine (such as cabbage and cucumbers), fruits, meat, fish, pulses, nuts, and seeds, which should be served crushed, as well as vegetable oils and fermented milk drinks. Proper nutrition of children is based on the use of foods from all groups: grain products, milk and dairy, meat, fish, eggs, vegetables, fruits, and fats. Using diets that exclude a specific product/group of products, such as vegetarian or vegan diets, requires specialized counseling and proper nutritional supplementation. Parents/caregivers should be informed about the health consequences of non-conventional diets in children [Position Statement of the PAS Committee on Human Nutrition Science 2019].

In the nutrition of young children, attention should be paid to products not recommended for frequent consumption, for reasons related to the possibility of the early development of improper eating habits and/or their undesirable health consequences. Such products include salt, sugar, low-quality processed meat, sweetened carbonated drinks, herbal teas, mushrooms, and plant-based beverages. Plant-based beverages, made through the extraction of plant material, typically soybeans, nuts, rice, and other grains, do not cover the child's basic nutrient needs and cannot serve as an alternative to milk-based formulas – including soy-based formulas

for infants and young children. Negative consequences of the improper introduction of certain plant-based beverages into a young child's diet include the risk of stunted growth and an increased risk of anemia and electrolyte disorders.

Good-quality water is the most suitable beverage/liquid for children. This criterion is met by natural mineral waters and spring waters – with low or medium mineral content, low sodium content, and low sulfate content. Natural mineral waters should be used for drinking, not for cooking. Therefore, they should not be used for preparing meals/dishes, unlike spring waters, which may be so used.

It is recommended that the nutrient profile of diets in children be compatible with current nutrition guidelines [*Jarosz* et al. 2020]. Potential nutrient deficiencies (in young children, these are most commonly related to such nutrients as: calcium, iron, iodine, zinc, magnesium, copper, *n*-3 PUFAs, vitamin D, vitamin A, carotenoids/lutein, zeaxanthin, B vitamins, especially vitamin B6, folate, vitamin B12, and choline) should be corrected/modified first of all through a varied selection of foods, including fortified foods. Attention should be paid to the amount and type of added fat and sugar in these products.

Children need vitamin D supplementation in keeping with the medical standards [*Rusińska* et al. 2018]. Supplementation using preparations that contain other vitamins and/or vitamin and mineral preparations is not indicated for the entire population. In at-risk groups, however, such supplementation may be beneficial after consultation with and under the supervision of a physician and/or dietician. In the nutrition of children, attention should be paid to the potential risk of iron, iodine, and calcium deficiency, as well as adequate intake of *n*-3 PUFAs, which is often insufficient.

Adequate dietary energy and protein intake protects children against an abnormal nutritional status (protein–energy undernutrition) and is crucial for their proper growth and development. By contrast, energy intake more than the energy requirement is associated with the risk of being overweight and obesity. Similarly, excessive intake of fat, including saturated fatty acids, and carbohydrates, chiefly monosaccharides, and disaccharides, in children increases this risk and contributes to the development of diet-related diseases in the future.

A particularly important element in the assessment of the development of children involves monitoring their nutritional status and physical development by systematically measuring their body weight and length/height and analyzing their weight gain over the year. It is necessary to diagnose the causes of being underweight/overweight in children aged 1–3 years. The causes that result from nutrition errors are treated by a pediatrician or by a dietician collaborating with the pediatrician/family physician providing medical care to the child. Parents/caregivers of young children should be informed/educated about the need for systematic monitoring of the physical development of children (regular measurements of body weight and length/height, analysis of weight gain over the year).

Emulation of eating behaviors (the imitation of parent/caregiver behaviors by the child) is the most effective method for the development of proper eating habits in children.

Physical activity is important for the proper development of children. Outdoor walks, plays, and games are recommended. It is necessary to promote daily physical activity, but this must be done in compliance with epidemic regulations (for example during the COVID-19 pandemic / the threat of a pandemic).

Healthy sleep hygiene, an adequate number of hours of sleep, and the quality of sleep-in early childhood may improve immunity, reduce the risk of excessive weight gain, and consequently reduce the risk of obesity later in life.

JUSTIFICATION

Nutrition of children in the post-infancy period depends on metabolic, physiological, family-related, and social conditions.

I. FUNCTIONING OF THE DIGESTIVE SYSTEM AS ONE OF THE DETERMINANTS OF THE NUTRITION OF CHILDREN AGED 1–3 YEARS

The digestive system, which is already prepared to undertake its basic functions of digestion and absorption after 36 weeks of gestation, continues to develop intensively after birth *[Indrio* et al. 2022]. In the first years of life, the digestive system matures anatomically (the stomach volume increases) and physiologically (the biosynthesis of digestive enzymes, which reach their full activity around two years of age, increases, as does the liver's detoxification capacity). Hence, in this period of life, it is important to adjust feeding (portion sizes, number of meals, the provision of high-quality products and meals that stimulate the development of the digestive system) to the capacity of the child's digestive system. According to the WHO, the stomach's capacity, and by the same token the amount that a child can eat at one meal, can be estimated by assuming that one kilogram of the child's body weight corresponds to 30 mL of capacity [WHO 2009].

The digestion of basic dietary components is associated with the activity of many enzymes, including pancreatic enzymes, which reach their full maturity in children over the age of two. The function of protein digestion by trypsin is the first to reach full maturity.

For reasons related to the low activity of pancreatic amylase, in turn, the child reaches the ability to fully digest complex carbohydrates (starch) at the age of 18–36 months. Current research suggests that the presence of foods that contain starch in the child's diet can increase/accelerate the biosynthesis and activity of pancreatic amylase, and that the activity of salivary amylase and other enzymes synthesized in the small intestine to support starch digestion - maltase and glucoamylase, enables proper digestion of starch in the early post-infancy period [*Liu* et al. 2004, *Rossiter* et al. 1974]. Oats and rice are easy to digest sources of carbohydrates that contain the smallest starch grains. The presence of complex carbohydrates, including starch and dietary fiber, as well as the much-desired oligosaccharides, represented by fructooligosaccharides (for children, the sources of fructooligosaccharides include bananas, as well as wheat, rye, and barley products, but also young beet leaves, onions, and tomatoes), stimulate the proper development of the gut microbiota. Maturation of the digestive system is likewise accompanied by an increase in the activity of pancreatic lipase, which takes over the full digestion of lipids, initially with the help of lingual lipase, produced by von Ebner's glands [*Goliszek & Oracz* 2015].

By the age of 24 months, the child develops the ability to chew food, and taste preferences, which started to form during fetal life, become more consolidated. Such preferences should be expanded through the consumption of a variety of foods and their proper consistencies, which means that mashing/shredding should be avoided to stimulate the secretion of saliva and affect its composition, including the activity of salivary amylase. The tastes preferred by children are: sweet, salty and, depending on the food, spicy, whereas sour and bitter are not accepted. Cognitive curiosity, typical of this stage in the child's development, may also help shape food preferences. The period between 13 and 36 months of life is a critical period in the development of certain preferences [*Harris & Mason* 2017]. Around the age of 20 months, children may show reluctance to eat certain foods and dishes (neophobia) and may refuse to eat any food even at the mere sight of it. This is a transitional stage that can last up to a maximum of six years of age. In this period, meals should be eaten at fixed times and snacks should be avoided. This involves setting off mechanisms that stimulate the secretion of digestive juices in advance, which makes it more likely for the child to feel hungry at mealtimes.

In addition to its digestive function, the gastrointestinal tract also fulfills secretory functions (production of gastrointestinal hormones that regulate its function) and defensive functions (protection against antigens and toxic substances), using liver macrophages and the intestinal wall, as well as secretory immunoglobulin A (sIgA) from breast milk.

The period in the child's development being discussed is also characterized by the development of the gut microbiota. Over time, it undergoes modifications, which depend on the child's diet during and after the neonatal period. Around the age of two years, the microbiota in the gastrointestinal tract begins to resemble the composition of the microbiota in adults [*Indrio* et al. 2022].

In general, the period of early childhood (1–3 years) is characterized by slower physical development compared to infancy and a decrease in appetite. In the assessment of the child's development, the rate of growth in body length/height and weight is therefore one of the most important measures of proper nutrition. It has been shown that ghrelin can impact significantly on growth processes through involvement in bone metabolism and stimulation of growth hormone release, and its concentration in the blood depends on the nutritional status [*Nikolopoulos* et al. 2010, *Zizzari* et al. 2007]. Since physical activity is one of the factors modifying the energy and nutritional value of the child's diet in this period of life, it is important to remember that excessive activity and fatigue may inhibit the release of ghrelin. The age of 1–3 years is also a period of "compensation" for differences resulting from the different rates of earlier development in children, which should lead to the individualization of their nutrition.

II. BASICS OF PROPER NUTRITION OF YOUNG CHILDREN

Research findings show that the preconception period, gestation, and the first 2–3 years of life are particularly important for the child's development. During this time, optimal nutrition is a major factor reducing morbidity and mortality among children, lowering the risk of chronic diseases in the future, and promoting normal development, including cognitive function (thanks to the development of the brain and the peripheral nervous system) [*Cohen Kadosh* et al. 2021, *Sepúlveda-Valbuena* et al. 2021, *Huang* 2020, *Lacagnina* 2020, *Schwarzenberg & Georgieff* 2018, *Koletzko* et al. 2017].

Breastfeeding in the first year of life offers well-documented benefits. Research findings show that breastfeeding has numerous benefits for both mother and child, not only in the first year of life. However, there is no scientific evidence that would allow it to be stated when exactly breastfeeding should be stopped completely. It is recommended that the child should receive breast milk until the age of two years (WHO) or beyond, as long and this is desired by the mother and the child (WHO, AAP, ESPGHAN, PTGHiŻDz[1]), and the number of feedings may be 3–6 per 24 hours [AAP

[1] Polish Society of Paediatric Gastroenterology, Hepatology and Nutrition

2012]. Breast milk can meet one-third of the energy needs in children at the age between 12 and 24 months and have a beneficial effect on their immunity. The composition of breast milk in the first year of lactation has been the subject of numerous analyses, but there are very limited data documenting its composition in later lactation. These studies found that the duration of lactation is positively correlated with the energy value of breast milk and its protein and fat content, and negatively correlated with carbohydrate content (from the first to the 48th month of lactation) [*Czosnykowska-Łukacka* et al. 2018, *Verd* et al. 2018]. After the 18th month of lactation, protein and fat content in breast milk increases, carbohydrate content decreases, and this composition remains stable until months 24–48 of lactation, with protein and fat content being negatively correlated and carbohydrate content being positively correlated with the daily number of feedings. The observed changes are probably related to the adaptation of milk composition to the increased energy demand in the growing child. Sources of calories in breast milk for children beyond the age of one include above all fat [*Czosnykowska-Łukacka* et al. 2018].

In addition, the duration of lactation, or breastfeeding a child from the 12th to the 48th month of life, is positively correlated with the concentration of immunoglobulins A and G (IgA and IgG, respectively) and lactoferrin in milk [*Czosnykowska-Łukacka* et al. 2020, *Czosnykowska-Łukacka* et al. 2019]. The duration of lactation is especially strongly correlated with the concentration of IgA, which reaches its peak after the 24th month of lactation. This indicates a high immune potential of human milk during prolonged lactation and is an argument against the cessation of breastfeeding too early. Since breast milk is not only a source of energy but also an immunomodulatory food for children after the age of one, supporting breastfeeding, even after the introduction of complementary foods, should be one of the public health goals in the area of the prevention of infections in early childhood. For reasons related to the high concentration of immunologically important compounds in breast milk, it is worth encouraging extended breastfeeding. In the formulation of recommendations, it is important to consider not so much the number of feedings per day as the fact that breastfeeding should be continued for as long as possible to support the child's maturing immune and digestive systems. Longer breastfeeding also improves maternal health, which includes reducing the risk of ovarian and breast cancer, type 2 diabetes mellitus, and osteoporosis [*Masztalerz-Kozubek* et al. 2021, *Victora* et al. 2016]. However, for their nutritional requirements to be met, children must receive both breast milk and appropriate solid foods.

Importantly, lactation requires an increased intake of energy-yielding and non-energy-yielding nutrients for the nursing woman, as these are lost together with breast milk. Prolonged breastfeeding requires the continuation of special nutrition in women to meet their increased demand for nutrients, sustain lactation, and replenish nutrient reserves depleted during pregnancy and/or the initial period of lactation. Pregnancy and breastfeeding may reduce reserves of especially folate, vitamin B_{12}, iodine, and iron *[Szostak-Węgierek* et al. 2021].

In children beyond the age of one fed breast milk at night, special attention should be paid to proper oral hygiene. Some research findings indicate that such children had an increased risk of dental caries compared to those who stopped being fed breast milk earlier. However, the reasons for the observed relationship require further research, taking into account other factors that may affect the risk of caries in children [*Tham* et al. 2015]. However, it should be stressed that for a number of reasons (caries prevention, regulation of the circadian rhythm of appetite and feeding), feeding/eating should not occur at night [*Olczak-Kowalczyk* et al. 2015].

In the nutrition of children in the post-infancy period, special attention should be paid to:

- the frequency of meals and their organization, including methods of preparing meals for children (the recommended methods are cooking in water, steaming, stewing, and baking in foil, baking sleeves, or heatproof dishes).
- selection of products in the diet.
- the energy and nutritional value of the diet.
- eating habits and behaviors.

Proper organization of meals given to children during the day promotes adequate energy intake and partially prevents nutrition errors. During the day, children should be given 4–5 meals – three main meals and 1–2 complementary meals. Children in the second year of life sometimes require more smaller-size meals. The energy and nutritional value of the diet should cover the nutritional requirements set out in the guidelines. At the same time, the diet should be tailored to the individual needs of children and their appetite. Therefore, in some countries, the recommended daily intake of food products is developed for various levels of energy demand. For children up to two years of age, the adopted levels are from 700 to 1,000 kcal/day [DGAC USA 2020].

According to current nutrition guidelines, it has been established that:

- Energy demand should be determined individually in relation to the child's body weight. In children aged 13–36 months, the daily energy requirement is about 83 kcal per kilogram of body weight.
- It is recommended that the minimum amount of protein should not be lower than 1 g/kg of the child's body weight and protein should not account for more

than 15% of the total daily recommended energy allowance (1,000 kcal). The recommended dietary allowance (RDA) for protein is 14 g/day.

- Fat should provide 35–40% of total energy (reference intake, RI) to meet the energy expenditure needed for the child's growth and development. It is very important to provide adequate-quality fats, including sources of unsaturated fatty acids (vegetable oils), in particular long-chain PUFAs (fish). The following dietary standards for the most important long-chain polyunsaturated fatty acids of the *n*-3 family (*n*-3 LCPUFAs) have been set for docosahexaenoic acid (DHA) – 100 mg/day (for children aged 7–24 months) and for eicosapentaenoic acid (EPA) and DHA combined – 250 mg/day (for children aged two years and more). Given the content of many important nutrients in dietary fats [such as LCPUFAs, fat-soluble vitamins, cholesterol, which is needed for the synthesis of cell membranes, bile acids, steroid hormones, and vitamin D], a well-balanced diet in young children should include a variety of fats: milk fat/butter, vegetable oils, and fat contained in fatty fish. In young children, limiting fat intake below the values set out in guidelines is not recommended. In children under three years of age, limiting the amount of cholesterol in the diet is not recommended. Sources of cholesterol include butter, eggs, red meat, and dairy products [*Szajewska* et al. 2017].
- Carbohydrates should account for 45–65% of the total energy allowance. Added sugars (sugars used in food production and meal preparation) should be limited to less than 10% of total energy. It is recommended that children should be given products that are a source of complex carbohydrates, such as whole-grain breads, groats, pasta, and products made from whole-grain flour. Such products provide an adequate amount of fiber, which regulates the function of the gastrointestinal tract. The adequate intake (AI) of fiber in children aged 1–3 years is 10 g/day.
- The recommended amounts for a child aged 13–36 months are 700 mg for calcium, 15 µg (600 IU) for vitamin D, 7 mg for iron, and 90 µg for iodine. Deficiencies in these components are most commonly found in young children.
- In children aged 1–3 years, sufficient water intake is defined at 1,250 mL/day (water from beverages and food products) [*Jarosz* et al. 2020]. The main source of water for children should be milk and good-quality water. For infants and children up to the age of three, the best waters are spring water or natural mineral water – with low mineral content, low sodium content, and low sulfate content. Natural mineral waters should be used for drinking, not cooking – therefore, they should not be used to prepare meals [*Szajewska* et al. 2021*, Woś* et al. 2011]. During the preparation of meals/dishes, appropriate spring or tap water can be used if the thermal method of choice is boiling or, less frequently, stewing and baking. Children should not be given sweetened and carbonated beverages to drink and should not receive fruit juices in the amount of over 120 mL/day. Juices must not replace fruit and vegetable consumption [*Lott* et al. 2019, *Heyman* et al. 2017, *Woś* et al. 2011].

Tables 1 and 2 show daily food rations according to various expert groups and nutrition guidelines for children aged 1–3 years [*Jarosz* et al. 2020].

III. RISK OF NUTRIENTS DEFICIENCIES

To develop and function properly, a child's body needs all the necessary nutrients, including protein, fats, carbohydrates, and vitamins and minerals, including those with antioxidant properties, as well as water to form and maintain its structure. However, special attention should be paid to such nutrients as iron, iodine, zinc, folate, vitamins B_1, B_6, PP, B_{12}, A, and D, carotenoids, choline, and *n*-3 LCPUFAs, which have been identified as particularly important for cognitive development [*Roberts* et al. 2022, *Zielinska* et al. 2019, *Robinson* 2015*, Prado & Dewey* 2014].

In addition to being involved in the synthesis of hemoglobin and myoglobin, the functioning of many enzyme systems, and electron transfer in cytochromes, iron is essential for the development of neural pathways in the brain as it is involved in synaptogenesis and the synthesis of myelin and neurotransmitters, which affect brain function. In the first two years of life, children experience rapid mental and physical development, which drives up demand for iron and the risk of iron-deficiency anemia. Iron deficiency or iron-deficiency anemia may impact negatively on overall intelligence and cognitive development, especially if it occurs in early childhood [*Roberts* et al. 2022, *McCann* et al. 2020, *Abbaspour* et al. 2014].

Iodine is necessary for the synthesis of thyroid hormones, which play an important role in the process of cell differentiation and maturation and brain development. Iodine deficiency in early life may have an adverse effect on cognitive function and body growth and is a key factor behind thyroid disorders in adults [*Zimmermann & Boelaert* 2015, *Prado & Dewey* 2014].

Zinc deficiency in infancy is associated with delayed motor development and detrimental effects on concentration and short-term memory *[Roberts* et al. 2022, *Prado & Dewey* 2014]. Zinc is necessary for the development and proper functioning of the brain, and an adequate concentration of zinc ions in the synaptic vesicles ensures proper neuronal function and nerve conduction [*Roberts* et al. 2022, *Prado & Dewey* 2014].

Table 1. Model food rations - daily food rations expressed in products for children aged 1–3 years according to various expert groups [g/day]

No.		Product groups	Unit	The amount of products in daily diet according to various expert groups		
				Mother and Child Institute (2013)1	American guidelines (per 1,000 kcal)2	PAS Group of Experts, 2022 (per 1,000 kcal)3
I. Starch products		Grain products	g		3 ounces/day (99 g, 66 g from whole-grain products)	75
	1.	bread (multigrain/whole grain)	g	20		40 [20/20]
		flour, pasta	g	25		20
		groats, rice, breakfast cereal	g	30		15
	1A.	Potatoes	g	80–100		80
II. Vegetables and fruits		Vegetables and fruits	g	450		400
	2.	vegetables	g	200	1 cup (150–200 g)	200
		fruits	g	250	1 cup (150–200 g)	200
III. Protein products		Milk and dairy products (in milk equivalent)	g		2 cups/day (300–400 g)	550
	3.	milk and fermented milk beverages	g	550		400
		fresh/cottage cheeses	g	10-15		15
		rennet cheeses	g	2		5
		Meat, poultry, legumes, fish, eggs	g		2 ounces (66 g)	70
		meat, poultry	g	20		30
	4.	pulses (such as beans and lentils)	g			5
		fish	g	10		10
		eggs	g (egg)	½ egg		25 g (½ egg)
IV. Fats and other		Fats	g			15
	5.	animal fats: butter and cream	g	6		5
		vegetable fats: oils and nuts	g	10	13 g	10
	6.	Sugar and sweets	g	20		no more than 10*

[1] *Weker H., Strucińska M., Barańska M.* et al. ; Modelowa racja pokarmowa dziecka w wieku poniemowlęcym – uzasadnienie wdrożenia." Standardy Medyczne/Pediatria 2013;10:815–830

[2] "Dietary Guidelines for Americans 2020–2025" drafted by the US Department of Agriculture and the US Department of Health and Human Services

[3] Drafted by the PAS Group of Experts 2022 (members of the Task Force for Children and Adolescents Nutrition, PAS Committee on Human Nutrition Science: *Halina Weker, Mariola Friedrich, Katarzyna Zabłocka-Słowińska, Joanna Sadowska, Jadwiga Hamułka, Anna Długosz, Jadwiga Charzewska, Jarosław Walkowiak, Piotr Socha*) based on the findings of the PITNUTS 2016 study, nutrition guidelines, and medical standards (*Weker* et al. 2013)

Explanations: 1 cup – 150–200 mL, 1 ounce – 33 g, *The smaller the quantity, the better.

Table 2. Nutrition guidelines for children aged 1–3 years developed in 2020 by the experts from the National Institute of Public Health – National Institute of Hygiene (Poland)

AGE [years]	BODY WEIGHT [kg]	Energy [MJ/day]			Energy [kcal/day]		
		PAL			PAL		
		low	moderate	high	low	moderate	high
1–3	12	-	4.3 (1.4)	-	-	1,000 (1.4)	-

AGE [years]	BODY WEIGHT [kg]	EAR		RDA		AI	
		Protein in the national food ration		Protein in the national food ration		Protein from breast milk	
		g/kg of body weight/day	g/person/day	g/kg of body weight/day	g/person/day	g/kg of body weight/day	g/person/day
1–3	12	0.97	12	1.17	14	-	-

Share of energy from fats, child aged 1–3, body weight: 12 kg	30%	35%	40%
PAL	1.4	1.4	1.4
g of fat/day	33	39	44

AGE [years]	Recommended levels for carbohydrates		Recommended level of carbohydrates in diet [% of energy] in people aged above 1 year	Fiber g/day [AI]
	AI	RDA		
1–3	-	130	45–65	10

AGE [years]	Vitamin A [µg]		Vitamin D [µg]			Vitamin E [mg]	Vitamin K [µg]
	EAR	RDA	EAR	RDA	AI	AI	AI
1–3	280	400	10*	15*	15	6	15

AGE [years]	Vitamin B1 [mg]		Vitamin B2 [mg]		Vitamin PP [mg]		Choline [mg]	Pantothenic acid [mg]
	EAR	RDA	EAR	RDA	EAR	RDA	AI	AI
1–3	0.4	0.5	0.4	0.5	5	6	200	4

AGE [years]	Vitamin B6 [mg]		Biotin [µg]	Vitamin B12 [µg]		Vitamin C [mg]		Folic acid [µg]	
	EAR	RDA	AI	EAR	RDA	EAR	RDA	EAR	RDA
1–3	0.4	0.5	8	0.7	0.9	30	40	120	150

AGE [years]	Calcium [mg]		Phosphorus [mg]		Magnesium [mg]		Iron [mg]		Zinc [mg]		Copper[mg]	
	EAR	RDA	EAR	RDA	EAR	RDA	EAR	RDA	EAR	RDA	EAR	RDA
1–3	500	700	380	460	65	80	3	7	2.5	3	0.25	0.3

AGE [years]	Iodine [µg]		Selenium [µg]		Fluorine [mg]	Sodium [mg]	Potassium [mg]	Chlorine [mg]
	EAR	RDA	EAR	RDA	AI	AI	AI	AI
1–3	65	90	17	20	0.7	750	800	1,150

Explanations: *Guidelines for vitamin D according to the US Institute of Medicine, EAR – Estimated Average Requirement
RDA – Recommended Dietary Allowances, AI – Adequate Intake, PAL – Physical Activity Level
Note: The reference values of the European Food Safety Authority (EFSA) for children aged 1–3 years differ from the Polish recommendations, which may affect the assessment of the nutrition of children [EFSA 2017].

An equally significant role in the development and functioning of the child's body is played by B vitamins, including vitamins B_1, B_6, and PP, which through many mechanisms are crucial for example in the metabolism of carbohydrates and neurotransmitters and connections between synapses. An important role is played by folate, needed for DNA and RNA synthesis and the formation of the nervous system [*Roberts* et al. 2022]. Maternal folate deficiency in early pregnancy is associated with an increased incidence of congenital disorders, including spina bifida and anencephaly in the child [*Prado & Dewey* 2014, *Monk* et al. 2013]. Vitamin B_{12} is a cofactor in numerous catalytic reactions necessary for the synthesis and function of neurotransmitters and the myelination of neurons [*Roberts* et al. 2020, *Prado & Dewey* 2014]. Vitamin A plays a key role in the function of vision. Choline, as a component of phospholipids and sphingomyelin, is necessary for the structural integrity of cellular membranes and the process of myelination. Choline deficiency in the fetal period and early childhood may impact negatively on the development of the entire nervous system, including the brain. Later in life, it can reduce cognitive function, which also involves the deterioration of memory and the ability to concentrate [*Derbyshire* et al. 2020, *Robinson* 2015, *Prado & Dewey* 2014].

LCPUFAs of the *n*-3 family, in particular DHA and EPA, play a particularly important role in the development of the nervous system, including the brain, and in the maintenance of cognitive function. Inadequate intake of *n*-3 LCPUFAs is associated with impaired neurodevelopment, visual recognition, and memory [*Tahaei* et al. 2022, *Weiser* et al. 2016, *Monk* et al. 2013].

Recent studies stress the key role of the gut microbiota in regulating brain and cognitive function in childhood and adolescence, and subsequent cognitive behavior in adults [*Basso* et al. 2022]. Studies, mostly using animal models, have shown that the gut microbiota influences brain development from its early stages, including synaptogenesis and myelination of brain areas [*Heijtz* 2016], as well as emotional reactivity and brain function across the lifespan [*Luczynski* et al. 2016].

Results from interventional studies and observational cross-sectional studies reveal the multidimensional and interactive effects of nutrition on the development of cognitive, motor, as well as social and emotional skills in children. Nutritional deficiencies during pregnancy and in the first three years of life may be detrimental to further development, functioning, productivity, and health during the school years, adulthood, as well as in old age (increased predisposition to the development of degenerative diseases). However, it should be remembered that in addition to nutritional factors, non-food factors are also very important, both those with adverse effects, such as exposure to stress, heavy metals, tobacco smoke, and alcohol, and those with positive effects, such as adequate levels of physical activity, cognitive exercises to stimulate brain development, and adequate length and quality of sleep [*Matonti* et al. 2020, *Cusick & Georgieff* 2016, *Prado & Dewey* 2014, *Hamułka & Brzozowska* 2013]. Long-term benefits for individuals and entire societies may therefore be brought by the focus on both nutritional factors to prevent nutrient deficiencies and on the elimination of adverse external/environmental stimuli in early childhood. A balanced diet should ensure the intake of all nutrients, and nutrition education should promote models of safe nutrition of children, including a balanced diet in relation to guidelines.

A particularly important challenge is posed by the period of changes in feeding and the gradual reduction of breastfeeding or infant formula together with their replacement with other products, such as cow's milk and plant-based beverages [*Verduc*i et al. 2021, *Wright & Smith* 2020*, Janicka-Rachtan & Horvath* 2019, *Hojsa*k et al. 2018]. The composition of cow's milk differs significantly from both breast milk and infant formula. Cow's milk contains more proteins and sodium and large amounts of saturated fatty acids and is deficient in vitamin D compared with breast milk and deficient in iron and iodine compared with formula. These nutrients should therefore receive special attention in efforts to balance the diet in children. Cow's milk is a rich source of calcium and therefore an important part of diet for children. The diet may be balanced for example through the use of young child formula (YCF) with appropriate modification of nutrients. According to ESPGHAN's position paper [*Hojsak* et al. 2018], in children over the age of one all nutritional requirements can be covered with a well-planned, balanced diet, but the use of this type of formula for younger children is appropriate mainly in children at risk of the nutrient deficiencies discussed above. In its position paper, ESPGHAN refers to studies evaluating the effects of the use of YCF - mainly in iron supplementation *[Hojsak* et al. 2018]. According to the ESPGHAN document, this type of milk is part of a strategy to increase the intake of iron, vitamin D, and *n*-3 PUFAs.

In order to pursue appropriate nutrition policies with respect to this age group, it is necessary to rely on data on the nutrition of young children in Poland. Reliable data on the nutrition of children aged 1–3 years was provided by the PITNUTS study, which was conducted on a random sample (N = 1,059) and involved structured interviews with parents or legal guardians of healthy children, including the collection of three-day records of their diets *[Weker* et al. 2019, *Weker* et al. 2017]. The study found a relatively good balance of nutrients in the diets of children in their second year of life in the context of the nutrition guidelines, compared with children in their third year of life, which resulted from

the consumption of infant formula or YCF milk, which are sources of not only calcium but also iron, vitamin D, iodine, and DHA. Similar findings were presented in another study, in which children were given two cups of YCF per day, which resulted in a reduced risk of vitamin and iron deficiencies in children after the first year of life [*Akkermans* et al. 2017]. The authors of the PITNUTS study also noted the reluctance to consume milk that develops as children get older, and the replacement of milk or infant formula with fruit yogurts, dairy desserts, and other products that are widely advertised for this target group. Regardless of products for young children available on the market, extensive educational campaigns should be conducted for parents to explain the consequences of nutrient deficiencies and the principles of a properly balanced diet. It is worth paying attention to dairy drinks and desserts, which are often alternatives to cow's milk, but contain added sugar (especially those aimed at adults) - parents looking for dairy products can therefore make significant mistakes in this regard.

IV. DEVELOPMENT OF PROPER EATING HABITS IN EARLY CHILDHOOD

The post-infancy period (ages 1–3) is the first and most important stage in the development of eating habits and behaviors. At this age, taste preferences become more consolidated, and children formulate their choices for certain food groups. At the age of over 3–4 years, food preferences are mostly already established and less changeable [*Mennella* 2014]. It is therefore important to be aware of the factors that influence eating habits early in life. Educating parents and caregivers in this area boosts the chance of the development of proper food choices in children, which influences eating habits/behaviors later in life - in adolescence and adulthood [*Mennella* 2014]. The factors that play an important role in modeling taste preferences and eating habits in the post-infancy period include:

- maternal diet during pregnancy and lactation,
- the way of feeding children during infancy, including breastfeeding and complementary feeding,
- parental practices in influencing food choices in children,
- lifestyles and environments that affect children,
- food neophobia.

1. Factors influencing taste preferences in early life

Preferences for sweet tastes, and probably also salty tastes, are known to be innate [*Lucas* 1998]. Consequently, children accept sweet and salty products faster during the introduction of complementary foods into their diets compared with food products with bitter or sour tastes. In particular, children choose to reject bitter-tasting foods. Bitter taste is characteristic of certain vegetables, so there is no natural preference for this group of food products in children [*Mennella* 2014]. However, taste experiences in prenatal life (amniotic fluid) and infancy (feeding method - breast milk) can impact significantly on later food choices and their differentiation in children [*Mennella* 2014].

The first experiences of taste and smell occur in the prenatal period [*Harris* 2008, *Goldberg* et al. 2008]. The environment in the uterus influences these experiences for the fetus by altering the taste and smell of the amniotic fluid [*Toporowska-Kowalska & Funkowicz* 2015, *Mennella* 2014]. Maternal dietary choices in pregnancy may determine to some extent the child's subsequent taste preferences. Acceptance of certain distinctive tastes, especially bitter taste, which is characteristic of certain vegetables, is greater in children whose mother consumed foods with such tastes during pregnancy [*Nehring* et al. 2015]. Therefore, it is reasonable to provide nutrition education to women before the conception and during pregnancy and encourage a properly balanced diet, rich in a variety of products and foods of high nutritional value and microbiological (hygienic) quality. Such a diet not only contributes to the proper development of the fetus, but also impacts positively on the diversification of taste preferences in later years of the child's life [*Koletzko* et al. 2019, *Mennella* 2014].

It has been shown that there are significant differences in taste preferences between children fed naturally and those fed with formula [*Goldberg* et al. 2008]. A review of the literature shows that children fed with breast milk more readily and easily accept the introduction of complementary new foods than children fed with formula. This is especially true in situations where certain foods and products were present in the diet of the nursing mother [*Forestell & Mennella* 2007]. This is linked to a high level of exposure to taste experiences during natural feeding. Changes in the taste of breast milk resulting from the mother's dietary choices, as opposed to the fixed, monotonous taste of formula, are a factor behind increased acceptance of new flavors during the expansion of the diet in both early and later stages of childhood. Breastfeeding duration also plays a role in influencing food preferences. A study of children at two years of age found that the longer the duration of breastfeeding, the more varied the child's diet is [*Scott* et al. 2012].

2. The impact of parental practices on proper food choices in children

The impact of the family environment on the formation of eating habits in children has been attracting growing interest, especially in the context of the growing obesity epidemic, including among very young children [*Vaughn* et al. 2013]. Awareness and understanding of

the factors that influence food preferences in the post-infancy period are crucial in efforts to build a strategy to improve diet quality in children *[Lucas* 1998]. Studies of the psychological aspects of the development of eating habits in children show that parents' food practices and lifestyles, especially their eating habits, significantly determine eating habits in children as early as in the post-infancy period [*Gubbels* et al. 2020*, Lopez* et al. 2018]. Free observation of parental eating behaviors (known as modeling) is strongly linked to the long-term development of eating habits [*Palfreyman* et al. 2015, *Brown & Ogden* 2004]. Serving as a model to emulate is one of the most effective parental practices influencing healthy eating habits in children – it is a lot more effective than, for example, verbal encouragement to eat certain foods [*Nicklaus & Monnery-Patris* 2018]. Children are more eager to taste a new food product and introduce it into their diets if the product has been consumed by an adult, especially by a parent [*Nicklaus & Monnery-Patris* 2018]. Emulation is not limited to choices – it also includes nutritional attitudes and beliefs demonstrated by parents and caregivers. Therefore, strategies for improving eating habits in children should also include efforts to improve the eating habits of parents and caregivers, as well as nutrition education to support proper attitudes towards nutrition [*Brown & Ogden* 2004]. Studies show that children whose parents attempted to control their diets without themselves demonstrating proper habits to emulate were more likely to reach for snack foods and had less healthy eating habits [*Brown & Ogden* 2004]. Similarly, pressuring children and forcing them to eat may have a detrimental effect. Children who are pressured to eat despite signaling that they are no longer hungry show less healthy eating habits [*Yee* et al. 2017].

Children make simple food choices: they reach for products they prefer. Preference for sweet tastes is innate, but other food choices and preferences are formed in early childhood based on factors that include the number and quality of experiences with certain foods and products [*Birc*h et al. 2007]. The social and psychological context and gastrointestinal sensations during digestion are crucial in modulating habits. This results from the direct acceptance of sensations that a young child associates with pleasure and the rejection of those sensations that evoke negative feelings and have negative associations [*Lucas* 1998].

The number of exposures to new foods impacts significantly on their ultimate consumption and inclusion in the diet. Research shows that repeated exposure to a specific food significantly increases its acceptance by the child. Positive feelings associated with a specific food product can be further enhanced if it is combined with another food product they liked or with high-energy food [*Paroche* et al. 2017, *Anzman-Frasca* et al. 2012]. No number of exposures sufficient for the acceptance of new food has been clearly established. Studies show that this number varies, depending on various factors, including the type of food and previous taste experience, and ranges from several exposures to well over 10 [*Paroche* et al. 2017, *Anzman-Frasca* et al. 2012, *Addessi* et al. 2005]. In addition to taste exposure, acceptance of certain foods can also result from other sensory experiences (seeing, smelling, and touching) [*Nekitsing* et al. 2018].

It is important for the child to exercise autonomy over the amount of food consumed during a meal. Parents decide what the child may eat and when, whereas the child decides on the amount of food [*Szajewska* et al. 2021]. This practice teaches the child to recognize hunger and fulness signals from an early age, which is one of the key mechanisms for preventing overeating [*Pérez-Escamilla* et al. 2017]. Studies show that infants and toddlers can self-regulate dietary energy intake [*Fox* et al. 2006]. In contrast, authoritarian parental attitudes (dictating what children should eat, when and how much) impact negatively on conscious dietary choices and may lead to obesity [*Kiefner-Burmeister & Hinman* 2020].

Rewarding the consumption of non-preferred foods by children with foods they accept (for example, the possibility of eating dessert after eating a vegetable) brings no long-term benefits in the development of healthy food choices. Research shows that this practice may increase the consumption of foods children do not accept in the short term, but it entails negative consequences in the long term by lowering preferences for the product whose consumption was rewarded [*Roberts* et al. 2018, *Yee* et al. 2017].

Excessively rigorous restriction of access to foods that are commonly considered unhealthy may lead to greater preference for these products and their overconsumption in situations of their increased accessibility. Children who have limited access to such products are more likely to choose them when they do happen to have the opportunity to do so [*Fisher & Birch* 1999].

3. Lifestyle and the development of healthy eating habits

At the age between 12 and 36 months, children are eager to explore and discover their surroundings and learn through observation and experience. For this reason, the proper development of young children depends largely on frequent physical movement [*Gunner* et al. 2005]. Motor, social, and cognitive development is fundamentally important in the development of healthy eating habits. In toddlers, lifestyle, which is conditioned by the environment, is strongly linked to the implementation of the principles of healthy eating [*Pérez-Escamilla* et al. 2017]. Creating an environment conducive to free play based on physical activity reduces

the risk of overweight and obesity and prevents the development of the habit of snacking between meals, which is typical of a sedentary lifestyle [*Masztalerz-Kozubek* et al. 2020]. Developing active leisure habits from an early age also reduces the risk of overweight and obesity later in life [*Nader* et al. 2012]. Studies involving children aged 1–5 years have shown that extended time spent in front of a TV (≥2 h/day) leads to higher dietary intake of energy, chiefly from foods with high fat and sugar content, compared with children who spend <2 h/day watching TV [*Manios* et al. 2009].

Regular and consistent sleep schedules in early childhood can also improve metabolic regulation and therefore ensure the achievement of optimal health and development [*Magee* et al. 2013]. In 2016, the American Academy of Sleep Medicine published recommendations on the amount of sleep in children and adolescents [*Paruthi* et al. 2016]. According to these recommendations, children aged 1–2 should sleep 11 to 14 hours per 24 hours (including naps), and children aged three should sleep 10 to 13 hours per 24 hours (including naps). A meta-analysis of a number of studies analyzing lifestyles, including in children, found that short sleepers had twice the risk of being overweight/obese than long sleepers [*Li* et al. 2017, *Fatima* et al. 2015].

Observing fixed bedtimes and ensuring appropriate sleeping conditions (for example by keeping the bedroom quiet and dark) help ensure a "good night's sleep" for children [*Kaczor & Skalski* 2015]. Sleeping in the dark is linked to the reduction of the influence of light, especially blue light, which has been proven to be most effective in eliciting non-visual responses [*Lucas* et al. 2014]. Blue light emitted by TV sets, laptops, tablets, and smartphones reaches the retinal ganglion cells and inhibits melatonin release [*Wood* et al. 2013], causing sleep disturbances [*Orzeł-Gryglewska* 2017, *Mindell* et al. 2011] and the disruption of the circadian rhythm with all of its negative consequences [*Kaczor & Skalski* 2015]. In addition to blue light, the content being watched can also have a stimulating effect and cause sleep disturbances in children.

4. Food neophobia

In the first months of life, an infant consumes only breast milk (or formula), and this diet is different from the later diet characteristic of humans as an omnivorous species [*Paroche* et al. 2017]. The transition from a milk-only diet to a varied diet takes time and practice to help a young child accept new tastes, smells, and textures of foods and meals [*Harris* 2008]. At the same time, early childhood, usually around the age of 2 to 5 years, is characterized by food neophobia, or reluctance to accept novel foods and meals. Such behavior is evolutionarily and genetically determined, and it is a natural and transitional stage of development. However, it plays an important role in the development of healthy eating habits and can lead to deficiencies in certain nutrients, mainly vitamins, minerals, and dietary fiber [*Białek-Dratwa* et al. 2022, *Etuk & Forestell* 2021, *Kutbi* et al. 2019, *Kozioł-Kozakowska* et al. 2018]. Vegetables and fruits are among the products that children are particularly reluctant to introduce into their diets in the neophobic period [*Kutbi* et al. 2019]. Methods used to reduce the child's aversion to new foods and meals include creating a varied diet even before the start of neophobia, which means before the age of two years [*Harris* 2008]. Sensory exposure (seeing, smelling, touching, and tasting) may help overcome fear of new foods, but taste exposure is generally the most effective method [*Nicklaus & Monnery-Patris* 2018]. However, in the case of strong aversion, familiarity with the appearance of foods and the ability to smell or touch them, for example during play, may help overcome the barrier to trying such foods [*Nicklaus & Monnery-Patris* 2018]. If parents or caregivers fear that the child may eat too little, especially during infancy, this may later lead them to pressure the child into consuming certain groups of products and foods and to divide them into "healthy" and "unhealthy". This practice can increase the risk of food neophobia [*Cassells* et al. 2014]. Factors that can help reduce the intensity and duration of neophobia include fixed meal times, regular intervals at which meals are offered, and emulation of adult eating behaviors.

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ORIGINAL ARTICLE

FACTORS ASSOCIATED WITH SUBOPTIMAL COMPLEMENTARY FEEDING PRACTICES AMONG MOTHERS OF INFANTS AND YOUNG CHILDREN IN INDIA

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ABSTRACT

Objectives. To examine the current complementary feeding practices among infants and young children aged 6 to 23 months in India, and factors influencing these practices at child, parental, household and community levels.

Material and methods. Data on 74,095 last-born children aged 6 to 23 months used in this study were obtained from the 2015 India Demographic and Health Survey (IDHS). Complementary feeding indicators (timely introduction of complementary foods to infants aged 6 to 8 months old, minimum meal frequency, minimum dietary diversity, and minimum acceptable diets) were estimated, and their associated factors were identified using descriptive and multivariate (logistic regression) analyses.

Results. The prevalence of the timely introduction of complementary foods to infants aged 6 to 8 months was 45.1%. The proportion of children between ages 6 to 23 months who received the minimum meal frequency, minimum dietary diversity and minimum acceptable diets were 36%, 21% and 9.1%, respectively. Findings from the multivariate analyses revealed that mothers of infants delivered at home, mothers who had no antenatal check-up, mothers who are Hindus, mothers living in rural areas or those from the Western/Northern geographical regions of India were at higher risk of suboptimal complementary feeding practices.

Conclusions. Our findings indicate that, among other factors, achieving the recommended four or more antenatal visits was consistently associated with improved complementary feeding practices. Thus, policies that ensure increased coverage and quality of antenatal check-up could improve complementary feeding practices of mothers in India, and help towards achieving sustainable development goal 2, targeted at eradicating hunger and malnutrition.

Key words: *complementary feeding, infant and child nutrition, India, developing countries*

INTRODUCTION

Nutrition in early childhood is a fundamental determinant of survival, health and productivity of an individual throughout lifetime [3]. In 2016, an estimated 5.6 million children under the age of five died worldwide. The International Food Policy and Research Institute on global nutrition reported that more than two–thirds of these deaths are associated with suboptimal infant and young child feeding practices which occur during child's first two years of life [12]. Globally, age-appropriate and safe complementary feeding practices have been shown to improve physical growth and mental development of children. However, in low - and middle - income countries, children between the ages of 6 and 23 months still have the highest risk of growth faltering due to malnutrition [29].

Micronutrient deficiency, stunting, underweight and wasting are the major implications of childhood malnutrition in developing countries [15, 20]. India still records one of the highest rates of poor child nutritional status in the world. According to the 2017 national family health report, it was estimated that about 38.4% of children under-five were stunted, 21% were wasted and 35.7% were underweight in India [13]. These outcomes are a reflection of missed opportunities during the complementary feeding period. Nutritional deficit that occur during the complementary feeding period has immediate consequences of increased mortality, morbidity, poor development of the child's brain and other components of the nervous system [

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20]. In addition, these deficits are almost impossible to compensate for after the first two years of life [6, 15]. Thus, complementary feeding period provides a critical window of opportunity for the prevention of malnutrition, and accordingly, the reduction in its related burden of retarded growth and development, morbidity and mortality.

In 2007, the World Health Organization (WHO) developed four core complementary feeding indicators, which are: time of introduction to solid foods, semi-solid or soft foods; minimum meal frequency; minimum dietary diversity; and minimum acceptable diet [30]. WHO and the United Nations Children's Fund (UNICEF) recommended exclusive breastfeeding for the first six months of a child's life, after which complementary feeding should gradually be introduced, alongside continued breast feeding up until child's second year or beyond. Despite numerous efforts to promote appropriate and safe feeding practices in India and several parts of the developing world, challenges during complementary feeding continues to pose a threat to proper nutrition in infants and young children. Although most of these challenges are context specific, many are common across different settings and are often characterized by suboptimal feeding practices and poor dietary quality of complementary foods [5, 16, 24]. Previous studies have shown that achieving optimal complementary feeding practices is influenced by socio-economic and demographic characteristics such as child's age, gender, breast feeding status, preceding birth interval, maternal education and age, mother's working status and exposure to media, father's educational and occupational status, household family size, household wealth index and geographical location [4, 8, 10, 17, 21]. Other factors include knowledge about infant's nutritional needs, cultural beliefs, taboos on child feeding practices, health care utilization, antenatal care visits and complementary feeding counselling by health professionals [2, 14].

Few studies in India had reported on the determinants of complementary feeding practices using the IDHS data. However, these studies did not include data on non-breastfed children in the computation of the minimum acceptable diet indicator, apparently because the relevant data were not collected in the 2006 IDHS and earlier surveys [13, 22]. Interestingly, the most recent IDHS (2015–2016), used in this present study, collected data for non-breastfed children [13]. This is therefore the first study on India to include the data on non-breastfed children in the computation of the minimum acceptable diet indicator. These data are very important to getting more accurate estimates of complementary feeding practices. Thus, the present study would provide valuable and updated information for health policy makers and children nutrition programme managers.

MATERIALS AND METHODS

This is a population-based cross-sectional study using data from IDHS, 2015-2016. This nationally representative survey is the fourth and the most recent in the IDHS series for India. Data collection took place from January 2015 to December 2016 (International Institute for Population Sciences (IIPS) and ICF 2017). The survey covered the thirty-six (36) states/union territories of India, and utilizes a stratified sample selected in two stages. A total of 601,509 households and 699,686 women were interviewed. The response rates for all eligible households and women were 98% and 97%, respectively [13]. Comprehensive details about the sampling design and survey methodology can be found in IDHS report [13]. Based on WHO recommendation *Ickes* et al. [10] analyses in this study only included data on children between the ages of six and twenty-three months, that were alive and were last-born of mothers between the ages of 15 and 49 years. The total analytic sample size for this study was 74,095.

Outcome

This study examined complementary feeding as the outcome of interest. The first indicator of complementary feeding in infants and young children is the timely introduction of solid, semi-solid or soft foods, defined as the proportion of children aged 6 to 8 months who received solid, semi-solid or soft foods. The second indicator is minimum dietary diversity, defined as the proportion of children aged 6 to 23 months who received foods and drinks from four or more of seven food groups in the previous day. The seven food groups are grains, roots and tubers; legumes and nuts; flesh foods (meat, fish, poultry and liver/organ meats); dairy products (milk, yogurt, and cheese); eggs; vitamin-A rich fruits and vegetables; and other fruits and vegetables [31]. The third indicator is minimum meal frequency, defined as the proportion of children aged 6 to 23 months who received solid, semi-solid or soft foods at least 2 times for breast-fed infants aged 6 to 8 months, 3 times for breast-fed children aged 9 to 23 months, and 4 times for non-breast-fed children aged 6 to 23 months (including milk feeds for non-breast-fed children) the previous day. The fourth indictor is minimum acceptable diet, defined as the proportion of children aged 6 to 23 months who received both minimum dietary diversity and minimum meal frequency the previous day [31].

Dependent variables (introduction to complementary feeding at 6 to 8 months, minimum dietary diversity, minimum meal frequency and

minimum acceptable diet) were coded 0 = no (i.e. the recommended minimum was not achieved) or 1= yes (i.e. the recommended minimum was achieved).

Potential factors of interest

The independent factors included in this study were chosen *a priori* based on evidence from previous studies. These variables are child characteristics (child's age, current breastfeeding status, stunting, diarrheal, birth weight); maternal characteristics (mothers age, body mass index (BMI), working status, education, those who watch television); household characteristics (wealth index, maternal decision making on household purchases); and community characteristics (place of child delivery, number of antenatal clinic visits, place of residence and geographical region)

Statistical analysis

Descriptive statistics was deployed to express the characteristics of the study population. Categorical data were describe using frequencies and percentages. Univariate, bivariate and multivariate analyses were performed on the data using statistical package for social sciences (SPSS) version 25. Multivariable logistic regression was used to determine the independent effect of potential factors on the complementary feeding practice indicators. Associations between the variables were calculated at 95% confidence interval and statistical association for all tests was considered significant at p-value less than 0.05. Underlying assumptions for logistic regression were checked while variance inflation factor was used to check for multicollinearity. The fitness of the model was assessed using Akaike information criterion (AIC).

RESULTS

Table 1 presents the descriptive characteristics of the 74,095 last born children aged 6 to 23 months, enrolled in IDHS 2015-2016, according to attributes of the individual child, parent, household, health care services and the community. Well over half of the children (66%) are a year or older. The majority of mothers in the study were in the age bracket of 20–34 years (88.9%) and only a very small proportion were teenagers (4.2%). Additionally, the proportion of mothers and fathers with no formal education were 28.3% and 17.0%, respectively. Most of the mothers (85.4%) were not currently working and nearly half (48.6%) belonged to poor families. About 20.2% of the mothers had no antenatal clinic (ANC) visits, and only 45.8% met the recommended minimum of four ANC visits.

Table 1. Child, parental, household, and community level characteristics of children 6 to 23 months of age, India 2015–2016

Characteristics	n	percentage	Characteristics	n	percentage
Child characteristics			**Religion (74,095)**		
Sex of child (74,095)			Hindu	53567	72.3
Male	38728	52.3	Muslim Christian	11667	15.7
Female	35367	47.7	Others	6052	8.20
Age of child (74,095)			**Reads newspaper (74,095)**		
6–8	13048	17.6	No	2809	3.80
9–11	12138	16.4	Yes	61039	82.4
12–17	24701	33.3	**Listens to radio (74,095)**		
18–23	24208	32.7	No	13056	17.6
Birth interval (46,496)			Yes	67455	91.0
<24 months	12004	25.8	**Watches television (74,095)**		
>=24 months	34492	74.2	No	6640	9.00
Currently breastfed (74,095)			Yes	29 474	39.8
No	10804	14.6	***Household characteristics***		
Yes	63291	85.4	**Wealth Index (74,095)**		
Stunting (68,221)			Poorest	44 621	60.2
No	43639	64.0	Poorer	18821	25.4
Yes	24582	36.0	Middle	17203	23.2
Birth weight (74,095)			Richer	15065	20.3
Small <2.5kg	10134	13.7	Richest	12644	17.1
Normal >2.5kg	63961	86.3	**Decision making (12,964)**		
Diarrhoea (74,095)			Mother involved	10362	14.0
No	63616	85.9	Mother not involved	8940	69.0
Yes	10479	14.1			

Characteristics	n	percentage	Characteristics	n	percentage
Parental characteristics			***Community level characteristics***		
Mother's age (74,095)			**Place of delivery (74,095)**		
15–19 years	3145	4.20	Home	4024	31.0
20–34 years	65861	88.9	Health facility	15437	20.8
35–49 years	5089	6.90	**Antenatal visits (74,095)**		
Mother's education (74,095)			None	58658	79.2
No education	21000	28.3	1-3	14939	20.2
Primary	10355	14.0	4+	25212	34.0
Secondary	34905	47.1	**Residence (74,095)**		
Higher	7835	10.6	Urban	33944	45.8
Mother's literacy (73,591)			Rural	17579	23.7
Cannot read	28575	38.8	**Region (72,063)**		
Can read	45016	61.2	North	56516	76.3
Working status (13,110)			East	20537	28.5
Not working	11192	85.4	West	15781	21.9
Working	1918	14.6	South	9745	13.5
Mother's BMI (74,095)			Central	6197	8.60
Too thin <18.5	19876	26.8	North-East	9284	12.9
Normal =18.5-24.99	44826	60.5		10519	14.2
Overweight/obese>25.0	9393	12.7			
Father's education (13,057)					
No education	2217	17.0			
Primary	1775	13.6			
Secondary	7245	55.5			
Higher	1820	13.9			

Due to no response or missing values, the total for each variable is different and is stated within brackets next to the variable.

Table 2. Adjusted determinants of complementary feeding indicators of children aged 6 to 23 months in India (2015 – 2016)

Characteristics	TIC (6-8 months) AOR (95%CI)		MDD AOR (95%CI)		MMF AOR (95%CI)		MAD AOR (95%CI)	
Child age								
6-8	----		1.00		1.00		1.00	
9-11	-----		2.20***	(1.33-3.62)	0.67***	(0.49-0.90)	1.02	(0.77-1.35)
12-17	1.00		5.31***	(3.43-8.21)	1.19	(0.93-1.52)	2.21***	(1.76-2.77)
18-23	0.99	(0.79-1.24)	7.21***	(4.65, 11.17)	1.19	(0.92-1.53)	2.62***	(2.09-3.28)
Currently breastfeeding								
No	1.00		1.00		1.00		1.00	
Yes	1.26	(0.95-1.66)	0.67***	(0.52-0.87)	3.90***	(3.07-4.97)	1.21**	(1.02-1.43)
Stunting								
Not stunted	-----		1.00		1.00		1.00	
Stunted	-----		0.85	(0.68-1.06)	1.00	(0.84-1.20)	1.10	(0.96-1.26)
Birth weight								
<2500	1.00		1.00		1.00		1.00	
>2500	1.24	(0.89-1.73)	1.09	(0.79-1.50)	0.68***	(0.52-0.89)	0.80**	(0.66-0.98)
Diarrhoea								
No	0.97	(0.73-1.29)	1.00		1.00		1.00	
Yes	1.00		1.29	(0.99-1.69)	0.78	(0.63-0.96)	0.90	(0.75-1.08)
Mother age								
15–19	1.24	(0.91-1.70)	1.00		1.00		1.00	
20–34	1.20	(0.93-1.56)	0.83	(0.50-1.38)	0.78	(0.52-1.14)	1.06	(0.74-1.51)
35–49	1.21	(0.81-1.80)	0.88	(0.46-1.71)	1.00	(0.58-1.71)	1.37	(0.90-2.09)
Mother's BMI (kg/m2)								
Overweight/obese	1.00		1.00		1.00		1.00	
Too thin <18.50	1.00	(0.77-1.30)	1.30	(0.89-1.90)	1.10	(0.80-1.51)	0.91	(0.73-1.14)
Normal =18.5-24.99	1.91***	(1.19-3.06)	1.23	(0.88-1.72)	1.06	(0.80-1.41)	0.99	(0.82-1.20)

Mother's education								
No education	1.21	(0.72-2.02)	1.00		1.00		1.00	
Primary	1.00		0.68**	(0.46-0.99)	1.18	(0.89-1.57)	0.94	(0.73-1.19)
Secondary	1.50***	(1.13-1.98)	0.82	(0.61-1.09)	1.08	(0.85-1.36)	1.22**	(1.01-1.47)
Higher	1.00		0.81	(0.52, 1.24)	1.00	(0.70-1.45)	1.21	(0.92-1.59)
Parent's religion								
Hindu	1.04	(0.79-1.37)	1.00		1.00		1.00	
Muslim	1.00		1.26	(0.95-1.66)	1.00	(0.74-1.26)	1.38***	(1.16-1.64)
Christian	1.15	(0.83-1.59)	1.73**	(1.08-2.75)	1.14	(0.74-1.74)	1.54***	(1.19-2.01)
Others	1.00		0.86	(0.46-1.62)	0.85	(0.50-1.45)	1.17	(0.84-1.63)
Mothers working status								
Not working	1.10	(0.87-1.40)	1.00		1.00		1.00	
Working	1.00		1.14	(0.86-1.51)	0.92	(0.73-1.15)	0.76***	(0.64-0.90)
Reads newspaper								
No/< once a week Once	1.45**	(1.09-1.94)	1.00		1.00		1.00	
a week/every day	1.40*	(1.00-1.98)	0.96	(0.70-1.31)	1.11	(0.85-1.45)	1.10	(0.92-1.31)
Listens to radio								
No/< once a week	1.29	(0.87-1.91)	1.00		1.00		1.00	
Once a week/every day	1.09	(0.70-1.68)	1.28	(0.92-1.78)	0.80	(0.60-1.07)	0.68***	(0.56-0.83)
Watches television								
No/less than once a	1.00		1.00		1.00		1.00	
once a week/every d	0.87	(0.71-1.06)	1.36**	(1.24-1.48)	0.99	(0.80-1.23)	1.07	(0.90-1.27)
Household Wealth Index								
Poorest	1.00		1.00		1.00		1.00	
Poorer	1.45**	(1.09-1.94)	1.10	(0.80-1.50)	1.02	(0.80-1.30)	1.24*	(1.00-1.54)
Middle	1.40*	(1.00-1.98)	1.33	(0.91, 1.93)	1.09	(0.80-1.47)	1.26*	(0.99-1.61)
Richer	1.29	(0.87-1.91)	1.34	(0.87-2.04)	1.15	(0.81-1.62)	1.24	(0.94-1.63)
Richest	1.09	(0.70-1.68)	1.36	(0.84-2.22)	1.39	(0.93-2.09)	1.35*	(0.99-1.84)
Decision making								
Mother involved	1.00		1.00		-----		1.00	
Mother not involved	0.87	(0.71-1.06)	0.79**	(0.63, 0.99)			1.18**	(1.02-1.37)
Place of delivery								
Home	1.00		1.00		-----		1.00	
Health centre	0.91	(0.70-1.18)	1.23	(0.93-1.64)			1.26**	(1.05-1.52)
Antenatal								
No	1.00		1.00		1.00		1.00	
1-3	0.99	(0.74-1.32)	0.85	(0.63-1.14)	1.47***	(1.16-1.86)	1.11	(0.90-1.38)
4+	1.51***	(1.12-2.03)	1.41**	(1.05-1.90)	1.80***	(1.41-2.31)	1.94***	(1.58-2.38)
Type of residence								
Urban	1.00		1.00		1.00		1.00	
Rural	0.74**	(0.58-0.95)	1.38	(1.01-1.88)	1.87	(0.67-1.14)	0.83**	(0.70-0.98)
Geographical region								
North	1.00		1.00		1.00		1.00	
East	0.99	(0.75-1.29)	1.26	(0.95-1.67)	0.82*	(0.65-1.02)	1.23**	(1.01-1.51)
West	0.72**	(0.53-0.96)	0.50***	(0.31, 0.80)	0.67**	(0.49-0.92)	0.46***	(0.35-0.61)
South	1.46**	(1.02-2.10)	3.31***	(2.31-4.73)	0.96	(0.69-1.33)	2.17***	(1.76-2.67)
Central	0.79	(0.57-1.11)	1.20	(0.78-1.87)	1.17	(0.84-1.64)	1.06	(0.83-1.35)
North-East	1.39*	(0.95-2.03)	2.20***	(1.45-3.35)	0.86	(0.60-1.27)	1.32**	(1.03-1.68)

***P < 0.01, **P < 0.05, *P < 0.1.

TIC, timely introduction to complementary foods; MDD, minimum dietary diversity; MMF, minimum meal frequency; MAD, minimum acceptable diet; AOR, adjusted odd ratios.

Determinants of timely introduction to complementary foods

The independent determinants of timely complementary feeding practice among children are shown in Table 2. Mothers dwelling in rural areas were less likely (AOR = 0.74, 95% CI: 0.58-0.95, p<0.05) to introduce complementary foods at the appropriate age, compared with mothers living in urban areas.

Working mothers were 50% more likely (AOR = 1.50, 95% CI: 1.19-3.06, p<0.01) to introduce solid food on time than mothers who were not working, and those in the poorer quintile (AOR =1.45, 95% CI: 1.09-

1.94, p<0.05) were less likely to delay complementary feeding, more than mothers in poorest quintile. Mothers who attended four or more antenatal check-ups were more likely to introduce complementary feeding at the appropriate age (AOR = 1.51, 95% CI: 1.12-2.03, p<0.01), compared with those who did not attend any antenatal clinics. Mothers who are Christians (AOR =1.91, 95% CI: 1.19-3.06, p<0.01) were significantly more likely to introduce complementary feeding at the appropriate age than Hindu mothers.

Determinants of minimum dietary diversity

Mothers from Western India (AOR = 0.50, 95% CI: 0.31-0.80, p<0.01) were at increased risk of suboptimal dietary diversity, compared with Northern mothers. However, mothers in the Southern (AOR = 3.31, 95% CI: 2.31-4.73, p<0.01) and North-Eastern regions (AOR = 2.20, 95% CI: 1.45-3.35, p<0.01) are 3.31 and 2.20 times more likely to offer varied diets than those from the North. Higher rates of achieving minimum dietary diversity were observed among children of mothers who watched television at least once a week or almost every day (AOR = 1.36, 95% CI: 1.24-1.48, p<0.05) and also among those who had four or more antenatal clinic visits (AOR =1.41, 95% CI: 1.05-1.90, p<0.05), compared to those with no visits. Children aged 9-11, 12-17 and 18-23 months were more likely to receive a varied diet compared with children aged 6-8 months old, (AOR = 2.20, 95% CI: 1.33-3.62, p<0.01), (AOR = 5.31, 95% CI: 3.43-8.21, p<0.01) and (AOR = 7.21, 95% CI: 4.65-11.17, p<0.01) respectively. Breastfed children were less likely to receive a varied diet when compared with those not breastfed (AOR = 0.67, 95% CI: 0.52-0.87, p< 0.01). Compared with uneducated mothers, those who had only primary education were less likely (AOR = 0.68, 95% CI: 0.46-0.99, p<0.05) to offer their children the minimum dietary diversity. Also, children of mothers not involved in decision making about household purchases (AOR = 0.79, 95% CI: 0.63-0.99, p<0.05) were at increased risk of inadequate dietary diversity. However, mothers who are Christians (AOR =1.73, 95% CI: 1.08-2.75, p<0.05) have significantly higher rates of offering a varied diet than Hindu mothers.

Determinants of minimum meal frequency

Mothers with children aged 9-11 were significantly at greater risk (AOR = 0.67, 95% CI: 0.49-0.90, p<0.01) of not meeting the minimum meal frequency, compared to those with children in the youngest age bracket (6 to 8 months). Those still breastfeeding are 3.90 times more likely to achieve adequate meal frequency (AOR = 3.90, 95% CI: 3.07-4.97, p<0.01) compared to children not presently breastfed. Also, mothers that had four or more antenatal clinic visits (AOR = 1.80, 95% CI: 1.41-2.31, p< 0.01) and those who had between one and three visits (AOR = 1.47, 95% CI: 1.16-1.86, p<0.01) were more likely to achieve minimum meal frequency, compared to those without antenatal visits. Children with normal birth weights (AOR =0.68, 95% CI: 0.52-0.89, p<0.01) and those living in Western region of India (AOR = 0.67, 95% CI: 0.49-0.92, p<0.05) as opposed to those in the Northern region, were more likely at risk of suboptimal meal frequency.

Determinants of minimum acceptable diet

Children in the 12-17 (AOR = 2.21, 95% CI: 1.76-2.77, p<0.01) and 18-23 (AOR = 2.62, 95% CI: 2.09-3.28, p < 0.01) months age brackets were at 2.21 and 2.62 times higher odds to meet minimum acceptable diets, as opposed to those in the youngest age group (6 to 8 months). Compared with uneducated mothers, those with secondary education were 1.22 times more likely to offer the minimum acceptable diet (AOR = 1.22, 95% CI: 1.01-1.47, p<0.05). Mothers who were Christians (AOR =1.54, 95% CI: 1.19-2.01, p<0.01) and Muslims (AOR = 1.38, 95% CI: 1.16-1.64, p<0.01) have significantly higher rates of feeding children the minimum acceptable diet than Hindu mothers. As compared with mothers living in the Northern region of India, the Southern (AOR = 2.17, 95% CI: 1.76-2.67, p<0.01), North-Eastern (AOR = 1.32, 95% CI: 1.03-1.68, p<0.05) and Eastern (AOR = 1.23, 95% CI: 1.01-1.51, p<0.05) regions of India had higher rates of meeting the recommended minimum, whereas the Western (AOR = 0.46, 95% CI: 0.35-0.61, p<0.01) region of India were less likely to meet this minimum. Having a child with normal weight at birth (AOR =0.80, 95% CI: 0.66-0.98, p<0.05), working (AOR = 0.76, 95% CI:0.64-0.90, p<0.01) and living in rural areas (AOR = 0.83, 95% CI: 0.70-0.98, p< .05) were significant risk factors for suboptimal diet. Mothers currently breastfeeding their children (AOR = 1.21, 95% CI: 1.02-1.43, p<0.05), not involved in decision making about household purchases (AOR = 1.18, 95% CI: 1.02-1.37, p<0.05), those that delivered child in health centre rather than at home (AOR = 1.26, 95% CI: 1.05-1.52, p<0.05) and those who met the minimum four or more antenatal visits compared with those who had none (AOR = 1.94, 95% CI: 1.58-2.38, p<0.01) had higher odds of achieving minimum acceptable diets.

DISCUSSION

Findings from this study have demonstrated that almost half of children in the 6 to 8-month age bracket had been introduced to solid and semi-solid foods. About two-fifths of the children met minimum meal frequency while one-fifths of them had minimum dietary diversity and one out of ten of the children satisfied the minimum acceptable diet

requirement. Apart from being alarmingly low, these rates indicate a decline in trend for the proportion of infants and young children that received adequate complementary feeding in India. Specifically, the rate of achieving timely introduction to complementary foods was reduced from 54.6% in 2006 to 45.1% in 2016; minimum meal frequency satisfaction rate reduced from 41.5% in 2006 to 36% in 2016; minimum acceptable diet satisfaction rate reduced only slightly from 9.2% in 2006 to 9.1% in 2016. Only the minimum dietary diversity indicator had improved satisfaction rate, increasing from 15.2% to 21%, over the ten-year period between the two national surveys [13, 22].

The poor rates of meeting minimum recommended complementary feeding practice indicators were reflected in the physical condition of children in India over the same period. For example, wasting increased slightly from 20% in 2006 to 21% in 2016**.** Also, it could have been expected that incidences of underweight would have reduced drastically over the ten-year period, given the huge efforts made by the Indian government to promote optimal feeding practices [7, 19]. Rather, the condition reduced only by 7% over the ten-year period [13, 22].

Results from the multivariate analyses show (among the child-related factors) that child age was significantly associated with minimum dietary diversity (MDD), minimum meal frequency (MMF) and minimum acceptable diet (MAD), with infants in the youngest age group at highest risk of poor complementary feeding. The negative impact of a child being in the youngest age bracket on maternal complementary feeding practices was also reported by [4, 14]. Inadequate complementary feeding in the youngest age group may be because mothers of these infants consider them too young to receive the minimum recommended complementary feeding. Breastfeeding status was also associated with feeding practices. Breastfed children are less likely to receive a varied diet when compared to non-breastfed children. However, the reverse is the case for achieving MAD and MMF, with non-breastfed children less likely to receive the minimum recommendations.

Consistent with previous studies, results from this study show that maternal factors are significantly associated with complementary feeding indicators [10, 17]. Mothers with secondary education have a higher odd of meeting the minimum acceptable diet, compared to mothers with no education. Similar to results from the secondary analyses of the 2006 IDHS of India, [22] mothers who were Christians in the present study were more likely to introduce their child to complementary foods at the right age, achieving MDD, and achieving MAD, respectively, compared with those who were Hindus. Muslim mothers were also more likely to meet MAD than those of the Hindu religion. Working mothers are at risk of not meeting the minimum acceptable diet for their children. A study in Lebanon by *Batal* et al. [1] also found that women in employment were almost twice as likely than those who were unemployed, to introduce semi solid or solid foods before their infants reached four months of age [1]. Timely introduction by working mothers may be because of the need to leave the children in the care of other persons while they are away at work.

Watching television at least once a week or almost every day was significantly related to higher odds of meeting the minimum dietary diversity. The association between watching television and achieving a varied diet could be attributed to a better standard of living and the increased awareness among mothers who had access to a television set. This is corroborated by findings from a study by *Paul* et al. [23] which showed that a significant proportion of mothers received advice on complementary feeding from watching television.

Household wealth index was not significantly associated with complementary feeding indicators, except the timely introduction to complementary feeding. Those in the poorer households were found to be at higher risk of delaying complementary feeding than those in the poorest households. This result suggests that, apart from food insecurity, cultural barriers may contribute to late introduction to complementary food in India. Mothers not involved in decision making about household purchases were less likely to meet minimum dietary diversity, but more likely to meet minimum acceptable diets. A previous study found that mother's increased decision-making autonomy generally had a positive impact on their feeding practices [27].

Several studies had provided indication that maternal access to healthcare services would augment desirable feeding practices [9, 18, 25]. This was confirmed by results from this study, which shows that meeting the recommended minimum of four or more antenatal visits, compared with no antenatal, is predictive of timely introduction to complementary foods, achieving minimum dietary diversity, meal frequency and acceptable diets. Likewise, mothers who gave birth to their children in health facilities rather than at home were more likely to achieve minimum acceptable diets. There is considerable evidence that receiving nutrition counselling on infant and young child feeding (IYCF) practices from trained health workers can effectively improve complementary feeding practices, and consequently the child's nutritional status [11, 26, 28, 32].

Furthermore, we found that mothers living in rural areas were 74 % and 83% less likely than those living in urban areas to achieve timely introduction to complementary foods and minimum acceptable

diets, respectively. Mothers from the Southern, North-Eastern and Eastern regions had higher rates of achieving the minimum recommended practices compared to mothers living in the Northern region of India, whereas mothers living in the Western region are at a higher risk of not meeting minimum meal frequency and minimum acceptable diets. These findings are consistent with those from the secondary analysis of the 2006 IDHS in India [22] indicating that the disparity between regions in India concerning complementary feeding practices has not changed over the last decade. Finally, mother's age and BMI, stunting, and occurrence of diarrhoea in the last two weeks' prior interviews, were not found to be significantly associated with complementary feeding practices in the multivariate analyses of India IDHS.

Data from DHS are considered one of the most reliable on mother and child's health in developing countries [8]. However, being a cross sectional survey, causal relationships between variables of interest cannot be assessed. Also, because the data were self-reported, there is the possibility of social desirability bias and recall bias. Mothers' 24-hour recall of the types of food and number of times given may not correctly reflect their actual feeding practices. The possibility of residual confounding factors can also not be ruled out. Despite these limitations, a major strength of this study is the fact that it used a large, nationally representative sample, thereby providing useful evidence for policy makers and researchers to develop appropriate interventions to improve complementary feeding practices in all of India. Additionally, this study used a more accurate estimate of minimum acceptable diets, as it included data for non-breastfed children in its statistical computations, unlike previous studies which did not take into account the non-breastfed children [17, 22].

CONCLUSIONS

The rate of compliance with optimal complementary feeding practices remains abysmally low in India. This study showed that multiple factors including child age, birth weight, maternal education, breastfeeding, antenatal care uptake, place of delivery, maternal involvement in decision-making, access to media, religion, employment, household wealth index, place of residence, and region are driving complementary feeding practices in India. Findings from this study will serve as vital information for health policymakers and health program implementers for developing and deploying interventions and health policies to optimize complementary feeding practices in India.

Ethical approval

Not required. This study was based on the analysis of a publicly available survey data from the Demographic Health Survey (DHS), with all the identifier information removed. Biomarkers and questionnaire information were collected in the survey only with informed consent from respondents and all information was collected confidentially.

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Competing interests

The authors have no competing interests.

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ORIGINAL ARTICLE

ASSESSMENT OF DIET QUALITY IN CHILDREN AND ADOLESCENTS WITH TYPE 1 DIABETES

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ABSTRACT

Background. Micronutrient malnutrition is a serious public health problem in most developing countries, including Morocco, due to poor and therefore lower quality diets that lack dietary diversity.
Objective. The present study aimed to assess dietary diversity and variety and their relationship with micronutrient adequacy in children and adolescents with type 1 diabetes (T1D).
Materials and methods. A cross-sectional study was carried among 240 children and adolescents with T1D. Weight and height were measured and BMI was calculated. Dietary intake data were obtained from two 24-h recalls. A Dietary diversity (DDS) and dietary variety scores (DVS) and mean adequacy ratio (MAR) and nutritional adequacy ratios (NARs) were calculated and compared according to sociodemographic/anthropometric categories.
Results. 52.1% of the patients were female. The mean age of the patients was 8.49 ± 4.1 years. The mean BMI was 19.44 ± 5.24 kg/m2; the mean DDS was 4.62±1.20 and the mean MAR was 0.66 ± 0.11. Older children living in rural areas have a low DDS/DVS. Parental education and income level are associated with DDS/DVS. General and central obesity were significantly elevated in children with high DDS. In addition, a high intake of vegetables, eggs, fiber and micronutrients (Magnesium, Calcium, Potassium, Zinc, Phosphorus and Vit B1) is associated with a high DDS; however, high DVS is associated with high consumption of dairy products, carbohydrates and low intake of protein and fat. There are also positive correlations between DDS/DVS and NARs for various nutrients.
Conclusion. The quality of the respondents' diets are moderately diversified. DDS or DVS can be used as indicators of micronutrient adequacy in Moroccan T1D children. Nutritional education needs to be strengthened to improve dietary diversity in children, especially in rural areas.

Key words: *diet quality, dietary diversity score, dietary variety score, nutritional adequacy, child/adolescent, T1D*

INTRODUCTION

Type 1 diabetes (T1D) is an autoimmune disease characterized by the destruction of beta cells in the islets of Langerhans of the pancreas that are responsible for insulin production [1]. Currently, T1D is one of the most common chronic diseases in children and adolescents [2]. The International Diabetes Federation (IDF) estimates that more than 1.1 million children and adolescents are living with T1D [1].

On the other hand, deficiencies of micronutrients constitute a serious nutritional problem in children in both developed and developing countries [3]. Whereas, overweight and obesity have been a public concern for decades in many countries, ranging from high-income to low-and middle-income countries[4]. As a result, Morocco, with respect to developing countries, faces the double burden of undernutrition and overnutrition [5]. On the one hand, more than a third of Moroccan children (31.6%) aged 6 months to 5 years old suffer from iron deficiency anemia; and about a third from folic acid deficiency; while vitamin A deficiency affects 40.90% of children aged 6 to 72 months [5]. Furthermore, the prevalence of childhood overweight

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and obesity has increased alarmingly. Thus, according to the World Health Organization (WHO), Morocco is classified among the countries with a prevalence of overweight/obesity of 10 to 14.9%, alongside Algeria and Tunisia [6]. This increase is partly explained by the nutrition transition in the Moroccan population, which consumes foods and beverages rich in calories and poor in micronutrients with an increase in sedentary activities [7].

Furthermore, dietary diversity (DD) is universally recognized as a measure of the nutritional quality of household access to a variety of foods and also reflects the nutritional adequacy of an individual's diet [8]. There are several indicators to assess dietary quality, such as the Dietary Diversity Score (DDS) and the Dietary Variety Score (DVS) [9]. In addition, several studies have shown that these measures have strong associations with diet quality and nutritional status of individuals [10]. International dietary guidelines recommend improving DD to meet daily nutritional needs and reduce the increased risk of chronic disease [8]. Indeed, most of the micronutrients we need come from the daily diet. In addition, several studies have shown that the nutritional quality of the diet is improved when it is diversified [11]. For this reason, a healthier diet is one that is more varied [12]. Moreover, studies have also shown that DDS is positively associated with micronutrient adequacy in children [13]. However, it is possible that diversified diets provide adequate micronutrients associated with increased energy intake [14]. This is confirmed by some research showing an association of high DDS with general obesity (GO) and central (CO) obesity [15], metabolic syndrome, and with the risk of cardiovascular disease (CVD) [16, 17]. This evidence indicates that DD can increase micronutrient intake and improve children's physical health and cognitive development.

Thus, data on dietary intakes are essential for understanding the role of diet quality in nutritional deficiencies and, eventually, for designing effective nutritional interventions. In low- and middle-income countries, of which Morocco is a part, the diet of children and adolescents lacks variety and consists mainly of cereals, with limited consumption of foods of animal origin, fruits and vegetables and dairy products [18]. To our knowledge, few national studies have assessed diet quality in children and adolescents. Therefore, the aim of the present study is to assess dietary diversity DD and dietary variety (DV) and their association with sociodemographic/anthropometric variables, dietary intakes and micronutrient adequacy in children and adolescents with T1D.

MATERIALS AND METHODS

Study population

This is a prospective descriptive study conducted at the level of the pediatric unit of the Mohamed V Provincial Hospital of El Jadida over a period from March 2018 to December 2020. The target population was 240 diabetic children, aged 15 years or less, with T1D for 12 months to avoid the remission period due to the residual secretion of endogenous insulin during recent diabetes. A structured questionnaire was used and completed with the patients or their parents to collect data on the sociodemographic and socioeconomic characteristics, family history, the disease characteristics, diabetes management (number of daily insulin injections and frequency blood glucose self-monitoring per day), and anthropometric measurements (weight, height, waist circumference, WHtR and BMI).

The interview was conducted with the parents (or the participant's guardian) when the child's age was less than 11 years and with the child him/herself when the child's age was 11 years or older. Treating physicians and medical records were also used as sources of data.

Socioeconomic and sociodemographic characteristics

Data collected on participants' socioeconomic (SES) and sociodemographic status are collected through structured interviews included, age, sex, area of residence, parental education level, and household income.

Anthropometric measurements

These parameters were measured on participants in the pediatrics unit on the day of the interview according to the WHO standards [19]. Weight, was measured in kilogram to the nearest 0.1 kg, on children wearing lightly dressed and without shoes, on a mechanical scale. The height was measured in the participants to the nearest 0.1 centimeter using a wall scale with heels joined, legs straight, arms dangling and shoulders relaxed.

Waist circumference (WC) was measured on respondents standing with feet 2.5 cm apart, legs straight, arms hanging down and shoulders relaxed, the measuring tape was placed uncompressed at midway between the iliac crest and the last rib, at the end of expiration. The Waist-to-Height Ratio (WHtR) was calculated and the WHtR cut-off of 0.5 is used to define abdominal obesity for both boys and girls [20].

Finally, the body mass index (BMI) a measure that estimates the fat mass of individuals, was calculated by dividing the weight in kg by the square of the height expressed in meters (kg/m^2): BMI = Weight (kg)/ Height^2 (m^2). The references established by WHO in

2007 are used to calculate Z Score values for BMI for age using WHO software, AnthroPlus (Version 1.0.4, 2010), to assess the growth of children and adolescents worldwide [21]. Thus, children under five years old are considered underweight when Z score < −2 standard deviations (SD), overweight when a Z score > +2 SD and obese if Z score > +3 SD [22]. For the children aged 5 to 19 years, they were classified into 3 categories: underweight when Z Score < −2 SD, overweight if Z Score > +1 SD and obese if Z Score > +2 SD [23, 24].

The 24-hour recall and the food frequency questionnaire

Dietary intake data are collected using two 24-hour dietary recalls technique (including one weekday and one weekend day) to list all foods ingested and participant's macronutrient and micronutrient intak. Each respondent was asked to describe precisely everything they consumed (drunk and eaten) during the previous 24 hours, rising the night before until the same time on the day of the survey. The respondent was also asked to quantify the foods described, with her own measures (household measures), using an iconographic manual [25]. Dietary intakes were converted to estimate energy and their composition in nutritional intakes using the BILNUT software (S.C.D.A. NUTRISOFT-BILNUT, version 2.01). The values obtained were then compared to the reference intakes.

Unlike the 24-hour recall, the food frequency questionnaire (FFQ) is a qualitative method that provides an overall idea of the eating habits of the population. The questions are oriented on the quantity and frequency of usual consumption of foods over a long period, referring to a pre-established list. Indeed, the FFQ is made up of two parts: a closed list of foods and a section where the frequency of consumption can be indicated (for example, several times a day, 3 to 4 times a week, 1 to 2 times a week, once or twice a month, less than once a month and never) and a section with more detailed questions about the size the portion consumed and its composition.

Measurement of DDS and DVS

DDS is defined as the number of unique food groups consumed by the child over a specified period [26]. The diet was classified into nine food groups according to FAO recommendations, which included: (1) starchy foods (cereals, roots and tubers), (2) dark green leafy vegetables, (3) other fruits and vegetables rich in vitamin A, (4) other fruits and vegetables, (5) organ meats, (6) meat, poultry and fish, (7) eggs, (8) legumes, nuts and seeds and (9) milk and milk products [26].

A score of '1' was assigned to each food group if at least one food from the specific food group was consumed during the reference period. A score of '0' was assigned if the child did not consume any food from a given food group. The DDS for each child was calculated as the sum of the scores, with a maximum possible score of '9'. The DDS could be low: consumption of foods from ≤3 groups, medium/moderate: consumption of foods from 4 to 5 groups, or high: consumption of foods from ≥6 groups [27].

The DVS, on the other hand, represents the number of foods consumed in the past 24 hours, 48 hours or 3 days [28]. In other words, the consumption of a mixture of foods belonging to different groups used for the calculation of the DDS (cereals, dairy products, etc.) and a mixture within each group: wheat, corn, rice, barley, bread, pasta, … for the cereals group for example [29].

Indices reflecting nutritional adequacy

To determine the nutritional adequacy of the diet, the Nutrient Adequacy Ratio (NAR) was calculated as the estimated individual daily intake of each nutrient divided by the recommended intake for that nutrient taking into account sex and age category of the subject. In the present study, NAR values were evaluated for 11 micronutrients that are most commonly used for calculating adequacy scores especially in adolescents (Sodium, Magnesium, Calcium, Potassium, Zinc, Iron, Phosphorus, Vit E, Vit B1, Vit C and Folate) [30].

The mean adequacy ratio (MAR), which represents the overall adequacy of the daily food intake with the nutritional recommendations, was calculated as the sum of the NARs of all the nutrients evaluated divided by the number of nutrients evaluated, expressed as a percentage [28]. All NARs with values greater than "one" were reduced to "one" to avoid compensation for deficiencies that may be recorded for some nutrients [28]. Thus, the maximum value of NARs should be capped at "one". The reference value of the MAR is also set at "one", which corresponds to 100% of the recommended dietary Allowance (RDA) and reflects an ideal adequacy to the dietary recommendations.

Statistical analysis

Data analysis was performed using SPSS for Windows (Statistical Package for the Social Sciences) version 23.0. A descriptive analysis is performed to describe the characteristics of the study participants, namely sociodemographic and socioeconomic variables and anthropometric measures. The independent sample t-test, ANOVA test and Chi-square test are applied for the comparison of means ± standard deviations and proportions (in percent) of continuous and categorical variables, respectively. P values less than 0.05 are considered statistically significant for all tests. In addition, *Pearson* correlations between the MAR and NARs variables and the DDS and DVS variables were performed.

Ethical considerations

The questionnaire used in this study was validated by a scientific committee of Chouaib Doukkali University of El Jadida and data collection began after obtaining authorization from the Regional Health Department of the Casablanca-Settat region in Morocco. For each child, free and informed written consent was obtained from the parents or guardians before starting the survey. The procedures and objectives of the study were also clearly explained to the participants. The confidentiality and anonymity of the information collected were also respected.

RESULTS

Characteristics of the population

Table 1 brings together the different sociodemographic and anthropometric characteristics of the study population. The survey included a total of 240 diabetic subjects, with a mean duration of T1D of 3.24±2.39 years and a family history of diabetes in almost half of them (48.8%). In addition, 52.1% of the patients were female (sex ratio 0.85). The mean age of the patients was 8.49±4.1 years, ranging from 2 to 15 years with the age group of 11-15 years being the most representative (40.8%), with a majority (68 .5%) of school age, 95.18% of them attending school. The majority of these participants resided in urban areas (61.4% vs. 38.6% in rural areas) and 63% lived in nuclear families. Overall, illiteracy was 75.5% among the patient's parents, with a higher rate among mothers (69%) than fathers (13.6%). However, a higher level of education was found in 3.8% of mothers. The patients came from parents of predominantly low socioeconomic level (83.2%). Table 1 also shows that the population a mean BMI of 19.44±5.24 kg/m2 with normal weight prevalent in 63.6%, underweight in 15.8%, overweight in 17.9%, GO in 2.7% and CO (WHtR ≥ 0.5) in 27.2% of patients.

Sociodemographic and anthropometric characteristics according to DDS and DVS level

The sociodemographic and anthropometric variables of the respondents distributed according to the categories of DDS and DVS are listed in Table 2. Older children and those living in rural areas have a low DDS/DVS. We also found that the higher the parents' education and income level, the more attention they paid to their child's nutrition. No significant association was found between DDS/DVS and gender in this study. The data in the table also show that WHtR was significantly higher in T1D children with a high DDS. In addition, GO and CO was significantly higher in children with high DDS.

Table 1. General characteristics of the study population

Characteristics		N(%) or mean±SD
Sociodemographic characteristics		
Age (years)		8.60±4.08
Sex	Male	115(47.9%)
	Female	125(52.1%)
Age category	≤ 4 years	57(23.8%)
	5-10 years	83(34.6%)
	11-15 years	100(41.7%)
Area of residence	Urbain	143(59.6%)
	Rural	97(40.4%)
Fathers education level	Never attended	161(67.1%)
	Primary school	19(7.9%)
	College school	21(8.8%)
	Secondary school	13(5.4%)
	University	26(10.8%)
Mothers education level	Never attended	176(73.3%)
	Primary school	35(14.6%)
	College school	13(5.4%)
	Secondary school	9(3.8%)
	University	7(2.9%)
Household income	Low	207(86.3%)
	Medium	26(10.8%)
	High	7(2.9%)
Disease characteristics		
Duration of diabetes (years)		3.24±2.395
Family history of diabetes		117(48.8%)
Number of injections / day	2 injections	194(80.8%)
	3 injections	41(17.1%)
	4 injections	5(2.1%)
Self-monitoring of	<4times/d	209(87.1%)
blood glucose	≥ 4times/d	31(12.9%)
Anthropometric characteristics		
Weight (kg)		29.41±14.81
Height (m)		1.25±0.23
BMI (kg/m^2)		19.51±5.12
WHtR (cm)		0.45±0.05
BMI categories n (%)	Normal weight	165(68.8%)
	Overweight	38(15.8%)
	Obese	6(2.5%)
	Underweight	31(12.9%)
WHtR categories n (%)	No abdominal obesity (WHtR < 0.5)	184(76.7%)
	Abdominal obesity (WHtR ≥ 0.5)	56(23,3%)

Abbreviations: Data are presented as mean ± standard deviation (SD) or as (%). BMI: Body Mass Index; WHtR: Waist-to-Height ratio.

Table 2. Sociodemographic and anthropometric characteristics according to DDS and DVS level

Variables		DDS				DVS		
		Low (n=38)	Medium (n=155)	High (n=47)	P-value	Insufficient (DVS≤6)	Correct (DVS>6)	P-value
DDS		2.73±0.44	4.56±0.49	6.36±0.73	≤0.01			
DVS						4.99±1.06	8.76±1.91	≤0.001
Sociodemographic characteristics								
Sex	Male	18(15.7%)	80(69.6%)	17(14.8%)	0.178	60(52.2%)	55(47.8%)	0.923
	Female	20(16.0%)	75(60%)	30(24%)		66(52.8%)	59(47.2%)	
Age categories	<= 4 yrss	2(3.5%)	41(71.9%)	14(24.6%)	0.019*	20(35.1%)	37(64.9%)	0.005*
	5-10 yrs	12(14.5%)	55(66.3%)	16(19.3%)		44(53%)	39(47%)	
	11-15 yrs	24(24%)	59(59%)	17(17%)		62(62%)	38(38%)	
Area of residence	Urban	13(9.1%)	92(64.3%)	38(26.6%)	≤0.001	60(42%)	83(58%)	≤0.001
	Rural	25(25.8%)	63(64.9%)	9(9.3%)		66(68%)	31(32%)	
Fathers education level	Never attended	34(21.1%)	105(65.2%)	22(13.7%)	0.001*	100(62.1%)	61(37.9%)	≤0.001
	Primary school	2(10.5%)	13(68.4%)	4(21.1%)		9(47.4%)	10(52.6%)	
	College school	1(4.8%)	16(76.2%)	4(19%)		6(28.6%)	15(71.4%)	
	Secondary school	0(0%)	9(69.2%)	4(30.8%)		4(30.8%)	9(69.2%)	
	University	1(3.8%)	12(46.2%)	13(50%)		7(26.9%)	19(73.1%)	
Mothers education level	Never attended	34(19.3%)	117(66.5%)	25(14.2%)	0.001*	105(59.7%)	71(40.3%)	0.003*
	Primary school	2(5.7%)	26(74.3%)	7(20%)		14(40%)	21(60%)	
	College school	1(7.7%)	5(38.5%)	7(53.8%)		3(23.1%)	10(76.9%)	
	Secondary school	1(11.1%)	4(44.4%)	4(44.4%)		3(33.3%)	6(66.7%)	
	University	0(0%)	3(42.9%)	4(57.1%)		1(14.3%)	6(85.7%	
Household income	Low	38(18.4%)	140(67.6%)	29(14%)	≤0.001	120(58%)	87(42%)	≤0.001
	Medium	0(0%)	12(46.2%)	14(53.8%)		5(19.2%)	21(80.8%)	
	High	0(0%)	3(42.9%)	4(57.1%)		1(14.3%)	6(85.7%)	
Anthropometric characteristics								
Weight (kg)		33.34±12.95	28.15±14.33	30.45±17.28	0.133	30.84±14.47	27.85±15.1	0.526
Height (m)		1.36±0.17	1.23±0.23	1.23±0.23	0.008*	1.29±0.22	1.21±0.24	0.117
BMI (kg/m2)		20.36±4.51	19.06±4.84	20.35±6.27	0.175	19.81±4.94	19.19±5.31	0.31
WHtR (cm)		0.42±0.04	0.45±0.05	0.47±0.04	≤0.001	0.44±0.05	0.46±0.05	0.473
BMI categories	Normal weight	20(12.1%)	119(72.1%)	26(15.8%)	≤0.001	82(49.7%)	83(50.3%)	0.062
	Overweight	7(18.4%)	18(47.4%)	13(34.2%)		19(50%)	19(50%)	
	Obese	0(0%)	2(33.3%)	4(66.7%)		2(33.3%)	4(66.7%)	
	Underweight	11(35.5%)	16(51.6%)	4(12.9%)		23(74.2%)	8(25.8%)	
WHtR categories	No abdominal obesity	36(19.6%)	117(63.6%)	31(16.8%)	0.007*	107(58.2%)	77(41.8%)	0.001*
	Abdominal obesity	2(3.6%)	38(67.9%)	16(28.6%)		19(33.9%)	37(66.1%)	

Abbreviations: Data are presented as mean ± standard deviation (SD) or (%).
BMI: Body Mass Index; WHtR: Waist-to-Height ratio; DDS: dietary diversity score; DVS: dietary variety score.
The differences between the sociodemographic and anthropometric characteristics according to the DDS/DVS categories were compared by the t test and Anova for the continuous variables and by the Chi2 test for the categorical variables. The mean difference is significant at the 0.05 level.

Association of dietary intake with DDS and DVS

Dietary intake, including food group intake, is presented in Table 3. High DDS was associated with high intake of vegetables, eggs and micronutrients (fiber, Magnesium, Calcium, Potassium, Zinc, Phosphorus and Vit B1). However, high DVS was associated with high consumption of dairy products, carbohydrates, and low intake of protein and fat.

Pearson correlation coefficients between the NAR of some nutrients, MAR, DDS and DVS

Table 4 revealed that the average MAR of the studied population is 0.66±0.11 and the nutrients with the lowest NARs are Calcium, Potassium, Vitamin E and folate. The use of bivariate correlation analyses showed that there are significant and positive correlations between the DDS/DVS and most of the NARS for various nutrients, except Sodium, Potassium for the DDS and Sodium, Potassium and Iron for the DVS.

Table 3. Association of food intake with DDS and DVS

	DDS				DVS		
	Low (n=38)	Medium (n=155)	High (n=47)	P-value	Insufficient (DVS≤6)	Correct (DVS>6)	P-value
Food groups intake (g/d)							
Cereals	381.82±95.80	380.24±170.88	371.68±178.28	0.944	390.75±152.88	365.62±171.98	0.526
Vegetables	210.15±70.60	205.84±66.15	239.18±85.56	0.019*	214.54±74.91	211.41±68.71	0.366
Legumes	7.38±4.74	7.09±4.14	7.26±4.55	0.923	7.46±4.66	6.86±3.87	0.153
Fruits	92.31±36.66	94.57±41.60	108.81±39.99	0.082	95.00±39.31	99.22±42.48	0.701
Meat/poultry	46.99±17.97	41.38±18.15	43.09±29.62	0.082	43.90±18.05	41.17±23.59	0.418
Fish	14.48±8.09	13.26±7.89	15.53±11.56	0.27	13.62±7.45	14.21±10.04	0.113
Eggs	17.79±8.34	18.89±9.20	24.63±21.35	0.012*	18.53±9.16	21.28±15.46	0.627
Dairy products	202.33±91.67	240.41±112.51	245.11±120.83	0.136	216.11±101.34	256.51±119.02	0.019*
Oils/fats	21.34±9.26	17.78±10.22	19.58±11.73	0.138	19.88±10.58	17.40±10.15	0.636
Macronutrients and energy intakes							
Calories (kcal/d)	1540.68±443.89	1419.33±485.86	1467.79±508.62	0.367	1422.32±428.98	1476.47±539.06	0.071
Carbohydrates (%TEI)	50.18±7.15	52.67±6.52	51.81±5.24	0.096	51.20±7.29	53.11±5.19	0.002*
Proteins (%TEI)	14.65±2.87	13.86±2.52	14.51±2.39	0.115	14.18±2.89	14.03±2.15	0.02*
Lipids (%TEI)	35.16±6.20	33.46±5.63	33.71±4.87	0.246	34.60±6.14	32.86±4.78	0.006*
Micronutrients intake							
Fibres (g/d)	10.27±4.35	11.10±6.78	15.26±8.75	0.001*	10.82±5.88	12.85±8.13	0.007*
Cholesterol	125.36±90.42	100.44±80.00	122.85±73.19	0.097	115.11±80.51	101.77±81.14	0.65
Sodium	2643.47±1330.47	2268.79±1223.37	2660.48±1253.09	0.076	2401.74±1256.48	2408.22±1258.49	0.196
Magnesium	201.71±160.88	183.90±85.09	242.85±107.22	0.004*	190.97±110.05	206.32±103.03	0.126
Calcium	448.13±374.18	570.20±326.44	758.83±432.17	≤0.001	536.47±355.06	644.56±374.984	0.368
Potassium	1729.79±1338.88	1555.88±713.59	1899.94±744.26	0.044*	1652.54±950.76	1648.87±739.42	0.688
Zinc	4.58±1.85	4.87±2.60	6.52±3.15	≤0.001	5.03±2.58	5.27±2.83	0.741
Iron	5.49±1.81	5.89±2.63	7.19±2.44	0.002*	5.80±2.33	6.38±2.73	0.082
Phosphorus	1079.18±483.45	895.32±427.42	1087.66±440.83	0.007*	969.02±443.45	954.46±451.94	0.985
Vit E	2.06±1.86	2.12±1.62	2.51±2.20	0.389	2.11±1.90	2.28±1.65	0.888
Vit B1	0.53±0.20	0.50±0.20	0.63±0.24	0.003*	0.52±.21	0.54±.22	0.954
Vit C	28.76±17.04	25.75±18.51	29.36±18.18	0.395	26.45±17.02	27.47±19.51	0.309
Folates	178.24±73.78	171.82±89.13	202.68±97.73	0.115	178.32±85.38	179.50±93.47	0.589

Abreviations: Data are presented as mean ± standard deviation (SD) or number (%). TEI: Total Energy Intake; DDS: dietary diversity score; DVS: dietary variety score. Differences between sociodemographic and anthropometric characteristics according to the DDS/DVS were compared by t-test and ANOVA for continuous variables. The mean difference is significant at the 0.05 level.

Table 4. Pearson correlation coefficients between NAR of some nutrients, MAR, DDS and DVS

	Mean ±SD	DDS r(p)	DVS r(p)
MAR	0.66±0.11	0.294** (≤0.001)	0.217** (≤0.001)
NAR Sodium	1.78±0.87	0.06 (0.354)	0.004 (0.945)
NAR Magnesium	1.16±0.71	0.298** (≤0.001)	0.302** (≤0.001)
NAR Calcium	0.56±0.41	0.322**(≤0.001)	0.330** (≤0.001)
NAR Potassium	0.40±0.18	0.126 (0.052)	0.045 (0.484)
NAR Zinc	0.88±0.55	0.329** (≤0.001)	0.326** (≤0.001)
NAR Iron	0.69±0.29	0.207** (0.001)	0.095 (0.143)
NAR Phosphorus	1.20±0.65	0.263** (≤0.001)	0.274** (≤0.001)
NAR VitE	0.24±0.20	0.188** (0.004)	0.140* (0.030)
NAR VitB1	0.71±0.28	0.319** (≤0.001)	0.255** (≤0.001)
NAR Vit C	0.82±0.60	0.135* (0.037)	0.127* (0.050)
NAR Folates	0.04±0.02	0.291** (≤0.001)	0.244** (≤0.001)

Abbreviations: mean ± SD: mean ± standard deviation; r: correlation coefficient; NAR: nutritional adequacy ratio; MAR: average adequacy ratio; DDS: dietary diversity score; DVS: dietary variety score. ** Significance level: <0.01; * significance level: <0.05.

DISCUSSION

The objective of this study was to assess the dietary quality of Moroccan children and adolescents with T1D. The results showed significant associations between sociodemographic, anthropometric and dietary intake characteristics with DDS/DVS. The mean DDS was 4.62±1.20 with a MAR of 66%; the majority of patients (64.6%) had a moderate DDS, whereas, only 19.6% of respondents had a high DDS. Similar results were found in other studies which reported that the majority of adolescents had an average DDS of 5 [31]. However, the South African study found a mean DDS of 3.58 with a mean MAR of 50% [32].

Several socioeconomic and demographic factors are significantly associated with DDS/DVS. One of these factors is the area of residence of T1D children. In this study, children from rural areas have poorer DD than those from urban areas. This result is consistent with other studies that have shown that people in urban areas consume more diverse foods than rural areas [33]. This could be explained by socioeconomic factors of households in these areas [34]. In addition, older children have a low DDS which is consistent with previous studies [13]. However, other studies have shown that older children have a better appetite for consuming more varied and diverse food groups [35]. Contrary to research findings that have shown a difference in DDS between the sexes due to gender inequality [36], in this study, no significant association was found between DDS and gender. Education level and income are also implicated. We also found that the higher parents' education and income level, more attention they paid to their child's nutrition. Several studies have found that lower levels of education are associated with less diverse and poor quality diets [37]. In addition, in this study, about the majority (86.3%) of the respondents have low monthly income and the middle and high family income groups have high DD. Similar studies have shown that DDS/DVS is related to socioeconomic status [38].

In our study, the majority of T1DM children had normal nutritional status (68.8%); about 13% are underweight and 18% were either overweight or obese. Moreover, as in previous studies, an association is found between DDS and CO and GO and a relationship between DVS and CO [15]. Although other research, they found no relationship between DD and obesity [39]. This may be because in children of high socioeconomic status or living in urban areas, obese children tend to have low DD [39]. In addition, studies have shown that high DD and variety is associated with a reduced risk of nutritional insufficiency [32]. The different results in the literature on DV and DD can be attributed, in part, to the use of different food groups and scoring methods [40].

In addition to analyzing sociodemographic and anthropometric factors, this study also explored associations between daily dietary intake and DDS/DVS in T1D children. Indeed, high DDS is associated with high intake of vegetables, eggs and micronutrients (fiber, Magnesium, Calcium, Potassium, Zinc, Phosphorus and Vit B1), and high DVS with high consumption of dairy products, carbohydrates, and low intake of protein and fat. Similar studies have reported that people with diabetes consumed onion, tomato and bell pepper vegetables [41]. Similarly, the low protein consumption among patients was attributed to the high cost of these foods due to low

socioeconomic status [42]. However, other research has shown that individuals with high DDS had increased protein intake [43]. In addition, diets that cost less were commonly consumed than those that cost more [40].

On the other hand, micronutrient deficiencies remain a public health problem, especially in developing countries [3]. This study revealed that the mean MAR of the study population was 0.66 ± 0.11 and the nutrients with the lowest NARs were Calcium, Potassium, Vitamin E and folate. This is consistent with other studies that have shown low intake adequacy for Calcium, Vitamin A and folate [44]. In addition, there are significant and positive correlations between the DDS/DVS and most NARs for various nutrients, meaning that the more food groups one consumes, the less likely he or she is to be exposed to micronutrient deficiency. Similar results have been reported in other studies confirming the validity of using the DDS as a measure of micronutrient adequacy in children [28].

Strengths and limitations of the study

To our knowledge, this is the first study in Morocco to assess DD and DV and their relationship with micronutrient adequacy in Moroccan T1D children and adolescents. Among the strengths of this study are the use of two 24-hour recalls to assess dietary intake, which is one of the best methods for collecting dietary data, and the use of the FFQ to more accurately determine the amount of food portions ingested. However, this study has some limitations that need to be considered. First, it should be mentioned that the estimation of food intake is frequently poorly reported, and especially underreported, by children and adolescents with T1D; second, the number of subjects who participated in the study should be larger. This limitation is, however, offset by the accurate clinical measures that were collected. Finally, the study population may not be representative of the Moroccan population of T1D children. It would be wise to extend this study to a larger representative sample in order to generalize the results obtained.

CONCLUSION

In conclusion, the results of the study revealed that the quality of the respondents' diet is moderately diversified. Moreover, the DDS or DVS are associated with sociodemographic factors, obesity and micronutrient adequacy in Moroccan T1D children. These indices are valuable tools for global dietary assessment and could be effective tools for nutrition education.

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Abbreviations:

T1D: Type 1 diabetes; **IDF:** International Diabetes Federation; **CVD:** cardiovascular diseases; **WHO:** World Health Organization; **WHtR:** Waist-to-Height ratio; **BMI:** Body Mass Index; **SD:** standard deviations; **TEI:** Total Energy Intake; **NAR:** nutritional adequacy ratio; **MAR:** mean adequacy ratio.

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Conflicts of interest

The authors declare that they have no competing interests.

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ORIGINAL ARTICLE

FOOD QUALITY AND NUTRITIONAL STATUS OF SCHOOL-GOING ADOLESCENTS IN THE PROVINCE OF EL JADIDA IN MOROCCO

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ABSTRACT

Background. Dietary diversity and variety scores represent tools for measuring the overall quality of diets. In children, they are good indicators of their nutritional status and growth.

Objective. The aim of this study was to assess the consumption and eating habits as well as the lifestyle of Moroccan adolescents attending school in the city of El Jadida.

Material and methods. A sample of 463 children of both sexes, aged 9 to 17, attending four schools in the city of El Jadida was studied. Eating habits and information on socioeconomic level are assessed using questionnaires and weight and height were measured on participants.

Results. According to the dietary diversity score (DDS) classes, 2.4% of the children surveyed were with low DDS, 55.7% moderate and 41.9%, with high DDS. The mean DDS was 5.67 ± 1.03 in underweight children and 5.53 ± 1.5 in those with overweight (obesity included) and the food variety scores (DVS) were of 12.94±3.24 food items and 10.81±3.25 in the 2 groups respectively. In addition, data analyzes show that children from parents with a low level of education had higher averages of DDS and DVS (DDS: 5.54 ± 0.84; SVA: 10.65 ± 2.32) compared to those of parents with medium education level (DDS: 5.31±0.96; DVS: 9.72±2.62) or high level (DDS: 5.17±0.93; DVS: 9.36 ±2.42). In addition, children from parents of high economic level had a lower averages of DDS and DVS (DDS: 5.24 ± 0.88; DVS: 8.84 ± 2.10) compared to those of parents of low economic level (DDS: 5.36±1.00; DVS: 10.14±2.85). The sugary products were consumed by 56.3% of underweiht children, 75% of normal-weight children and 67% of overweight children (including obese).

The estimated total energy intake (TEI) was higher than the Recommended Daily Allowances (RDA) in underweight 2933 Kcal/d and in overweight (including obese) children 3061.75 Kcal/d, while the mean daily intakes of folate, calcium, iron, potassium and zinc were lower than the (RDA). The food groups consumed by the majority of children were cereals (98.5%), fruits and vegetables (87.7%), and sweet products (69.8%) while oilseed products and fat were less consumed (9.7% and 7.8% respectively).

Conclusion. The study data show that the adolescents diet were moderately diverse, little varied and poor in certain nutrients essential for their nutritional status and growth. The study draws attention to the need for parents to be aware of the benefits of improving the diet quality and weight status of adolescents.

Keywords: *Dietary Diversity Score, Dietary Variety Score, eating behavior, eating habits, malnutrition, teenagers*

INTRODUCTION

Despite the efforts of governments, people in developing countries still face malnutrition in all its forms. The situation has worsened with the increase in food insecurity and the economic crisis caused by the advent of the COVID-19 pandemic showing an increase in the problems of both undernutrition and overnutrition or double burden of malnutrition in more people of all ages [1]. In children and adolescents, malnutrition is less likely to be linked to insufficient nutrition but rather to unhealthy diets. Indeed, overnutrition has been considered a problem of industrialized countries. But this scourge is increasing more and more with the nutritional transition or the rapid evolution of diets and lifestyles. These have been linked to industrialization, urbanization, economic development and market globalization over the past decade [2].

In the developing world, one in four children under five (27%) or a total of some 146 million children are underweight [3]. The World Health

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Organization (WHO) has estimated the contribution of undernutrition to one third of total child mortality [4]. It can also cause developmental delays in young people during childhood and adolescence and lead to poor academic performance and school dropout. The WHO has also estimated the number of overweight children at 42 million in 2010, of which nearly 35 million (83%) are in developing countries [5]. In Morocco, it is reported that one in ten Moroccan children and adolescents are affected by the scourge of obesity, which corresponds to 10.3% of boys and 9.9% of girls aged 5 to 19 [6]. Due to profound changes such as those in lifestyle and unhealthy eating habits, this problem is a major determinant of major chronic diseases, such as cardiovascular disease (CVD), certain cancers, type 2 diabetes and their risk factors [7, 8, 9, 10]. A diet capable of contributing to the prevention of malnutrition must comply with nutritional recommendations and meet criteria of diversity and balance in terms of food quantity and quality.

The objective of this study was therefore to characterize the quality of the diet and the nutritional status of school-going adolescents by evaluating the scores of food diversity and variety.

METERIAL AND METHODS

Study location

The survey was carried out on children attending school in two private secondary schools in the urban area of El Jadida, province of the greater region of Casa-Settat in Morocco, over a period from September 2016 until the end June 2018, during the 2016/2017 and 2017/2018 school years.

Sample and data collection

The study included a sample of 463 adolescents (e), from 9 to 17 years old, with an average age of 14.16 years ± 1.93, of both sexes (58.1% boys and 41.9% girls). Using a structured questionnaire, information on the sociodemographic and socioeconomic characteristics of the participants was collected and the anthropometric parameters measured.

Dietary data was collected using the 24-hour dietary recall to list all foods ingested and determine participants' macronutrient and micronutrient intake using BILNUT software. In addition, a food consumption frequency questionnaire was used to estimate the number of food groups consumed by each adolescent and to calculate the dietary diversity score (DDS) and assess the dietary habits of the sample.

Calculation of the Dietary Diversity Score (DDS)

For the calculation of this score, the diet must be accurately described during a reference period [11], the food groups to be included are defined in such a way as to reflect the eating habits and practices of the population studied [11]. In the present study, the foods consumed belong to the following 8 food groups (vegetables and fruits, cereals, milk/dairy products, meat/fish/eggs, sugar/sweet products, fat, sugary drinks, oilseed products). A simple count of the food groups an adolescent has eaten can be used to calculate the DDS in a period prior to the survey. This number of food groups consumed reflects the degree of diversity of the food intake. DDS was classified into three categories indicating low dietary diversity if DDS is <3; medium if it is [3-5] and high if DDS is >5.

Calculating the Food Variety Score (DVS)

The DVS estimates the number of biologically distinct foods consumed at a threshold of at least 0.1 g by a household or person over a given period ranging from 24, 48 hours or 3 days [12]. In the present study, it is the number of different foods identified from a list of 242 items consumed by the adolescent and belonging to different food groups (cereals, fruits, dairy products, etc.) and within each group: wheat, rice, rye, … for the group of cereals for example [13].

Anthropometric data

The height (Ht) of the children, determined by the length of the skeleton in meters, was measured using a fathom, with the legs straight, the heels together, the arms dangling and the shoulders relaxed [14].

The weight is measured to the nearest 100 g, in the naked child or with light underwear, preferably in the morning and after evacuation of the bladder [14].

Waist circumference (WC), linked to the risk of cardiovascular disease and other forms of chronic disease [15], is measured with a tape measure halfway between the lower costal edge and the iliac spine, antero-superior on the mid-axillary line, at the end of a normal exhalation and without exerting pressure on the skin [16]. The waist circumference (WC) to height or height (WC/Ht or WHTR) ratio is also calculated and the threshold of 0.5 is used to define presence, if WHTR ≥ 0.5 or absence if WHTR < 0.5 of abdominal fat or abdominal obesity in boys and girls [17].

Body mass index or BMI is increasingly used to determine excess weight in children 2 to 17 years old [18, 19]. BMI is calculated by dividing weight (kg) by height (m) squared (Weight (kg) / Height (m^2)). The distribution of BMI values is used to determine BMI Z-scores to obtain a numerical indication of the standard deviation (SD) from the median for sex and age. According to the value of the Z-score obtained, the adolescent's weight status would indicate underweight if "Z Score ≤ -2DS", normal weight if "-2DS <Z Score<+1DS", overweight if "Z Score ≥+1DS" and obesity if "Z Score≥+2DS" [20].

Sociodemographic and socioeconomic characteristics

The collected informations are age, sex, school level, the parents education level (determined by the highest level of one of the parents), the size of the household, the type of habitat and the parents' socioeconomic status (SES) divided into four levels according to monthly income: SES1≤2500MAD, 2500MAD<SES2≤7000MAD, 7000MAD<SES3≤15000MAD and SES4>15000MAD.

Statistics analysis

Data analysis was performed using SPSS (Statistical Package for the Social Sciences) software for Windows version 23.0. Quantitative variables were described by means and standard deviations and qualitative variables by frequencies and percentages. For weight status, the children were classified into 4 categories based on the reference standards established by the WHO according to sex and age and using a macro from the WHO Anthro software for SPSS. The analysis of variance (ANOVA) was used for the comparison of several means. The Student t-test was used for independent samples and the chi-square test to compare categorical variables. Correlation analyzes were performed. All probability values below 0.05 are considered statistically significant.

Ethical considerations

The study on the pupils is carried out after obtaining an authorization from the Regional Academy of Education, the selected schools and after obtaining the oral consent of the parents. All participants were informed about the objectives and the course of the survey as well as their willingness to withdraw from the study at any time if they so wish.

RESULTS

In the Table 1 the average dietary intakes of macronutrients and micronutrients are presented in comparison to the recommended daily intakes in the study population using the Student's t test. The Table shows that the surveyed adolescents had a significantly higher consumption of total lipids (t test =10.755, p-value <0.0001***), DEI (t test (Girls) =3.274, p-value <0.001** ; t test (Boys) =3.429, p-value <0.001**), Phosphorus (t test = 10.461, p-value <0.0001** *), sodium (t test = 7.691, p-value <0.0001***), SFA in % energy (t test = 34.308, p-value <0.0001***), AGM in % energy (t test = 29.717, p-value <0.0001***), AGP in % energy (t test = 7.338, p-value <0.0001* **) than the recommendations.

Conversely, there were lower intakes of vitamin B1 (t test = -10.857, p-value <0.0001***), vitamin C (t test = -14.350, p-value <0 .0001***), vitamin E (t test = -27.040, p-value <0.0001***), calcium (t test = -9.118, p-value <0.0001***), in folates (t test = -7.919, p-value <0.0001***), in magnesium (t test (Girls) = -9.450, p-value <0.0001***; t test (Boys) = -12.151, p-value <0.0001***), iron (t test =-22.869, p-value <0.0001***), zinc (t test (Girls) = -12.159, p- value <0.0001***, t-test (Boys) = -14.374, p-value <0.0001***), potassium (t-test = -30.013, p-value <0.0001***) and fiber (T test (Girls) = -10.939, p-value <0.0001***; t test (Boys) = -26.556, p-value <0.0001***) than the recommendations.

Table 2 presents averages of DDS and DVS according to the socio-demographic and anthropometric characteristics of the study population. The adolescents studied had on average 16.16 ± 1.93 years old, 1.57 ± 0.12 m for height, 50.35 ± 13.43 kg for weight and a corpulence estimated by their BMI 20.03±3.83 kg/m^2 on average. The table results also show that the participants had amean DDS of 5.28±0.93 and DVS of 9.71±2.51. These DDS and DVS scores average were higher (DDS: 5.44±0.96); (DVS: 10.35±2.66)] in the primary school pupils than those in middle school (DDS: 5.31±0 ,89); (DVS: 9.80±2.50) and high school (DDS: 5.20±0.94); (DVS: 9.40±2.41). The study data also show that children from parents with a low education level had an average of DDS (5.54 ± 0.84) and DVS; (10.65±2.32) higher than those with a medium education level (DDS: 5.31±0.96); (DVS: 9.72±2.62) or high education level (DDS: 5.17±0.93); (DVS: 9.36±2.42). In addition, children from parents with a high SES had lower mean DDS (5.24±0.88) and DVS (8.84±2.10) compared to those from low SES parents (DDS: 5.36±1.00); (DVS: 10.14±2.85).

The Table 2 also shows that according to their anthropometrical parameters, adolescents with abdominal fat had a lower average DDS (5.06±1.00) and DVS (9.66±2.52). The same observation is true for overweight children (including obesity) who had a low mean DDS (5.12±1.19) and DVS (8.94±2.66) in comparison with their underweight counterpart (DDS: 5.37±0.93); (DVS: 9.36±2.20). The analysis also highlighted that the differences of the food variety and diversity scores found according to the demographic and anthropometric characteristics, were not significant, except for the BMI categories (p-value = 0.021*) and parent education level (p-value = 0.001**).

The results in Table 3 present the socio-demographic characteristics of the adolescents surveyed according to BMI categories. The use of the chi2 test confirms significant differences between BMI categories according to gender (p-value = 0.004**), age group (p-value = 0.004**), school level (p- value = 0.003**) and to parents' level of education (p-value = 0.009**). The data in this table also shows that overweight children (including obesity) represented 21.60% of the sample of which 33% were boys and 67% girls, while underweight was prevalent in 18.79% of whom 56.3% were boys and 43.7 girls. According to these results, overweight children (including obesity) had

Table 1. Mean energy and nutrients daily intakes compared to the recommended daily allowances (RDA) of the study adolescents

Energy and nutrient	RDA	Means ± SD	p-value	*Student's* t test
Energy (Kcal)				
Girls	2100	2494.46±925.38	<0.001**	3.274
Boys	2240	2640.56±991.07	<0.001**	3.429
Total fat	30-35	68.49±40.96	<0.0001***	10.755
Cholesterol	<300 mg/day	214.02±151.62	<0.0001***	-6.490
SFA (% energy)	8-12	46.06±11.36	<0.0001***	34.308
MUFA (% energy)	>12	40.25±10.88	<0.0001***	29.717
PUFA (%energy)	>8	13.28±8.23	<0.0001***	7.338
Vitamin B1 (mg)	1.2	0.48±0.76	<0.0001***	-10.857
Vitamin C (mg)	110	51.88±46.36	<0.0001***	-14.350
Vitamin E (mg)	12	2.57±3.99	<0.0001***	-27.040
Calcium (mg)	1200	796.89±505.98	<0.0001***	-9.118
Iron (mg)	20.7	9.96±5.37	<0.0001***	-22.869
Magnesium (mg)				
Girls	370	261.17±88.46	<0.0001***	-9.450
Boys	410	247.89±113.21	<0.0001***	-12.151
Phosphorous (mg)	800	1224.50±464.47	<0.0001***	10.461
Zinc (mg)				
Girls	9	4.90±2.59	<0.0001***	-12.159
Boys	11	5.38±3.32	<0.0001***	-14.374
Folates (µg)	200	149.97±72.31	<0.0001***	-7.919
Fiber (g)				
Girls	30	16.24±9.66	<0.0001***	-10.939
Boys	40	13.57±8.45	<0.0001***	-26.556
Potassium (mg)	2500-5000	2348.55±1011.13	<0.0001***	-30.013
Sodium (mg)	500-1600	3161.36±2323.43	<0.0001***	7.691

Legends: the values represent means ± SD (standard deviation); *significant. NS: Not significant ; t: value of the *Student's* t Test; RDA: recommended daily allowances

Table 2. Mean scores for dietary diversity and variety according to the socio-demographic and anthropometric characteristics of the adolescents surveyed

		DDS Mean ± SD	p-value	DVS Mean ± SD	p-value
	Total	5.28±0.93		9.71±2.51	
Sex	Males	5.35±0.93	NS	9.97±2.37	NS
	Females	5.23±0.93		9.53±2.60	
Age category	[9-11]	5.42±0.89	NS	10.02±2.46	NS
	[12-14]	5.40±0.97		10.07±2.66	
	[15-17]	5.19±0.91		9.47±2.42	
School level	Primary	5.44±0.96	NS	10.35±2.66	NS
	Medium school	5.31±0.89		9.80±2.50	
	High school	5.20±0.94		9.40±2.41	

Habitat type	Owner	5.28±0.92	NS	9.68±2.46	NS
	Renter	5.29±0.95		9.76±2.59	
Household size	[3-4]	5.26±0.90	NS	9.68±2.50	NS
	[5-6]	5.31±0.95		9.76±2.55	
	[7-8]	5.23±0.99		9.65±2.43	
Parents education level	Low	5.54±0.84	0.006**	10.65±2.32	0.001**
	Medium	5.31±0.96		9.72±2.62	
	High	5.17±0.93		9.36±2.42	
SES	SES1	5.36±1.00	NS	10.14±2.85	NS
	SES2	5.25±0.97		9.59±2.23	
	SES3	5.24±0.84		9.99±2.35	
	SES4	5.22±0.88		8.84±2.10	
BMI categories	Underweight	5.37±0.93	NS	9.36±2.20	0.021
	Normal weight	5.31±0.82		10.11±2.47	
	Overweight & obesity	5.12±1.19		8.94±2.66	
WHTR : abdominal fat	> 0.5 with	5.06±1.00	NS	9.66±2.52	NS
	> 0.5 without	5.31±0.92		9.72±2.51	

DDS: dietary diversity score; DVS: food variety score; SES: Socioeconomic Status; BMI: Body Mass Index; WHTR: waist-to-height ratio (WC/HT); * significant. NS: Not significant; The statistical test used is the one-factor Anova test.

Table 3. Socio-demographic characteristics of the adolescents surveyed according to BMI categories

		BMI categories N(%)			p-value
		Normal weight 276(59.61)	Overweight & Obesity 100(21.60)	Underweight 87(18.79)	
Sex	Males	112(40.58)	33(33.0)	49(56.3)	P=0.004**
	Females	164(59.42)	67(67.0)	38(43.7)	
Age category	[9-11]	27(9.78)	8(8.0)	18(20.7)	P=0.004**
	[12-14]	75(27.17)	31(31.0)	32(36.8)	
	[15-17]	174(63.04)	61(61.0)	37(42.5)	
School level	Primary	55(19.93)	16(16.0)	29(33.3)	P=0.003**
	Medium school	67(24.28)	29(29.0)	29(33.3)	
	High school	154(55.80)	55(55.0)	29(33.3)	
Habitate type	Owner	152(55.07)	68(68.0)	52(59.8)	NS
	Renter	124(44.93)	32(32.0)	35(40.2)	
Household size	[3-4]	125(45.29)	45(45.0)	33(37.9)	NS
	[5-6]	125(45.29)	46(46.0)	41(47.1)	
	[7-8]	26(9.42)	9(9.0)	13(14.9)	
Parents education level	Low	48(17.39)	10(10.0)	26(29.9)	P=0.009**
	Medium	89(32.25)	38(38.0)	28(32.2)	
	High	139(50.36)	52(52.0)	33(37.9)	
Parents SES	SES1	98(35.51)	31(31.0)	34(39.1)	NS
	SES2	51(18.48)	17(17.0)	17(19.5)	
	SES3	72(26.09)	24(24.0)	16(18.4)	
	SES4	55(19.93)	28(28.0)	20(23.0)	

SES: Socioeconomic status of parents; BMI: Body Mass Index;
* significant. NS: Not significant; Statistical test used is the Chi2 test.

parents with a high level of education (52%) and a high economic level (28%). Similarly, thin children had parents with a high level of education (37.9%) but a low economic level (39.1%).

Table 4 presents dietary diversity according to weight status among adolescents participating in the study. The table shows that overweight including obesity was prevalent in 63.64% of children with low DDS, 20.93% among students with moderate DDS and in 20.10% of children with high DDS while the Underweight was present in 9.09% of children with low DDS, 18.99% among those with moderate DDS and in 19.07% of students with high DDS. The results in the table show also that while high DDS was found in only 19.07% of uner and 20.1% of overweight, the low DDS was found among the majority of overweight (60.82%).

The analyzes also revealed a non-significant negative correlation between the DDS and the BMI and WHTR while a significant negative correlation was found between the DVS and BMI. As shown in Tables 5 and 6, the diversity score categories and BMI classes are characterized by different dietary intakes of energy, macronutrients and micronutrients.

On the other hand, Person correlation analysis showed that energy intake is positively and significantly associated with BMI (r = 0.212*) while a significant but negative association (r = -0.019*) was found between the latter and vitamin C.

Table 6 indeed shows that using the calculated DDS, dietary diversity was low in 2.4%, moderate in 55.7% and high in 41.9% of the children surveyed.

The table 6 shows also that overall adolescents with low DDS had lower energy intake (349.00±142.84) than those with medium DDS (2532.32 ±1039.70) or high DDS (2744.72± 938.82). Similarly, lower intakes of carbohydrates, proteins and lipids were found in adolescents with a low DDS than those with a high

Table 4. Prevalence of DDS classes according to BMI and WHTR categories

		DDS categories N(%)			p-value
		Low 11(2.4)	Moderate 258 (55.7)	High 194 (41.9)	
BMI categories	N(%)				
- Underweight	87 (18.8)	1(9.09)	49(18.99)	37(19.07)	0.019*
- Normal weight	276 (59.61)	3(27.27)	155(60.08)	118(60.82)	
- Overweight &Obesity	100 (21.6)	7(63.64)	54(20.93)	39(20.10)	
WHTR categories					
WHTR ≥0.5	50(10.8)	3(27.3)	28(10.9)	19(9.8)	NS
WHTR <0.5	413 (89.2)	8(72.7)	230(89.1)	175(90.2)	

WHTR: Waist-to-Height ratio; BMI: Body Mass Index;
* significant. NS: Not significant; Statistical test used is the Chi2 test.

Table 5. Daily energy and nutritional intake of adolescents according to their weight status

Énergy & nutrient		BMI Categories			p-value	Person correlation
		Normal weight 81(61.8%)	Overweight & Obesity 32(24.4%)	Underweight 18(13.7%)		
Energy (Kcal)	Girls	2459.20±1120.26	2974.52±660.56	2906.40±286.25	<0.0001***	r = 0.212*
	Boys	2096.77±842.92	3228.27±791.34	2944.23±655.67		
Carbohydrates		153.42±104.41	219.73±74.05	202.32±73.87	0.002**	r = 0.04
Protein (mg)		81.81±26.13	84.80±31.36	86.13±34.50	NS	r = 0.01
Lipids totaux		62.23±36.28	72.41±48.33	89.69±41.06	0.029*	r = -0.09
Vitamin B1 (mg)		0.41±0.70	0.47±0.51	0.83±1.20	NS	r = -0.04
Vitamin C (mg)		52.52±42.11	34.47±24.41	79.94±74.82	0.003**	r = -0.19*
Vitamin E (mg)		1.95±2.13	3.84±6.62	3.11±3.89	NS	r = -0.06
Calcium (mg)		819.48±530.62	743.91±474.65	789.44±462.82	NS	r = 0.03
Iron (mg)		9.30±4.19	10.44±7.18	12.11±6.08	NS	r = -0.03
Magnesium (mg)	Girls	238.35±85.42	273.86±154.32	226.60±145.50	NS	r = -0.07
	Boys	263.66±74.53	225.27±75.16	284.85±124.78	NS	
Phosphore (mg)		1202.11±418.04	1288.25±566.28	1211.94±481.98	NS	r = 0.05

Zinc (mg)	Girls	5.00±2.66	6.29±4.21	5.00±4.64	NS	r = 0.01
	Boys	5.43±2.58	4.27±2.53	4.00±2.48	NS	
Folates (µg)		147.89±65.45	147.91±89.17	163.00±71.57	NS	r = 0.01
Fiber (g)	Girls	13.89±8.57	12.95±7.82	13.20±11.43	NS	r = -0.09
	Boys	17.83±10.97	11.09±5.47	16.31±7.34	NS	
Cholesterol		222.07±155.33	191.41±131.76	217.98±171.21	NS	r = -0.06
Potassium (mg)		2352.01±963.91	2365.00±1036.36	2303.72±1218.43	NS	r = -0.08
Sodium (mg)		3124.68±2598.68	3173.47±1845.19	3304.89±1806.89	NS	r = 0.00

Values are dietary intakes averages+ standard deviation; BMI: Body mass index ; r: correlation coeficient ; ** significant at 0.01; *significant at 0.05 ; NS: Not significant

Table 6: Daily energy and nutritional intake of adolescents according to their dietary diversity

Énergy & nutrient		DDS Categories			p-value	Person correlation
		Low DDS 2(1.5%)	Medium DDS 68(51.9%)	High DDS 61(46.6%)		
Énergy (Kcal)	Girls	-	2788.37±796.70	2246.47±964.93	NS	r= -0.11
	Boys	349.00±142.84	2532.32±1039.70	2744.72±938.82		
Carbohydrates		166.20±55.72	161.97±89.13	192.69±106.76	NS	r= 0.16
Protein (mg)		78.40±27.01	76.84±29.00	90.31±26.70	0.026*	r= 0.27**
Lipids totaux		49.15±25.81	56.50±36.13	82.49±42.34	0.001*	r= 0.36**
Vitamin B1 (mg)		1.00±0.00	0.44±0.76	0.51±0.77	NS	r= 0.02
Vitamin C (mg)		27.50±7.78	46.93±39.56	58.20±53.10	NS	r= -0.01
Vitamin E (mg)		2.00±3.20	1.79±2.15	3.46±5.27	NS	r= 0.19*
Calcium (mg)		772.50±422.14	679.25±529.24	928.84±453.39	0.01*	r= 0.28**
Iron (mg)		6.00±1.41	9.43±5.46	10.69±5.27	NS	r= 0.16
Magnesium (mg)	Girls	-	239.33±79.73	279.59±92.43	0.004**	r= 0.40**
	Boys	209.00±11.31	218.41±88.49	292.24±133.75		
Phosphore (mg)		1197.50±292.04	1100.96±464.84	1363.11±433.42	0.005**	r= 0.38**
Zinc (mg)	Girls	-	5.07±2.59	4.75±2.63	NS	r= 0.05
	Boys	2.50±2.12	5.78±3.65	5.00±2.79		
Folates (µg)		148.00±12.73	141.63±74.39	159.33±70.57	NS	r= 0.16
Fiber (g)	Girls	-	15.30±10.09	17.03±9.38	NS	r= 0.19*
	Boys	7.00±4.24	12.68±8.79	15.28±7.91		
Cholesterol		111.00±115.97	207.29±149.94	224.90±154.77	NS	r= 0.13
Potassium (mg)		2097.00±347.90	2176.03±1026.67	2549.11±979.47	NS	r= 0.23**
Sodium (mg)		3217.50±1820.80	3027.25±2501.92	3309.02±2146.76	NS	r= 0.08

Values are dietary intakes averages ± standard deviation; DDS: dietary diversity score; r: correlation coeficient; *significant; NS:Not significant

DDS (166.20±55.72 vs 192.69±106.76; 90.31±26, 70 vs. 78.40±27.01 and 82.49±42.34 vs. 49.15±25.81 respectively). The use of the ANOVA test shows that these differences by DDS categories were significant for protein and lipid intakes.

The same comparison is found for intakes of certain micronutrients in particular vitamin C and vitamin E and also for certain minerals brought particularly calcium, iron, magnesium, phosphorus, zinc, folates and fibers which were also found lower in participants with low DDS compared to those with high DDS. These differences were found to be significant for calcium, magnesium and phosphorus intakes.

Furthermore, the Person correlation analysis revealed a significant and positive association between DDS and protein (r=0.27**), lipid (r=0.36**), calcium (r =0.28**), vitamin E (r=0.19*), magnesium (r=0.40**), phosphorus (r=0.38**), potassium (r=0 .23**) and dietary fiber (r= 0.19*). Similarly, positive correlations have been noted between the DVS and some nutrients including magnesium, iron, calcium, phosphorus, vitamin E, fiber and lipids.

DISCUSSION

In this study, the evaluation of eating habits and the quality of food was studied in relation to the nutritional status of adolescents attending school in the city of El Jadida. The quality of food consumption was estimated in terms of food diversity and variety.

The results of this study, show the existence of the double burden of malnutrition in this population, as indicated by their weight status manifested by the problem of overweight which affects 21.60% in addition to underweight prevailing in 18, 79% of children surveyed aged 9 to 17. The prevalences found in this study for the two problems of malnutrition are alarming for both underweight and excess weight compared to data from the literature [21, 22, 23]. The presence of overweight and underweight, within the same population, confirms the nutritional transition that Morocco is going through, which is associated with socioeconomic and sociodemographic changes as well as lifestyle changes including those of food. The socio-economic environment in which an individual evolves also influences weight gain. Indeed, *Goyal* et al (2010) found that overweight (obesity included) is higher in high socioeconomic backgrounds [24]. The same is true for poor countries because of several factors including globalization [22] and in other Western Countries, which have considered that the prevalence of obesity is higher in adults and children from a disadvantaged socio-economic background. [25, 26]. In fact, in developing and underdeveloped countries, overweight increases with the improvement of the families socio-economic level, although underweight still persists [27, 28, 29].In this study, the prevalences of the two malnutrition problems, both underweight and overweight with obesity, were more marked among children from families with a very low socio-economic level. These results are in agreement with those of *Renzaho* et al. (2006) who observed that underweight affects more disadvantaged backgrounds [30].

In underprivileged areas, the socio-economic level influences the diet of children by leading to the availability of few healthy foods, such as fresh fruits and vegetables, associated with a high consumption of inexpensive, energy-rich and healthy foods. poor in nutrients [31, 32, 33]. The coexistence of the two problems of malnutrition, underweight and overweight, can thus be the result of an insufficient diet or an unhealthy diet. In addition, the fact that the parents are unemployed or have a low-income job has repercussions on the quality of the children's diet, which is then poor and not very varied with a low consumption of meat, fruit and vegetables, which are expensive food items.

The low dietary variety and diversity scores found in the present study reveal low dietary quality in children of high economic status parents. Several studies have also reported that the level of parental education influences both the eating habits of children and their weight status [26]. Contrary to certain studies which have reported an inverse association of the weight of children with the level of education of their parents [33], the present population of children who are both overweight (including obesity) and those who are underweight have parents with a high level of education. These results, which are in agreement with other studies, bear witness to parents' poor perception of their children's weight problems and a lack of education in terms of nutrition [34].

Determination of food intake among the students surveyed showed that the average energy intake was generally higher than the recommendations [35]. This result is different from that of a study carried out in a country of the same region reporting in normal weight children aged 6 to 12 years, an average energy intake, lower than the recommended intakes [36].

In relation to weight status, both overweight (including obesity) and underweight children had a higher energy intake than normal-weight children. The same is true for protein, lipid and carbohydrate intake, although their quantitative distribution more or less complied with the recommendations for all children. Indeed, these intakes were also higher in children with the two abnormal weight statuses, underweight and overweight, compared to those with normal weight with an even higher intake of these macronutrients in thin children compared to those with overweight (including obesity) as is the case with lipid intake. High energy intake is the expression of energy-dense foods whose consumption is reported to be associated with obesity [37, 38, 39].

In the present study, the foods most consumed by the majority of children studied were bread and sugary products (results not shown) with daily consumption of sugary products (69.8%) and drinks (87%) among children with overweight (obesity included) while fruit and vegetable intake was lower than recommended.

The data reported here also provide information on food quality, judging by the diversity (DDS) and variety (DVS) scores calculated in the study population. The diet of the participants in the present study is considered moderately diverse. Thus, of the 242 foods or varieties divided into 8 food groups which are vegetables and fruits, cereals, milk/dairy products, meat/fish/eggs, sugar/sweet products, fat, sugary drinks, oilseed products, there is an abundance of varieties for the food groups ranging from [Items: 62] for the group [vegetables and fruits] to [Items: 8] for the [oilseed products] group. However, the variety

scores are distributed very unevenly within the diets of the adolescents studied.

A diversified diet allows adequate intake of macro and micronutrients that the body needs and it is a way to assess the quality of food that affects the nutritional status and health of individuals in general [40, 41, 42, 43].

In this study, the intake of energy and macronutrients was increased while a downward trend is observed for micronutrients with increasing body size in the children surveyed. In addition, a less diversified diet estimated by a low DDS was more prevalent in overweight children, while high dietary diversity (high DDS) was less prevalent in underweight and overweight children compared to children normal weight. This less diversified diet observed in both types of malnutrition was also revealed in children with abdominal obesity. In addition, the study also reports that nutrient intakes increase with increasing dietary diversity, as demonstrated by the positive correlations found for the majority of nutrients with increasing dietary diversity and variety scores.

Both the state of health and the nutritional balance in children depend on the socioeconomic status of their parents [26]. The data reported here concerning sociodemographic and economic characteristics reveal the coexistence of the double burden of malnutrition in the population studied, whatever the socioeconomic level. Moreover, the level of education of the parents does not seem to improve either the diversity and variety of the diet or the weight status of their children. These results reveal a need raising awareness on management and education in terms of nutrition and healthy weight among the parents of the adolescents surveyed.

CONCLUSION

The present data report the presence of the double burden of malnutrition with alarming prevalences of both underweight and overweight in the study school children.

The diet of this opulation age group, being characterized by a moderate diversity can be qualified as unhealthy.

The study also shows that increasing parental education was not associated with normal weight status or good dietary diversity. This reveals a poor perception among parents, of both the normal weight and the healthy diet of children. The study draws attention to the need for parents to be aware of the benefits of improving the quality of nutrition and the weight status of adolescents.

Declaration of interest

The authors declare that they have no conflict of interest regarding this article.

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ORIGINAL ARTICLE

FACTORS INFLUENCING ALCOHOL CONSUMPTION AMONG UNIVERSITY STUDENTS IN SOUTHERN THAILAND

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ABSTRACT

Background. Underage drinkers are the primary cause of death and illness worldwide. Initiation of drinking at younger ages and levels of drinking during young adulthood may also shape future public health by influencing alcohol consumption. From this situation, it is necessary to study various factors to provide sufficient information to reduce adolescent alcohol consumption.

Objective. This study aimed to examine the prevalence and factors that influenced alcohol consumption of first-year students in a university network in Southern Thailand.

Material and methods. A total participant 685 of 1,100 first-year students from 12 universities in southern Thailand were randomized and recruited using eligible criteria. The instrument was an online questionnaire based on the preceding model that consisted of 9 parts with 93 items. For descriptive analysis, percentages were used to describe the characteristics and alcohol consumption behaviours of participants. In addition, logistic regressions were used to determine the factors influencing.

Results. The results showed 62.3% of participants responded to the online questionnaire. During the past six months, 36% reported consuming alcohol. Males reported drinking more (45.3%) than females. The most popular drink was beer (57.7%). There were 8.16 standard drinks, (82.3%) consumed at night, (70.2%) drank at their place, and consumed with friends (83.6%). The results of multiple logistic regression showed significant factors influencing drinking alcohol. The lower attitude was 2.56 times more likely to consume alcohol than a high level (AOR: 2.56, 95%CI: 1.53-4.28). Reversely, the higher marketing perception was more likely to consume alcohol than a low level (AOR: 5.35, 95%CI: 1.94-14.58). In addition, students with mother drinker, lover drinker, and close friend drinker were more likely to consume alcohol (AOR: 2.35, 95%CI: 1.07-5.16), (AOR: 3.60, 95%CI: 1.99-6.50), and (AOR: 5.29, 95%CI: 3.31-8.45) respectively.

Conclusion. In conclusion, attitude, marketing factors, and social factors were associated with alcohol consumption among Thai university students that were revealed as positive predictors regarding binge drinking. The study shows how healthcare providers may reduce binge drinking by designing effective prevention programs.

Key words: *alcohol consumption, university student, multiple logistic regressions, marketing factors, social factors*

INTRODUCTION

World Health Organization (WHO) presented gender, age, health status, economic wealth in a country, lifestyle choices, religion, and cultural norms that impact alcohol use. More than half of the population in three regions have consumed alcohol – the European Region (EUR) (59.9% of current drinkers), the Region of the Americas (AMR) (54.1%), and the Western Pacific Region (WPR) (53.8%) [1]. For instance, the ratio is 2.9 in the African Region with 32.2% current drinkers, whereas the ratio is 1.8 in the European Region with 59.9% current drinkers [2]. Worldwide, alcohol consumers drink some 32.8 grams of pure alcohol per day (or 15.1 liters of pure alcohol annually). It is 20% higher (40.0 g/day) in the African Region and about 20% lower (26.3 g/day) in the Southeast Asia Region [1].

Unrecorded alcohol is often cheaper and maybe more produced and consumed in low-income countries. Worldwide in 2016, 57% of the population (15+ years) had not consumed alcohol in the previous 12 months; some 683 million people (12.5% of the world population) had ceased alcohol consumption. Until 2025, half of the WHO regions are expected to increase alcohol per capita consumption among 15+ years, which in the Region of the Americas (from 8.0 to 8.4 liters), the Western Pacific Region (from 7.3 liters to 8.1 liters), and the South-East Asia Region (from 4.5 to 6.2 liters). The highest increase is expected

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in the South-East Asia Region [1]. Total alcohol per capita consumption (APC) is defined as recorded and unrecorded alcohol consumption. As shown by the most recent WHO data, the entire APC in the world's population 15 years of age or older amounts to drinking on average 6.4 liters of pure alcohol per year, translating into 13.9 grams of pure alcohol per day.

Thailand has an average consumption of pure alcohol by people aged 15 years and over at 7.1 liters per person per year. Prevalence (in %) of heavy episodic drinking (HED) increases from age 15–19 years to the age of 20–24 years, 15–24-year-olds, when they are current drinkers, often drink in heavy drinking sessions [1]. According to the National Statistical Office's survey of smoking and alcohol behavior data from 2001 to 2014, it found that Thai people aged 15 years and over are current drinkers or the number of people who drank alcohol in the past 12 months was 16,992,017 people or 31.5 percent of the adult population. And although the overall alcohol consumption rate was slightly higher than the previous year. But when analyzed by age group, it found that the trend of alcohol consumption rates between 2011 and 2013 was higher among youths (15-24 years) [1].

The Centers for Disease Control and Prevention (CDC) reports that alcohol is the most used and misused substance among US adolescents and is responsible for an estimated 4,700 deaths per year among youth under age 21. Social norms, social support, and resources available through a social network constitute social-level influences on individual health behavior. Sexual and gender minority (SGM) youth are also found to be the factors of alcohol use [3]. 11.4% of all alcohol consumed consists of unrecorded alcohol, whereas, in low-income and lower-middle-income countries, around 40% of all alcohol consumed is unrecorded alcohol. Worldwide, the prevalence of women's drinking decreased in most regions, except the South-East Asia and Western Pacific regions. Women who drank alcohol in 2016 compared with 2000 despite a worldwide 5% decrease in the current drinking prevalence from 32.3% to 37.3%. Among men, most current drinking decreased by 4.3%, from 53.6% to 57.9%. The main factor affecting the use of alcohol and the effect of alcohol consumption is access to alcohol beverages, business marketing, and the price of alcohol drinks [1].

Sex, there are also essential differences in total APC among drinkers (male/female ratio between 2.7 and 2.8) and HED among drinkers (male/female ratio between 2.1 and 4.2). Females are less often current drinkers than males. More than 50 percent of the world's female population aged 15 years or older are lifetime abstainers (54.6% or 1.489 billion; for men, the figures are: 34.5% or 941 million) [1]. The finding of alcohol outlet density and advertising influence on youth drinking alcohol in Tanzania revealed a high prevalence of outdoor advertisements and the density of alcohol-selling outlets [4].

Alcohol causes more than 200 diseases and entails negative social consequences. The total number of deaths from all causes increased globally from 53.5 million in 2010 to 56.4 million in 2016 [1]. A recent attempt from the Thai government to reduce harm from alcohol is to decrease outlet densities in areas around universities [5].

From the situation above, many related factors have been tried to study as a guide to solving the problem but still found that there is still insufficient information to solve the problem. Therefore, to complete the knowledge on this topic, this study aims to examine the prevalence, patterns, and factors that influenced the alcohol consumption of first-year students in 12 universities in Southern Thailand. This knowledge will indicate the demonstrated patterns of alcohol consumption behavior and important factors affecting students' drinking to design activities and develop a more concrete policy to control alcohol consumption in educational institutions.

MATERIAL AND METHODS

Study design: This primary research is a cross-sectional analytical study. The research was conducted among 19,778 first-year students aged 18-22 years from 12 universities in Southern Thailand. Data were collected from April 2019 to September 2019 via the online questionnaires (URL; https://alcoholfree.sct.ac.th/index.php) with the convenience sampling method, and completion data were analyzed on 31 December 2019. Inclusion criteria for the study subjects included 'Youth' as the age group 18-22 years, studying in the first year, understanding and writing down online data, and communicating in Thai. For exclusion criteria, a person who was unwilling to complete the questionnaire, provide inaccurate data or have comorbidities that could bias the study results will be excluded.

Sample: The 1,100 participants were calculated according to the Krejcie & Morgan formula [6]. The proportion of traits of interest in the population was 0.5, a 3% sampling error was accepted at the 95% confidence level, and an error calculating 10% was added. The final 685 participants were conducted after adjusting eligible criteria. Convenient sampling was used to collect data. The distribution of online questionnaires relies mainly on online media through representatives of coordinators from all 12 universities who have been trained to understand the questionnaires well.

Research tools: In the online survey questionnaire, participants were asked all 93 items divided into nine:

Socio-demographic eleven items, alcohol consumption two items, the pattern of alcohol drinking behavior nine items. The effect after drinking was two items, knowledge twelve items, attitude towards alcohol use eighteen items, Marketing twenty-two items, self-efficacy for alcohol refusal ten items, and influence of relative drinker seven items. A detailed questionnaire has been attached as a supplementary file. The quality of the tools was checked, and the accuracy and reliability were analyzed with tried out with 30 participants. The *Cronbach's* alpha Coefficient showed high reliability, and the whole questionnaire was 0.89.

Data analysis: The data analyzed in this study was performed using STATA version 13 by analyzing descriptive statistics to analyze the process that presented the characterization of the data. Using frequency and percentages, mean and standard deviation (SD), and the coefficients of Multiple logistic regression to find out the factors influencing alcohol consumption of first-year students in the University Network for Happiness in Southern Thailand, presented the Adjusted OR value with a confidence interval of 95% CI.

Ethics: The researcher attached importance to safeguarding online questionnaire responses and informed online consent. The data obtained from the research will be presented academically and confidentially keeping. This is utilized only for analysis and does not affect lifestyle. If the participants are not comfortable providing information, they can withdraw from providing information at any time. This study was approved by the ethical committee, at Walailak University (WUEC-19-042-01).

RESULTS

Characteristics

The majority of respondents were female (74.9%), aged between 18-20 years (81.61%), and Islam (71.8%). In terms of economic burden, there was an average income (Median; 4,000-baht, min: max; 0:50,000), and more than two-thirds (77.1%) showed spending conditions with "not enough or in debt". The data showed nearly half of the respondents (47.2%) lived in apartments or condominiums for the living place. Smoking behavior, gambling, and addiction were rarely reported, with 2% smoking, 5% gambling, and only one person using substances. In addition, the result showed 6.9% of respondents had a congenital disease, and most of them were joyful (84.2%) [Table 1].

Alcohol consumption behaviors

The results of an analysis of the alcohol consumption behavior of first-year students in the past six months, 685 participants found 248 participants with alcohol use, 36.20. percent. The percentage of drinking in

Table 1. Characteristics and socioeconomic factors of participants (n=685)

Characteristics and socioeconomic factors	Number	%
Sex		
Male	172	25.1
Female	513	74.9
Age		
Under 18	13	1.9
18-20 years	559	81.6
20 years or more	113	16.5
Religion		
Islam	492	71.8
Buddhism	187	27.3
Christianity	6	0.9
Average monthly income (baht)		
No income	89	13.0
Not more than 3,000 baht	201	29.3
3,001 – 5,000 baht	273	39.9
5,001 baht or more	122	17.8
Mean (SD) = 4,202.2 (3,545.7) baht, Median (min, max) = 4,000 (0, 50,000)		
Spending conditions		
Not enough/Debt	528	77.1
Enough	140	20.4
Few Save	17	2.5
Living place		
Own house	68	9.9
Dormitory	288	42.0
Apartment / Condo	323	47.2
Other	6	0.9
Smoking		
Never	639	93.3
Quit	32	4.7
Smoking	14	2.0
Addicted		
Never	677	98.8
Quit	7	1.1
Using	1	0.1
Gambling		
No	651	95.0
Yes	34	5.0
Congenital disease		
No	619	90.4
Yes	66	9.6
Personality		
Joyful	577	84.2
Sober	74	10.8
Introvert	22	3.2
Other	12	1.8

Table 2. Number and percentage of alcohol consumption behaviors in the past 6 months (n = 248)

Alcohol consumer behaviors	Number	%
Type of drinking		
Beers	143	57.7
Thai vodka/ whiskey	30	10.3
Thai / Foreign brandy	28	9.5
Alcohol smoothies	55	22.2
Wine	16	6.4
Frequencies (times per week)		
1	141	56.9
2	94	37.9
3-4	5	2.0
More than 4	8	3.2
Amount of standard drinking (Sd) per time (1 Sd is 10 grams of pure alcohol)		
At least 4 Sd	147	59.3
4.1 Sd to 10 Sd	46	18.5
10.1 Sd to 20 Sd	17	6.9
More than 20 Sd	38	15.3
Mean (SD) = 8.16 (10.80), Median (min, max) = 3.03 (0.47, 94.68)		
Place for living		
Dormitory	174	70.2
Somewhere around university	30	12.1
others	44	17.7
Partner of living		
Friend	214	86.3
Family, siblings	33	13.3
others	1	0.4
Smoking		
Never	224	90.3
Sometimes	20	8.1
Always	4	1.6
Amount paying (Bath)		
Not to pay	23	9.3
No more than100	86	34.7
101 – 300	84	33.9
> 300	55	22.2
Mean (SD) = 274.80 (403.56), Median (min, max) = 200 (0, 4,000)		
Affordability		
Always cash	233	94
Sometimes cash	6	2.4
Indebted	9	3.6
Timings		
Afternoon (6.00–7.59 pm.)	16	6.4
Early evening (8–11.59 pm.)	204	82.3
Late evening (12.00–03.59 am.)	28	11.3
Affecting after drinking		
No	90	36.3
Mild	128	51.6
Yes	30	12.1
Behave after drinking		
Normal	136	54.8
Enjoy	86	34.7
Thinking depressive	20	8.1
Manic or aggressive	6	2.4
Driving (car, motorbike) behaviour		
Always	28	11.3
Sometimes	54	21.8
Never	166	66.9

males was 45.3%, more than in females (33.5%). The average is at the age of 16 years of both sexes. The data found females start drinking alcohol more quickly than males, with females starting their first alcohol beverages used at age 10, while males begin drinking for the first time at age 12. The beverage popularity was found that most alcohol drinks were beer 57.7%, followed by alcohol smoothies 22.2%.

Regarding the frequency of drinking, most college students, drank less than 1 to 2 days/week, 56.9 percent, and most students tend to drink late at night (8 pm. to midnight) 82.3%. In terms of drinking volume, it was found that the average alcohol consumption per time was 8.16 standard drinks, which was equivalent to the average consumption of pure alcohol at 81.6 g. Regarding the location of each glass, 70.2% drank alcohol at their residences. Most drinkers were friends (86.3%), and 9.7 percent had smoked during their drinking. The cost for each drink is averaged at 274.80 baht, with most students paying by cash every time 94.0 percent.

It was also found that after drinking alcohol, most of the students felt slightly drunk (51.6 percent). The expression after drinking was as regular as when they did not drink, 54.8 percent, followed by 34.7%, felt more enjoyable. In terms of driving after drinking, it was found that more than 33.1 percent were driving after drinking, which can be categorized as: 11.3% of drivers were drivers every time they drank, and 21.8% were occasionally drivers, as shown in Table 2.

Influencing of relative drinkers on students' alcohol consumption

An analysis of 685 respondents found that 287 students, or 53.5 percent, said that the person who drank the most alcohol was a close friend, followed by people of the same age, accounting for 51.2%, and relatives 43.8%. In contrast, most respondents stated that maternal drinking influenced students at a high level of 77.8%, followed by teacher/staff drinking with a high level of influence on students (74.7%) and couples with a high level of power 72.3% (Table 3, Table 4).

Table 3. Number and percentage of relative drinkers on students' alcohol consumption (n = 685)

Relative drinker	Number	%
Father drink	287	41.9
Mother drink	57	8.3
Siblings/relatives drink	300	43.8
Lover drink	100	14.6
Close friends drink	365	53.3
Teachers/staff drink	70	10.2
Peers drink	351	51.2

Table 4. Influencing of relative drinkers on students' alcohol consumption (n = 685)

Relative drinker	Number and percentage of the level of influencing		
	High	Moderate	Low
Father drink	436	124	125
	(63.6)	(18.1)	(18.2)
Mother drink	533	48	104
	(77.8)	(7.0)	(15.2)
Siblings/relatives drink	401	165	119
	(58.5)	(24.1)	(17.4)
Lover drink	495	96	94
	(72.3)	(14)	(13.7)
Close friends drink	336	197	152
	(49.1)	(28.8)	(22.2)
Teachers/staff drink	512	75	98
	(74.7)	(10.9)	(14.3)
Peers drink	348	198	139
	(50.8)	(28.9)	(20.3)

Factors influencing alcohol consumption

The multivariable analysis was performed using multiple logistic regressions, including variables that showed statistically related alcohol consumption behavior from the bivariate analysis (Table 5).

The results of multiple logistic regression showed that religions were significantly associated with alcohol consumption behavior. The odds of Buddhism were 8.65 times the risk to consume alcohol more than Islam (AOR: 8.65, 95%CI: 4.41 to 16.97). There was also an association with tobacco consumption: the current smoker is associated with an increased risk of alcohol consumption (AOR: 17.9, 95%CI: 2.72 to 117.78). Interestingly, even the people who have already quit smoking are still 6.28 times more likely to consume alcohol (AOR: 6.28, 95%CI: 2.12 to 18.59). In addition, gambling can escalate the chance of drinking alcohol 6.41 times (AOR: 6.41, 95%CI: 2.09 to 19.57). Regarding the attitude, the medium-level odds were 2.56 times more likely to consume alcohol (AOR: 2.56, 95%CI: 1.53 to 4.28) than a high level. Reversely in marketing, the high and medium levels had more likely to consume

Table 5. Binary and multiple logistic regression of factors influencing alcohol consumption (n = 685)

Factors	n	% Drink	COR 95%CI	AOR 95%CI	P-value
Sex					
Female	513	33.5	Ref		
Male	172	44.2	1.62 (1.13-2.31)		0.007*
Age (years)					
< 18	13	30.8	Ref		0.050*
18-20	559	34.3	1.19 (0.96-3.92)		
>20	113	46.0	1.98 (0.57-6.82)		
Religion					
Islam	187	9.1	Ref	Ref	
Buddhism	492	46.5	8.77 (5.16-14.89)	8.65 (4.41-16.97)	<0.001**
Christianity	6	33.3	4.94 (0.84-28.98)	5.17 (0.38-69.32)	0.214
Monthly income (baht)					
<3,000	201	27.4	Ref		0.003*
3,001 – 5,000	273	37.4	1.58 (1.47-3.80)		
>5,000	122	46.7	2.36 (0.97-2.79)		
No income	89	38.2	1.64 (1.06-2.34)		
Spending					
Not enough	17	23.5	Ref		0.488
Enough	140	37.9	1.88 (0.60-5.85)		
Few Save	528	36.2	1.97 (0.61-6.38)		
Living place					
Own house	68	29.4	Ref		0.661
Dormitory	288	36.5	1.37 (0.77-2.43)		
Apartment	323	37.5	1.42 (0.80-2.52)		
Other	6	33.3	1.17 (0.19-6.94)		

Factors	n	% Drink	COR 95%CI	AOR 95%CI	P-value
Smoking					
Never	639	33.0	Ref	Ref	
Quit	32	81.3	8.66 (3.51-21.37)	6.28 (2.12-18.59)	0.001**
Smoking	14	78.6	11 (2.41-50.07)	17.90 (2.72-117.78)	0.003**
Gambling					
No	651	33.6	Ref	Ref	
Yes	34	85.3	11.25(4.29-29.48)	6.41 (2.09-19.57)	0.001**
Congenital disease					
No	619	36.0	Ref		
Yes	66	37.9	1.09 (0.64-1.84)		0.741
Knowledge level					
High level	365	37.5	Ref		0.133
Medium level	259	37.1	0.97 (0.70-1.35)		
Low level	61	24.6	0.54 (0.29-1.01)		
Attitude level					
High level	538	30.5	Ref	Ref	
Medium level	147	57.1	3.04 (2.08-4.42)	2.56 (1.53-4.28)	<0.001**
Marketing					
Low level	100	6.0	Ref	Ref	
Medium level	279	51.3	16.29(6.90-38.44)	15.15(5.49-41.78)	<0.001**
High level	306	32.4	7.63 (3.23-18.03)	5.35 (1.94-14.58)	0.001**
Self-competency					
High level	537	31.8	Ref		
Medium	148	52.0	2.27 (1.57-3.29)		<0.001*
Relative drinker					
Fathers					
No	398	23.9	Ref		
Yes	287	53.3	3.63 (2.61-5.04)		<0.001*
Mother					
No	628	32.8	Ref	Ref	
Yes	57	73.7	6.53 (3.43-12.45)	2.35 (1.07-5.16)	0.032**
Sibling/relatives					
No	385	21.6	Ref		
Yes	300	55.0	4.43 (3.17-6.19)		<0.001*
Lovers					
No	585	29.7	Ref	Ref	
Yes	100	74.0	6.60 (4.08-10.68)	3.60 (1.99-6.50)	<0.001**
Close friend					
No	320	15.3	Ref	Ref	
Yes	365	54.5	6.78 (4.69-9.80)	5.29 (3.31-8.45)	<0.001**
Teacher/staff					
No	615	33.8	Ref		
Yes	70	57.1	2.56 (1.55-4.23)		<0.001*
Peers					
No	334	21.9	Ref		
Yes	351	50.0	3.63 (2.59-5.07)		<0.001*

COR: Crude Odd Ratio, AOR: Adjusted Odd Ratio
* P-value of the binary regression (COR) significant at 0.05
** P-value of the multivariable model (AOR) significant at 0.05

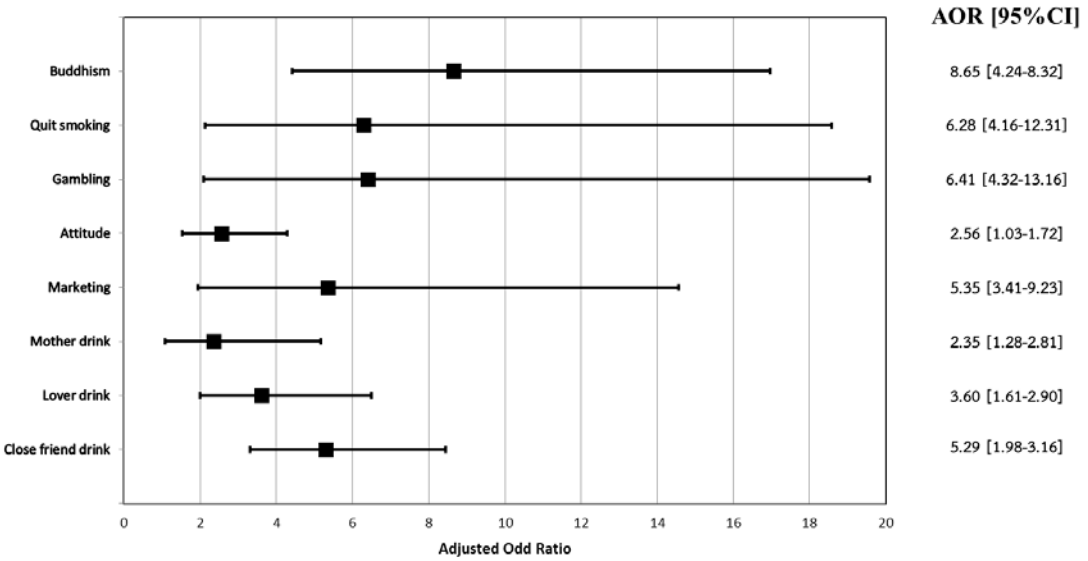

Figure 1. Adjusted Odd Ratio of factors influencing alcohol consumption

alcohol than the low level with the odds were 5.35 (95%CI:1.94 to 14.58) and 15.15 (95%CI: 5.49 to 41.78) times. Students with mother drinker, lover drinker, and close friend drinker were more likely to consume alcohol compared to students without drinker (AOR: 2.35, 95%CI: 1.07 to 5.16), (AOR: 3.60, 95%CI: 1.99 to 6.50), and (AOR: 5.29, 95%CI: 3.31-8.45) respectively as shown in Table 5 and Figure 1.

DISCUSSION

Prevalence of alcohol consumption

This study sought to examine the prevalence and factors that influenced alcohol consumption of first-year students in twelve universities in Southern Thailand. We found that the current prevalence of alcohol consumption among first-year students was 36.2%. This finding shows high prevalence than the study in other countries, such as Aboagye RG., which reported a current alcohol consumption prevalence of 19.4% among tertiary students in the Hohoe Municipality of Ghana [7], and the USA reported 18.7% of alcohol consumption in the past 30 days between 1991 and 2019, among youth ages 12–20 [8]. The studies from Nigeria with the current use of alcohol was 31.1% among Nigerian university students [9]. The plausible reason for this could be the differences between sample, cultural, social, legal, and religious. In addition, approximately 44.2% of men and 33.5% of women reported consuming alcohol in the previous six months. The result was analogous to one in Thailand [10] and more than the findings from other countries' researchers [11] and [12]. The study found that 33% - 36.42% of men reported drinking alcohol, compared with only 2% - 3.73% of women. In Thailand, it is perfectly acceptable to drink alcohol for men. This is a long-established value and an alternative form of social interaction, which differs from females whose drinking alcohol is highly inappropriate behavior. It also explains why males had high current drinking rate than females. Interestingly, the average age of newcomers drinkers was 16 years; females started drinking alcohol at age ten more quickly than males at age 12. This finding contrasts with results from Romania that males begin to drink faster [13]. This could be the difference in a societal context, including parents' and friends' drinking habits, social normative ideas about alcohol use, and cultural environment influence factors, including attitudes about alcohol consumption.

Drinking pattern

The findings showed that most people preferred to drink beer 57.7%, followed by alcohol smoothies 22.2%. This finding is consistent with the report about alcohol consumption in Bangkok-Year-2015 and various studies [14] and [15]. This may be because beer is a drink that is easily accessible to students. Due to the low price, the taste and degree of alcohol are not as heavy as spirits. As well as liquor shakes with a mixture of liquor with sweetened beverages, making drinkers popular in taste and still felt that they were not drunk.

According to the results, although the students had a drinking frequency of only one to two days per week, their median drinking was three standard drinks per time (equivalent to 30 grams of pure alcohol) [16]. This amount was higher than the World Health Organization recommended that both males and females not consume more than two standard alcohol beverages per day [17]. This may be because most Thai students tend to drink only on weekends, after exams, or on essential days than to drink regularly, resulting in high drinking volumes.

Factors influencing alcohol consumption

Consistent with the previous research, religion was associated with alcohol consumption behavior [18]. The statistical significance of the first-year students showed that Buddhists consumed alcohol 8.65 times Islam. According to the religious doctrines of Muslims that alcohol consumption is prohibited in the Islamic religion.

Our findings showed very high odds of alcohol consumption among current smokers or even those already quit smoking. Other studies came to the same conclusion [19], especially in China. Drinking and smoking have been traditionally accepted and expected behaviors for Chinese men. Traditionally, men believe that giving a cigarette and drinking together can quickly bring people closer [12]. Likewise, gambling could increase your chances of drinking alcohol by 6.41 times. This shows similarity result to a study in Italy which indicated that gambling could be understood as one potential risk behavior associated with alcohol use [12]. One explanation for these concerning results could be that since gambling in some societies is illegal, so the nature of gambling often happens in places that are out of sight. In the case of students, it may be gambling at the accommodation and playing among friends only for relaxation. This situation has a high probability of drinking alcohol, thus causing such factors to influence alcohol consumption.

For more than a decade, attitude was considered a decisive factor related to alcohol drinking behavior [20] and a robust predictor of drinking behavior [21]. Our study found a strong effect on attitude toward alcohol consumption behavior. The lower attitudes were 2.56 times more likely to consume alcohol than those with a highly positive attitude. It reinforces that if attitudes can be adjusted at an individual level, alcohol consumption can be prevented or reduced. Therefore, the campaign should focus on students' understanding and adopt the right attitude.

Results from the current study are consistent with previous literature on the impact of marketing perception on alcohol consumption [22]. Our results suggested that first-year students who had moderate and high perceptions of marketing were more likely to consume alcohol than low marketing perceptions 15.15 times and 5.35 times, respectively. This may be due to the motivation for the purchase decision. Alcohol marketing may promote positive associations at an early age, encouraging social drinking [23]. According to Social Cognitive Theory, human behavior can change by observing others and witnessing the consequences of their actions [24]. Significantly, the effect of media proposes two ways of media influencing behaviors [25]. First is learned via modeling, and the other is through favorable images or perceptions of people who drink and a greater willingness to drink [22]. Therefore, students' popularity in accessing various media, especially online media, is an important marketing channel that increases students' alcohol consumption [26].

From Table 3, the majority of students identified the most influential people in their drinking as mothers, teachers, and lovers, consistent with Figure 1 showing that students who are familiar with their mother's drinking, their lovers' drinking, and close friends' drinking are more likely to drink alcohol 2.35 times, 3.6 times, and 5.29 times respectively. Surprisingly, family drinking had a more negligible effect on students' drinking than their lovers or close friends. These results were like one study in northern Thailand [27]. One possibility to explain the findings is that most students live in dormitories that are not close to their family members. Unlike friends and couples who spend more time together, they have a higher chance of leading alcohol drinking together. In addition, it is an age that gives importance to friends quite a lot. The peer group's behavior will directly affect the acceptance of the peers or even the attitudes that may be amenable to friends or people around them, leading to the consumption of alcohol beverages.

Limitation

In this study, the sample included students from 12 Universities with an unequal portion because the sampling and data collecting method, which, although adequately represents the population sampled in this case, limits the generalizability of the findings.

CONCLUSION

In summary, first-year students show a high prevalence of alcohol consumption, both male and female. Further, beer was the most famous, and consumption per time was more elevated than World Health Organization recommended. Six factors show a high risk of alcohol consumption (religion, smoking, gambling, attitude, marketing, and peers' drinks). Our findings highlight social factors including friend's drinks and lovers' drinks, which can increase alcohol consumption drastically. These findings have implications for health initiatives aimed at college students and suggest the importance of considering attitude, marketing, and social factors to develop a concrete alcohol control policy for youth.

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Conflict of interest

The Authors declare no conflict of interest.

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ORIGINAL ARTICLE

CALCIUM AND VITAMIN D CONTENT IN THE MENUS OFFERED TO ELDERLY PEOPLE DURING SPA TREATMENT IN KRYNICA-ZDRÓJ RESORT

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ABSTRACT

Background. Calcium and Vitamin D are key nutrients in the diet of elderly people due to osteoporosis. One of the places where seniors, through observation, can gain knowledge on how to compose a meal to make it wholesome is a sanatorium that combines spa treatment and rehabilitation with diet therapy.

Objective. The aim of the study was to assess the menus in terms of the content of calcium and vitamin D in the meals consumed by the elderly people during spa treatment in the health resort and to compare the results with the Polish Dietary Reference Values.

Material and methods. The study was carried out at Krynica Zdrój resort among patients who underwent spa therapy as part of 14-day stay periods. Menus prepared for 3 different diets were assessed, namely regular diet, easy-to-digest diet and diet for diabetics with limitation of easily digestible carbohydrates. The meals were served for 309 people (194 women and 115 men) most of them aged over 50.

Results. All meals served in the spa were deficient in calcium and vitamin D. The mean daily intake of calcium throughout the six months was 711.68 mg, whereas the Estimated Average Requirement (EAR) for both women and men is 1000 mg. The mean contents of vitamin D in all 3 served diets were at a similar level. The diets daily supplied approximately 4-5 µg vitamin D/person, which constituted about 30% of the daily requirement for this vitamin.

Conclusions. In order to reduce the risk of diseases resulting from calcium and vitamin D deficiency, the amount of foods containing these nutrients should be increased in daily diet or, if this is impossible, they should be supplemented.

Key words: *calcium, vitamin D, nutrition, spa resort, sanatorium, menus*

STRESZCZENIE

Wprowadzenie. Wapń i witamina D są kluczowymi składnikami diety osób starszych w aspekcie osteoporozy. Jednym z miejsc, gdzie seniorzy poprzez obserwację mogą zdobyć wiedzę na temat komponowania zdrowego posiłku jest sanatorium, które łączy leczenie uzdrowiskowe i rehabilitację z dietoterapią.

Cel. Celem badań była ocena jadłospisów pod kątem zawartości wapnia i witaminy D w posiłkach spożywanych przez osoby starsze w trakcie leczenia uzdrowiskowego oraz porównanie wyników z obowiązującymi w Polsce normami żywienia.

Materiał i metody. Badanie przeprowadzono w uzdrowisku Krynica Zdrój w grupie kuracjuszy korzystających z 14-dniowego pobytu uzdrowiskowego. Ocenie poddano 14-dniowe jadłospisy przygotowane dla 3 różnych diet, a mianowicie podstawowej, łatwostrawnej oraz diety z ograniczeniem łatwo przyswajalnych węglowodanów. Posiłki spożywało 309 osób (194 kobiet i 115 mężczyzn), w większości powyżej 50. roku życia.

Wyniki. Wszystkie posiłki serwowane w sanatorium były ubogie w wapń i witaminę D. Średnia zawartość w nich wapnia w ciągu sześciu miesięcy wyniosła 711,68 mg, podczas gdy średnie zapotrzebowanie (EAR) zarówno dla kobiet jak i mężczyzn wynosi 1000 mg. Średnia zawartość witaminy D we wszystkich 3 dietach była na zbliżonym poziomie. Diety dostarczały dziennie około 4–5 µg witaminy D, co stanowiło około 30% dziennego zapotrzebowania na ten składnik.

Wnioski. W celu zmniejszenia ryzyka chorób wynikających z niedoboru wapnia i witaminy D należy w codziennej diecie zwiększyć ilość pokarmów zawierających te składniki lub, jeśli to niemożliwe, suplementować.

Słowa kluczowe: *wapń, witamina D, żywienie, sanatorium, jadłospisy*

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INTRODUCTION

Modern society has an age structure characterized by an increase in the number of elderly people with a reduced number of new-borns. Therefore, it is important to take measures in every possible field to ensure that the elderly remain in proper health and physical condition for as long as possible. Many social campaigns promote a proper lifestyle and physical activity. Healthy eating is also promoted. One of the places where seniors, through observation, can gain knowledge on how to compose a meal to make it wholesome is a sanatorium that combines spa treatment and rehabilitation with diet therapy [1, 2]. The obligation of the diet therapy during spa treatment results from the Polish regulations [3].

In Poland and other countries of Central and Eastern Europe, spa treatment is perceived as an integral part of healthcare systems. It is estimated that annually 400 000 patients in Poland use spa services and most of them receive this treatment financed by the National Health Fund [1]. Although spa treatment is very popular in Poland, nutritional value of menus planned for elderly in sanatoriums has not been sufficiently investigated.

The essence of spa treatment is a 2- or 3-week therapeutic, rehabilitative and preventive procedure delivered in a sanatorium or other spa hospital located in health resorts. Most of such places use natural mineral waters, gases and peloids in the form of bathing, drinking, or inhalation. Balneotherapy is thought to be a method of treating various diseases, rehabilitation and prevention that's why in sanatorium, there are many therapeutic devices for patients, such as mineral water pump rooms, graduation towers, parks, spa pools, which perform rehabilitation and treatment functions. According to the Ministry of Health, there are currently 45 towns in Poland considered to be health resorts. Among them is Krynica-Zdrój, whose history dates back to 1793.

For the comfort of life of the elderly, it is important to have the correct content of vitamins and minerals in meals the deficiencies of which may result in various adverse changes in the body, such as osteoporosis. Adequate nutrition, especially adequate intake of vitamin D and calcium and limitation of sugar and saturated fatty acids in a diet [4], the avoidance of risk factors such as smoking and abuse of alcohol [5] and regular exercises are the most effective nonpharmacologic measures preventing osteoporosis. The conscious composition of meals and an appropriate diet can directly translate into health, better physical and mental condition, and greater independence of the elderly, which in turn gives a measurable social and economic effect.

Calcium is a mineral that is essential in the daily diet of people of all ages. According to the Polish Dietary Reference Values (DRVs) the level of Estimated Average Requirement (EAR) for calcium is 1000 mg for men over 65 years and women over 50 [6].

Vitamin D is essential for the proper functioning of the body. Its active form, i.e. 1,25-dihydroxyvitamin D, has a number of positive effects, especially on the skeletal system. It also affects the immune system, namely: it regulates the body's immune response to factors that threaten it. It was shown that its deficiency may cause the development of autoimmune diseases or their aggravation [7]. Regular vitamin D supplementation also reduces the risk of developing cardiovascular and nervous system diseases, including multiple sclerosis, Alzheimer's disease.

The recommended intake for vitamin D established in 2020 by the National Institute of Public Health NIH – National Research Institute at the level of Adequate Intake (AI) is 15 µg/person/day [6].

Although spa treatment is very popular in Poland, content of calcium and vitamin D in meals served for elderly in sanatoriums has not been sufficiently investigated. To our knowledge, only one study concerning nutritional values was realised in spa [8].

The aim of the study was to assess the menus in terms of calcium and vitamin D content in the meals consumed by elderly people during spa treatment at the Krynica-Zdrój resort and to compare the results with the Polish Dietary Reference Values [6]. The study also assessed the energy value of meals, and protein, carbohydrate and fat content in them.

MATERIAL AND METHODS

The research was based on the analysis of the menus served to patients receiving 14-days long spa treatment in Krynica-Zdrój in the first half of 2020. Six patients' stays, one in a month, were randomly selected. Three types of diets, namely regular diet, easy-to-digest diet and diet for diabetics with limited digestible carbohydrates were assessed for each stay, resulting in a data obtained from 252 daily menus.

14-days menus were analysed with regard to the number of patients, their gender and the diet used. The obtained data of patients was completely anonymous and contained only information about gender, age, height, body weight and the diet used during the spa treatment. All anthropometric measurements were made and recorded by nurses employed in the spa. Body weight and height were measured on the first day of patients' stay using a certified scale (BA200L, Axis, Poland). Based on the information obtained about the body weight and height of the patients, the BMI was calculated. The BMI values were compared with the classification established by the World Health

Organization, namely: normal weight was in the range of 18.5-24.9 kg/m^2, overweight: 25-29.9 kg/m^2, obesity class I: 30-34.9 kg/m^2, obesity class II: 35-39.9 kg/m^2, obesity class III: BMI ≥ 40 kg/m^2.

The spa center had its own kitchen where meals were prepared. The spa manager and all patients were informed of the study procedures and provided written informed consent.

Dieta 6 software was used to assess energy intake and content of calcium, vitamin D, proteins, fats and carbohydrates in the patients' meals [9]. Dieta 6 software contains a database of Polish food composition tables [10] and recipes based on the Polish cuisine. The nutrient content was calculated for each menu. All calculations considered food losses resulting from technological processes. Then all values were summed up to achieve energy, calcium, vitamin D, proteins, fats and carbohydrates intake during 14 days long stay. In this way, the average intake of calcium, vitamin D and energy and macronutrients were estimated. Descriptive statistics (mean and standard deviation) were used to report the nutritional value of the menus [11]. Next, the results obtained were compared to the Dietary Reference Values for elder people in Poland [6]. The Estimated Average Requirement (EAR) for calcium and the adequate intake (AI) for vitamin D were used for comparisons. The average energy value of the menus established by the spa dietitian was 2500 kcal, and the percentage distribution of the energy supply was planned as follows: 35% of the daily energy supply during breakfast, 40% of the energy was lunch and 25% dinner. Taking into account the relatively low physical activity of the patients and their age, the physical activity level (PAL) was 1.6 and the planned energy value for all age groups was 1925 kcal for women and 2240 kcal for men [6]. It was assumed that the patients consumed all food served.

Characteristics of the group

The study was carried out at the Krynica Zdrój resort among patients who underwent spa therapy as part of 14-day stay periods. The study population consisted of 309 patients, including 115 males and 194 females, of whom almost 95% were over the age of 50. The age of the patients ranged from 39 to 87 years, with the mean age of 62.58 years. Most patients were on regular diet or easy-to-digest diet with predominance of water-boiled, low-fat meals (Table 1).

Women constituted 63% of the group. Table 2 presents the division of the study group by gender, BMI and type of diet used by patients. The most popular diet in the group of women was regular diet; it was used by 43.3% of patients. Among men, the regular diet was also the most popular (61.7%). Easily digestible diet was much more popular among women than men. Only one woman in the study population followed an easily digestible diet with reduced fat and was excluded from the analysis. Detailed data is presented in Table 2.

Table 1. Age of the study groups

	Total (N=309)	Women (N=194)	Men (N=115)	p*
Mean value [years]	62.58	62.19	63.23	0.231
SD	7.40	7.48	7.25	
Min	39	39	39	
Max	87	84	87	
>50 years [%]	94.8	94.3	95.6	

*- *Student's* t-test

Table 2. Study group according to gender, BMI and type of diet used (N = 309)

		Women (N=194) %	Men (N=115) %	p
Diet	Regular	43.3	61.7	0.0043
	Easy-to-digest	42.8	23.5	
	With limitation of easily digestible carbohydrates	13.4	14.8	
	With limitation of fat	0.5	0.0	
BMI	Normal weight	33	21.7	0.038
	Overweight	42.3	40.9	
	Obesity class I	17.0	31.3	
	Obesity class II	5.7	4.4	
	Obesity class III	2.0	1.7	

The body mass index in the studied group most often indicated overweight - 82 women and 47 men struggled with it, which constituted 41.7% of the group. In general, overweight and obese patients represented up to 71.3% of the group. Obesity was more common among men than among women. Detailed data is presented in Table 2.

RESULTS

The minimum calcium content in the assessed menus was in the diet with limitation of easily digestible carbohydrates and was 198.95 mg. The maximum content of calcium amounted 1962.93 mg and it was found in the regular diet. The mean calcium intake throughout the six months was 711.68 mg. The calcium content provided in the meals did not meet the recommended values (EAR: 1000 mg), neither in the group of women nor in the group of men (Table 3).

The average vitamin D content in the three diets significantly differed from the Polish DRVs. The recommended Adequate Intake (AI) for vitamin D,

Table 3. Calcium and vitamin D content in menus in six month period compared to the Polish Dietary Reference Values

Diet	Calcium [mg]								Vitamin D [µg]					
	N	Mean value	SD	Min	Max	EAR [mg/ person/ day]	% of the daily requirement for women	% of the daily requirement for men	Mean value	SD	Min	Max	AI [µg/ person / day	% of the daily requirement for women	% of the daily requirement for men
Regular	155	812.41	202.47	505.36	1962.93	1000	81.2	81.2	4.71	4.54	0.75	28.87	15	31.4	31.4
Easy-to-digest	110	776.07	209.80	485.80	1491.16	1000	77.6	77.6	4.55	4.15	0.66	28.87	15	30.3	30.3
With limitation of easily digestible carbohydrates	43	546.57	206.44	198.95	1262.46	1000	54.6	54.6	4.03	4.04	0.75	29.15	15	26.9	26.9
Total	308	711.68	206.24	396.70	1572.18	1000	71.13	71.13	4.43	4.24	0.72	28.96	15	29.53	29.53

SD - Standard Deviation; EAR - Estimated Average Requirement; AI - Adequate Intake

established in 2020 by the National Institute of Public Health NIH – National Research Institute, is 15 µg/person/day. The mean content of vitamin D in the individual diets were at a similar level. The diets daily supplied approximately 4-5 µg of vitamin D, which constituted about 30% of the daily requirement for this vitamin.

For meals served for patients, the energy value, average protein, fat and carbohydrate content were determined. The average energy value was the highest in the menus of the regular diet during the whole six months and amounted to 2616.9 kcal. In turn, in a diet with limited easily digestible carbohydrates, the average energy value was the lowest - 2265 kcal. The above mentioned menus for 3 diets met the Polish DRVs in 117.7-136% for women and 101-116.8% for men.

The mean content of protein in the regular and easily digestible diets were at the level of 105 g and 108 g, which corresponded to the DRVs for women in 181% and 186%, and 159% and 163.6% for men. In turn, in the diet with limited easily digestible carbohydrates, the recorded amounts were the lowest - 98.52 g., but still higher than the EAR level.

The mean fat values were 91.52 g, 107.2 g and 101.9 g, respectively, for the diet with the restriction of easily digestible carbohydrates, the regular diet and the easily digestible diet. The regular diet contained 328.4 g of carbohydrates, which met 117.2% of the recommended value for women and 96.8% for men. An easy digestible diet - 319.9 g, which is 114.2% of the recommended daily amount for women and 94.3% for men. Content of carbohydrates was the smallest in the diet for diabetics. Carbohydrates met the recommended value in 101.2% for women and 83.6% for men (Table 4).

DISCUSSION

Proper nutrition is a very important element of any treatment process. Both nutritional excess and deficiency are associated with disease. Moreover, according to Polish law, diet is one of the main therapeutic methods used in practice during spa treatment in all sanatoriums [3]. Unfortunately, according to this study, it can be said that during spa treatments patients do not receive proper diet.

In this study, the average content of calcium and vitamin D in all three diets do not meet the Dietary Reference Values of the National Institute of Public Health NIH – National Research Institute for the elderly for these nutrients. The regular and easily digestible diets contained nearly 800 mg of calcium. In turn, the average amount of calcium present in the diet with the limitation of easily digestible carbohydrates met only 54.6% of the daily requirement. Moreover,

Table 4. Detailed data on energy value, protein, fat and carbohydrate content in menus of 3 diets

	Regular diet		Easy-to-digest diet		With limitation of easily digestible carbohydrates diet		Reference values for women	Reference values for men
	Mean ±SD	Range	Mean ±SD	Mange	Mean ±SD	Range		
Energy [kcal]	2616.9±271.2	1594-3663	2561.8±246.8	2015-3229	2265.5±263.4	1773-3164	1925	2240
Protein [g]	104.8±14.3	72.9-136.4	108.2±21.0	72.86-179.8	98.5±15.9	63.0-137.4	33-58	37-66
Fat [g]	107.2±18.4	65.6-193.4	101.9±18.3	72.4-155.3	91.5±16.8	64.1-141.9	64* (43-75)	75* (50-87)
Carbohydrates [g]	328.4±33.2	261.4-448.9	319.9±35.3	227.7 -448.9	283.70±43.6	199.9-458.6	217-313	252-364

* The amount of fat covering 30% of the energy in the diet of women (1925 kcal) and men (2240 kcal)

the fiber level in the study was high (33g±3.7), which may further hinder calcium absorption.

The average vitamin D content in all three diets differed significantly from the AI and accounted for about 30% of the daily requirement for this vitamin.

To our knowledge, only one other work concerning menu assessment was realised in spa [8]. The authors took into account seasonality of meals in spa centers in Kłodzko Valley but the number of menus and number of centers are not known. However, calcium and vitamin D intake was similar as in our study.

No other reports were found showing the supply of calcium and vitamin D in sanatoriums. Many studies on the nutrition of elderly people in nursing homes also confirmed insufficient calcium intake [12, 13, 14]. In the study by *Goluch-Koniuszy* and *Fugiel* [15], conducted on a group of 37 seniors aged 60-84 who lived in a nursing home, the daily intake of calcium by residents was 420 mg. In nursing homes, the mean intake of vitamin D ranged from 1.98 µg to 2.7 µg/person/day [12, 13, 14, 15]. Comparing the assessment of menus carried out in Poland, it can be noticed that in none of the mass catering establishments the reference value for vitamin D was not even met in half.

Rodrigues-Rejon et al. [16] evaluated nutritional value of 3 types of menus served in long-term care homes in Granada. The calcium was mostly at the recommended level. Only in pureed menues calcium content was not enough. The vitamin D level was even lower than in our study. However, the possibility to obtain vitamin D from other sources is greater in Granada than in Krynica Zdrój because of greater sunlight exposure.

The analysis by *Vaes* et al. [17], carried out on the population of elderly people in the Netherlands, shows that seniors with a daily diet provided an average of 3.9 µg of cholecalciferol per day. Small amounts of this vitamin in the meals of seniors from Poland and other European countries may be due to a diet poor in food products containing it. In mass catering establishments, menus are often organized in terms of the daily financial rate, which may contribute to the fact that diets are deficient in certain nutrients or have an excess of others. In turn, the prices of food products depend on the season, harvest and their availability.

It should be noted that in this study, the average value of energy value of the different diets used in the sanatorium met the reference values in 118-136% for women and 101-117% for men. Proteins recorded in the menus in Krynica significantly exceeded recommended values - 58 g for women and 66 g for men. In an easily digestible diet, the recommended value for this macronutrient was exceeded twice for women and reached almost 170% of the recommended level for men. It can be seen that in the spa-provided diets, women consumed about 30% more protein than

men. The amounts of protein in all the diets were very similar, regardless of the sex and diseases of the patients for whom they were intended.

The amount of fat found in all 3 diets was high. In diet with limited simple carbohydrates, although the amount of fat was the lowest, it met the reference value for this macronutrient in 144% for women and 119% for men. Considering that the fat content in this diet should be regulated and limited, exceeding the recommended value to such an extent is not a desirable phenomenon. The recommended level was also exceeded in the case of the regular diet. For women, the reference value was exceeded by 69%, and for men by 19%. Despite the fact that the regular diet is used by people who do not require special modifications for nutritional treatment, the macronutrients, minerals and vitamins which contains should be composed in such a way as to maintain the appropriate proportions that ensure the proper functioning of the body and prevent the development of diseases. In the case of an easily digestible diet the recommended amounts of this nutrient were exceeded by 71% in women and 41% in men. It can be seen that in the regular and easily digestible diets, the observed amounts of fat are very similar to each other. It is strange, because fat in an easily digestible diet should be limited. In addition, despite the division into different types of diets, they are characterized by a similar fat content. The long-term use of such a diet by elderly people whose metabolism is slowed down may lead to undesirable weight gain.

The level of carbohydrates was very similar in all 3 diets and was higher than in a similar study by *Rodrigues Rejon* [16]. The regular diet contained 328.4 g and met 117.2% of the assumed recommended value for women and 96.8% for men. None of assessed diets met 100% of the daily requirements for men. A diet limiting easily digestible carbohydrates differs to the greatest extent from the recommended value for men (83.6%). Considering that as many as 61.7% of men were on this diet, its failure to meet the recommended value for carbohydrates may cause anxiety. In diabetes, which is the main disease in which this type of nutrition is used, the proportions of all nutrients, with an emphasis on carbohydrates, should be precisely regulated according to recommendations. Otherwise, the metabolic processes may be disturbed and there may be a risk of health deterioration.

Sanatoriums are thought to be places where patients receive spa treatment, rehabilitation and diet therapy. However, according to literature review nutrition in spa places is not examined. Our study was realised during 6 different 14-days long stays and included 3 different diets but only in one spa. More studies are needed to assess nutrition in spa centres dedicated to the treatment of elderly people. Due to the treatment of osteoporosis in sanatorium conditions, the content of calcium and vitamin D in the meals served in these places is very important.

CONCLUSIONS

1. Calcium and vitamin D content in menus offered for elderly people during spa treatment in sanatorium did not reach the Dietary Reference Values established by the National Institute of Public Health NIH – National Research Institute.
2. To reduce the risk of diseases resulting from calcium and vitamin D deficiency, the amount of foods containing these nutrients should be increased in the daily diet or, if this is impossible, they should be supplemented.

Conflict of interest statement
The authors declare no conflict of interest.

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ORIGINAL ARTICLE

SUGAR-SWEETENED BEVERAGES CONSUMPTION DURING COVID-19 PANDEMIC AMONG OFFICE WORKERS IN SEMI-URBAN AREA IN SOUTHERN THAILAND: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background. During COVID-19 pandemic, office worker has spent more than 6-8 hours per day sitting for online working following social distancing policy. Considering the popularity of online ordering and home delivery services, sugar-sweetened beverages (SSB) consumption have increased. However, the link between the types SSB consumption and their BMI was less well documented.

Objective. To determine the association of the habitual intake (type, frequency, and volume) of sugar-sweetened beverages (SSB) with body mass index (BMI).

Material and methods. A cross-sectional study, 337 office workers were selected according to probability proportion-to-size and systematic random sampling. Data were collected using face-to-face interviews on the type, frequency, and volume of sugar-sweetened beverage intake. Samples of sugar-containing beverages were analyzed using high-throughput liquid chromatography/mass spectrometry (LC-MS/MS). The chi-square test was used to determine the relationship of SSB consumption with BMI. Unadjusted binary logistic regression analysis was used to assess the associations between BMI and metabolic diseases.

Results. Most respondents (56.1%) were overweight (BMI >23 kg/m^2). The most consumed SSB was milk tea (e.g., Thai tea and green tea), which was significantly related with BMI (p=0.03). LC-MS/MS analysis showed that sucrose and lactose were the major sugars in milk tea (34.7 g/100mL, on average). 70.6% of the respondents consumed >24 g/day of sugar, which is more than the World Health Organization's recommendation.

Conclusions. Health control policies and health education, for example warning labels for the reduction of SSB consumption, may urgently be required to promote health in workplaces and prevent SSB-related metabolic diseases.

Key words: *body mass index, LC-MS/MS, sugar-sweetened beverages, office worker*

INTRODUCTION

Sugar is commonly added to foods and drinks to enhance flavor, especially in the case of sugar-sweetened beverages (SSBs) [1], including freshly prepared iced tea and coffee [2]. SSB consumption has gradually increased from an average of 270.8 mL in 2018 to 278.5 mL in 2019 [3]. The rapid and complete absorption of added sugars (glucose and fructose) stimulates the release of insulin which leads to sugar uptake by the target cells [4]. In adipose tissue, excess glucose is converted to fat (triglycerides) for energy storage [5], whereas in the liver, excess fructose stimulates the synthesis of fatty acids that accumulate in the visceral adipose tissue, leading to weight gain and obesity [1, 4, 6, 7].

Convincing evidence indicates that overweight and obesity remain the major underlying causes of public health issues such as type 2 diabetes, hypertension, and cardiovascular disease, which contributes to premature disability and mortality in both developed and developing countries [8]. In general, overweight

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and obesity are characterized by excessive fat mass accumulation in the body [9], particularly in the abdominal area (abdominal adipose tissue) [10, 11]. Recent studies report that the epidemic of obesity and obesity-related diseases has aggravated simultaneously with the increased consumption of high amounts of added sugars, given the association of added sugars with health issues [12, 13].

As compared to the general population, the prevalence of obesity is higher among office-based workers owing to the extended periods of sedentary behavior (sitting) related to this type of work [14, 15]. Our preliminary data indicated that during the coronavirus disease (COVID-19) pandemic, office workers have spent more than 6–8 hours per day sitting for online working. Considering the popularity of home delivery services, the consumption of SSBs has increased to 500 mL per day [3]. However, there are no studies on the association between the SSB consumption of office workers and their body mass index (BMI) or the presence of obesity-related metabolic diseases during the COVID-19 pandemic.

Therefore, this study was conducted among office workers with the aim of determining the association between patterns of SSB consumption (type, frequency, and amount) and BMI status. The emergence of high-throughput liquid chromatography/mass spectrometry (LC-MS/MS) allows for the simultaneous detection of the sugar profile and amount of sugar in SSBs by means of high quality, quantitative analysis of the specific mass-to-charge ratio (m/z) [16, 17]. Furthermore, obesity-related health outcomes were revealed.

MATERIAL AND METHODS

Study design, sample, and study setting

This cross-sectional study was conducted in Tha Sala district of Nakhon Si Thammarat province, Thailand (Latitude: 8° 38’ 42.2’’ N; Longitude: 99° 53’ 47.6’’ E). Nakhon Si Thammarat is the most working aged province in the southern part of the country where 16.5% of southern Thai working aged population residing in. We purposively selected one university where the biggest campus has been implemented because it would be more feasible and flexible for this university to implement campaigns on awareness raising and reduction of SSB consumption in the future. The participants comprised 337 office workers who were recruited from 51 departments at a university. The sample size was calculated using the Taro Yamane formula (N=2,118, e=0.05) and probability proportional to size and systematic random sampling. Written informed consent was obtained from all participants prior to data collection. The inclusion criteria were as follows: i) working for 6–8 hours per day, ii) excess BMI and waist circumference, and iii) consumption of SSBs on a daily basis. The exclusion criteria were the inability to answer questions owing to physical, mental, or cognitive handicaps, and stopping the participants. This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Human Research Ethics Committee of Walailak University (Approval Number: WUEC-20-185-01).

Data collection

Anthropometric measurements including weight and height were obtained to the nearest 0.1 kg and 0.1 m, respectively. Standardized equipment was used and the BMI was subsequently calculated as the weight divided by the square of the height (kg/m^2), as per the World Health Organization guidelines. Waist circumference was measured, to the nearest 0.1 m, at the level of the iliac crest while the subject was standing in the upright position and at minimal respiration. All measurements were performed by researchers who received standardized training in anthropometric measurements.

The data were collected by means of face-to-face interviews using a beverage intake questionnaire which was conducted as per *Hedrick* et al., with slight modification [18]. Modifications included the addition of an open-ended question to cover all types of SSBs consumed by the participants, as well as a question on the presence of metabolic syndrome as diagnosed by a medical professional. The questionnaire consisted of two main sections: (i) socio-demographic data (e.g., age, sex, educational background, marital status, and the presence of metabolic syndromes), and (ii) behavioral patterns related to SSB consumption. We determined the type, frequency, and volume of SSB consumption using a 24-hour dietary recall as an intensive method, capturing consumption data from midnight to midnight of the previous day. The frequency of SSB consumption was categorized into the following groups: none, 1–2 servings/week, 3–4 servings/week, and 5–7 servings/week, while the volume per serving was divided into 360 mL, 480 mL, 540 mL, 600 mL, and 660 mL groups.

Sugar determination (LC-MS/MS)

Freshly prepared iced tea samples were subjected to an ultrasonic bath and centrifuged at 12000 rpm (30 min at 4°C). After passing through a membrane filter (0.22 µm, PVDF, Millex, Ireland), all samples were diluted with ultrapure water (1:100) and 10 µL was subsequently injected into the LC-MS/MS system. The standards for fructose, glucose, sucrose, and lactose were obtained from Sigma-Aldrich (Darmstadt, Germany). The LC-MS/MS method [17] was performed using a triple quadrupole mass spectrometer with negative ion mode electrospray

ionization equipped with an ultra-performance liquid chromatography system (Agilent Technologies, Santa Clara, CA). The sucrose, lactose, fructose, and glucose standards and freshly prepared iced tea samples were separated using the Asahipak NH2P-50 column (4.6 µm, 250 mm; Showa Denko America, Inc., New York, NY). A mobile phase consisting of 80% 10 mM ammonium acetate and 20% acetonitrile at a flow rate of 0.2 mL/min was used. The column temperature was maintained at 28°C and the volume of injection was 10 µL. The mass spectrometer detector conditions were set as follows: the capillary voltage was maintained at 4500 V, the nebulizer was set to 2 bar, the drying heater to 200°C, and the drying gas flow to 8 L/min.

Statistical analysis

Data were analyzed using R version 3.0.2 in RStudio GUI version 1.3.959 (R Foundation for Statistical Computing, Vienna, Austria). The Chi-square test was employed to determine the relationship of SSB consumption and the amount of sugar in SSBs with BMI status. Unadjusted binary logistic regression analysis was used to examine the associations between BMI classification and metabolic diseases. Differences were considered statistically significant at $p<0.05$.

RESULTS

The socio-demographic characteristics of the participants are presented in Table 1. There were 114 males (33.8 %) and 223 females (66.2%) participants aged 20–59 years. Most of the participants were 30–39 (n=122, 36.2%) or 40–49 (n=109, 32.3%) years old and had obtained a bachelor (n=127, 37.7%) or master or doctoral degree (n=108, 32.1%). There was a 1.5-fold higher proportion (n=189, 56.1%) of individuals who were overweight (BMI: 23–30 kg/m^2) and obese (BMI: >30 kg/m^2) than those with a normal weight (BMI: 18.5–22.9 kg/m^2; n=148, 43.9%). Approximately 30% of both male and female participants had a normal waist circumference, indicating that more than 60% of participants were at risk of abdominal obesity. Moreover, we observed a history of metabolic diseases including type 2 diabetes (n=9, 2.7%), hypertension (n=6, 1.8%), and dyslipidemia (n=4, 1.2%).

Among the 19 types of SSBs, the participants most often consumed milk and freshly prepared iced milk tea (both: n=136, 40.4%), Carbonated drinks (n=135, 40.1%), cocoa drinks (n=133, 39.5%), fermented milk (n=130, 38.6%), and juice packs (n=118, 35.0%), with an average volume of 110–151 mL/day during the prior month (Table 2). The consumption of freshly prepared iced milk tea beverages (e.g., iced matcha green tea latte, iced Thai milk tea, and iced bubble tea; p=0.03) and iced lemon tea (p=0.01) was significantly associated with BMI status (Table 3), indicating that a high consumption of freshly prepared iced milk tea might be one of the risk factors associated with weight status. This result prompted us to further examine the amount of sugar and the sugar profile in freshly prepared iced milk tea and iced lemon tea. According to the LC-MS/MS multiple reaction monitoring analysis, the standards of sucrose (m/z 341→179), lactose (m/z 341→179), fructose (m/z 179→161), and glucose (m/z 179→161) were eluted at retention time

Table 1. Sociodemographic characteristics of the study participants

Sociodemographic characteristic	Number of subjects (%)
Age (years)	
20–29	72 (21.4)
30–39	122 (36.2)
40–49	109 (32.3)
50–59	34 (10.1)
Gender	
Male	114 (33.8)
Female	223 (66.2)
Education	
Primary level	24 (7.1)
Secondary level	78 (23.2)
Undergraduate	127 (37.7)
Graduated	108 (32.1)
Monthly income (Thai bath)	
5,000–10,000	76 (22.6)
10,001–15,000	26 (7.7)
15,001–20,000	45 (13.4)
20,001–25,000	46 (13.6)
25,001–30,000	44 (13.1)
>30,000	100 (29.7)
Body mass index (kg/m^2)	
<18.5	25 (7.4)
18.5–22.9	123 (36.5)
23.0–24.9	65 (19.3)
25.0–29.9	91 (27.0)
≥30.0	33 (9.8)
Waist circumference (cm)	
Males	
<90	84 (73.7)
>90	30 (26.3)
Females	
<85	136 (61.0)
>85	87 (39.0)
Metabolic diseases	
Type 2 diabetes	9 (2.7)
Hypertension	6 (1.8)
Dyslipidemia	4 (1.2)

Table 2. Type and volume of sugar-sweetened beverage consumption by the study participants

Type of sugar-sweetened beverage	Number of subjects (%)	Volume (mL/day)	
		Mean	SD
Milk	136 (40.4)	151.5	109.4
Freshly prepared iced milk tea	136 (40.4)	146.8	109.6
Carbonated drink	135 (40.0)	110.5	90.7
Cocoa drink	133 (39.5)	140.7	107.7
Fermented milk	130 (38.6)	113.7	79.1
Juice pack	118 (35.0)	117.6	103.1
Freshly prepared iced Americano	92 (27.3)	226.1	135.2
3-in-1 instant coffee mix	73 (21.7)	163.1	93.4
Herbal drink	66 (19.6)	135.0	124.9
Freshly prepared iced lemon tea	63 (18.7)	121.7	99.1
Low fat milk	46 (13.7)	110.1	62.4
Freshly prepared iced espresso	40 (11.9)	186.0	118.5
Freshly prepared iced cappuccino	35 (10.4)	191.9	152.1
Energy drink	34 (10.1)	93.1	57.7
Freshly prepared iced latte	33 (9.8)	171.9	135.1
Sugar green tea (bottle)	32 (9.5)	111.4	79.1
Freshly prepared iced black tea	29 (8.6)	123.1	106.9
Skim milk	26 (7.7)	129.1	95.3
Freshly prepared iced mocha	20 (5.9)	138.9	86.5

Table 3. Association between sugar-sweetened beverage consumption and body mass index

Type of sugar-sweetened beverage		Body mass index (kg/m^2)					P-value
		≥30	25–29.9	23–24.9	18.5–22.9	<18.5	
Freshly prepared iced milk tea	Consumption, n (%)	19 (14.0)	28 (20.6)	24 (17.6)	51 (37.5)	14 (10.3)	0.03*
	Non-consumption, n (%)	14 (7.0)	63 (31.1)	41 (20.4)	72 (35.8)	11 (5.5)	
Freshly prepared iced lemon tea	Consumption, n (%)	7 (11.1)	9 (14.3)	9 (14.3)	32 (50.8)	6 (9.5)	0.01*
	Non-consumption, n (%)	26 (9.5)	82 (29.9)	56 (20.4)	91 (33.2)	19 (6.9)	

*p<0.05 is considered a statistically significant difference (chi-square test)

5.2, 5.7, 3.2, and 4.2 minutes, respectively (Figure 1). The sugar concentration of iced milk tea and iced lemon tea was calculated by comparison with standard curves; the results are presented in Table 4. Most of the free sugar in all the samples was sucrose, with an average concentration of 35.9+5.2 g/100 mL for iced lemon tea, 32.7±2.8 g/100 mL for Thai milk tea, 31.9±1.9 g/100 mL for milk green tea, and 30.8±6.6 g/100 mL for bubble tea. However, lactose, the sugar found in milk, was observed in only 5 among 12 milk tea samples (range: 2.4–4.7 g/100 mL), suggesting that the milk tea assessed in this study might have contained non-dairy creamer instead of milk (Figure 2).

The daily consumption of sugar for all the participants was calculated based on the LC/MS-MS analysis as well as the information found on nutrition facts labels. Approximately 60% of the participants consumed more than 24 g of added sugar from SSBs per day and this trend was significantly associated with an increased BMI (p=0.01). As presented in Table 5, approximately 78.8% of individuals with obesity (BMI >30 kg/m^2) consumed more than 24 g of added sugar from SSBs per day. As shown in the Figure 3, the waist circumference of the participants gradually increased by 0.30 cm for every 1-unit increase in BMI. Furthermore, Table 6 shows that, when compared to a normal BMI, a BMI >30 kg/m^2 was associated with a higher risk of type 2 diabetes (OR 15.1, p=0.02, 95% CI 1.51–150.13).

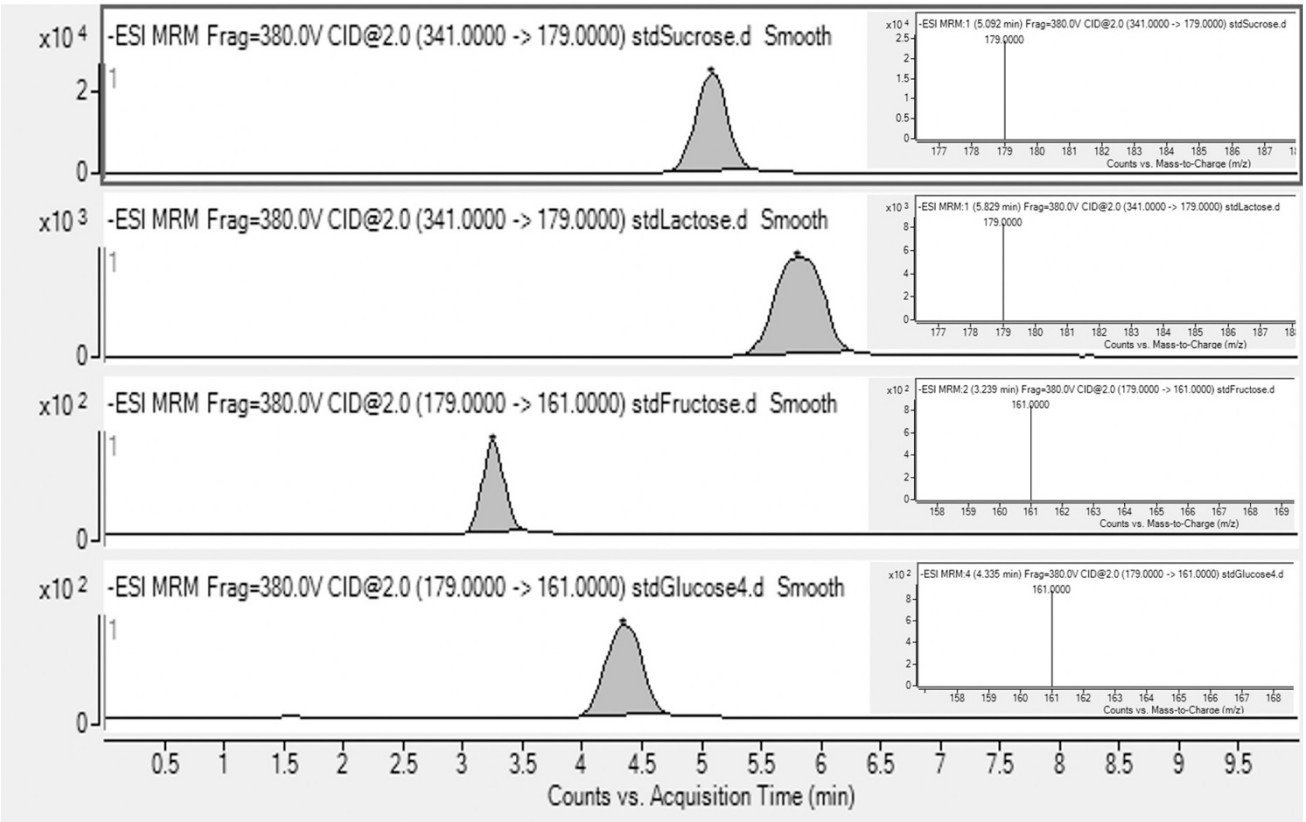

Figure 1. Standards of sucrose, lactose, fructose, and glucose were separated using the Asahipak NH2P-50 column (4.6 µm, 250 mm) with an isocratic mobile phase consisting of 80% 10 mM ammonium acetate and 20% acetonitrile. Standards of sucrose, lactose, fructose, and glucose were eluted at retention time 5.2, 5.7, 3.2, and 4.2 minutes, respectively.

Table 4. Sugar profile and amount of sugar in freshly prepared iced beverage samples

Freshly prepared iced beverage	Sucrose (g/100 mL)	Lactose (g/100 mL)	Fructose (g/100 mL)	Glucose (g/100 mL)	Total sugar (g/100 mL)
Milk green tea					
Sample 1	30.0	n.d.	n.d.	n.d.	30.0
Sample 2	34.4	3.00	n.d.	n.d.	37.4
Sample 3	32.2	n.d.	2.8	1.6	36.6
Sample 4	30.8	2.8	1.8	2.7	38.1
Average	31.9	2.9	2.3	1.85	34.6
SD	1.9	-[a]	-[a]	-[a]	3.9
Thai milk tea					
Sample 1	32.2	n.d.	n.d.	n.d.	32.2
Sample 2	29.0	4.7	2.9	3.4	39.9
Sample 3	35.7	n.d.	n.d.	n.d.	35.7
Sample 4	33.8	n.d.	0.1	0.8	34.8
Average	32.7	4.7	1.5	2.1	35.6
SD	2.8	-[a]	-[a]	-[a]	3.2
Bubble milk tea					
Sample 1	23.1	4.2	0.1	0.58	27.9
Sample 2	39.0	n.d.	n.d.	n.d.	38.9
Sample 3	32.2	n.d.	0.1	1.04	33.4
Sample 4	29.0	2.4	1.8	2.69	35.8
Average	30.8	3.3	0.7	1.4	34.0
SD	6.6	-[a]	0.9	1.2	4.7

Lemon tea					
Sample 1	28.2	-	0.9	1.1	30.2
Sample 2	37.9	-	0.9	1.3	40.0
Sample 3	39.3	-	0.4	1.4	41.1
Sample 4	38.3	-	0.5	0.7	39.4
Average	35.9	-	0.7	1.1	37.7
SD	5.2	-[a]	0.3	0.3	5.0

n.d. : Non detected

-[a] : Not available

All samples were purchased from different shops depending on the frequency of participants selected. Data were analyzed using LC-MS/MS methods and the amount of sugar was calculated by comparison with standard curves for sucrose, lactose, fructose, and glucose.

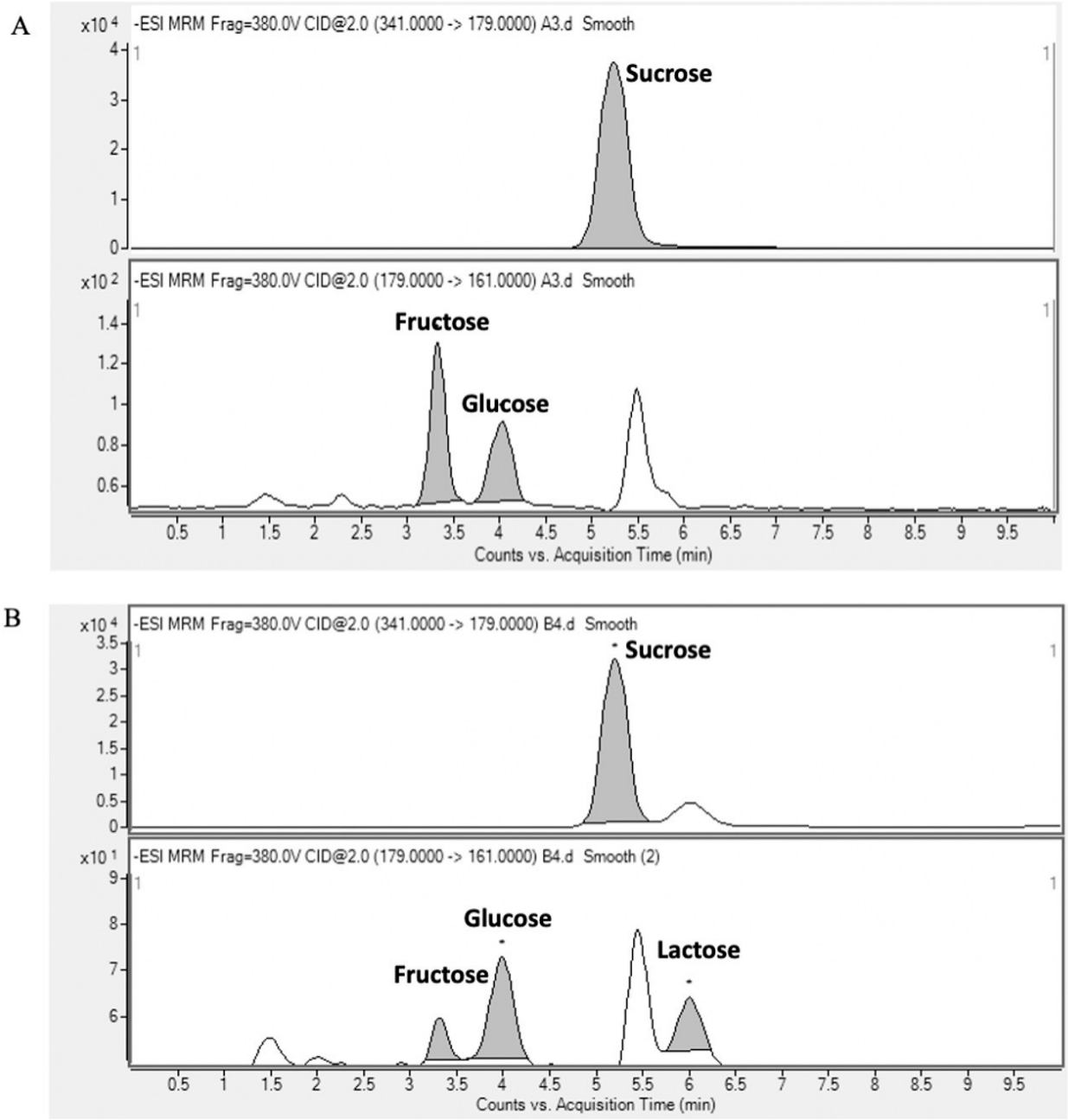

Figure 2. The sugar profile of freshly prepared iced milk green tea (A) Sample 3 and (B) Sample 4. Lactose (milk sugar) was not detected in Sample 3, whereas it was detected in Sample 4.

Table 5. Relationship between sugar consumption and body mass index

Amount of added sugar consumed	n (%)	Body mass index (kg/m²)					P-value
		≥30	25–29.9	23–24.9	18.5–22.9	<18.5	
>24 g/day	238 (70.6)	26 (10.9)	53 (22.3)	44 (18.5)	93 (39.1)	22 (9.2)	0.01*
<24 g/day	99 (29.4)	7 (7.1)	38 (38.4)	21 (21.2)	30 (30.3)	3 (3.0)	

*p<0.05 is considered a statistically significant difference (Chi-square test)

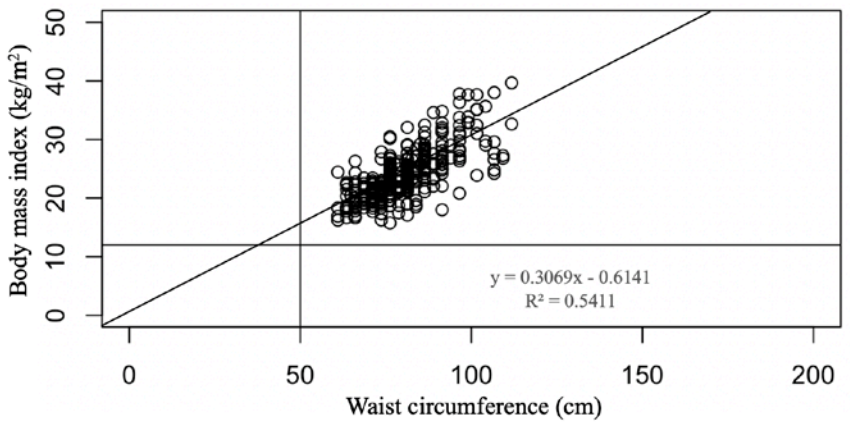

Figure 3. The association of body mass index and waist circumference determined using linear regression analysis

Table 6. Odds ratios of metabolic syndrome according to body mass index

Body mass index (kg/m²)	Disease	Non-disease	P-value	OR	95% CI	
					Lower	Upper
Type 2 diabetes mellitus						
≥30	3 (33.3)	30 (9.1)	0.02*	15.10	1.51	150.13
25–29.9	4 (44.4)	85 (25.9)	0.08	7.10	0.78	64.60
23–24.9	1 (11.1)	62 (18.9)	0.53	2.43	0.15	39.55
<22.9	1 (11.1)	151 (46.1)	Ref.			
Hypertension						
≥30	1 (16.6)	32 (10.5)	0.492	2.34	0.2	26.63
25–29.9	2 (33.3)	87 (25.8)	0.589	1.72	0.23	12.45
23–24.9	1 (16.6)	62 (18.7)	0.877	1.21	0.1	13.58
<22.9	2 (33.3)	150 (44.5)	Ref.			
Hyperlipidemia						
≥30	1 (25.0)	35 (10.5)	0.277	4.31	0.28	77.43
25–29.9	1 (25.0)	85 (26.3)	0.704	1.77	0.10	27.77
23–24.9	1 (25.0)	62 (18.6)	0.531	2.43	0.15	39.55
<22.9	1 (25.0)	151(45.3)	Ref.			

OR: odds ratio, CI: confidence interval

DISCUSSION

This study was to determine the association between the habitual intake of SSBs (type, frequency, volume, and total amount of free sugar) and BMI among office workers during the COVID-19 pandemic (March to December 2020). Our findings demonstrated that 56.1% of participants were overweight or obese, which is consistent with results from a previous report by *Sakboonyarat* et al [19]. Among 19 types of SSBs, freshly prepared iced milk tea (e.g., milk green tea, Thai milk tea, and bubble tea) and iced lemon tea were the most consumed, and were found to be associated with an increased BMI. This result is consistent

with that of *Phulkerd* et al. [3], who found that the consumption of freshly prepared milk tea increased by approximately 3% from 2018 (270 mL) to 2019 (278 mL). The increasing trend of consuming tea-based beverages may be due to the price of SSBs, which are non-taxable items. This is consistent with *Bleich* et al. [20], who reported a decrease in the consumption of SSBs after the implementation of SSB tax [20-22]. Moreover, tea-based beverages contain caffeine (an addictive substance), leading to their continuous intake, and the experience of tea-related traditional Thai medicine may also incentivize the consumption of these beverages and popularize them among young people and the working population [23].

According to the LC-MS/MS analysis, university staff members consumed an average of 50.25 g (12.56 teaspoons) and 39.18 g (9.75 teaspoons) of added sugar per serving of milk tea and lemon tea, respectively; these values are approximately 2-fold higher than the World Health Organization's recommendations. Moreover, we found that 70.6% of the participants consumed more than 24 g of total sugar per day from SSB, where sucrose was the most prevalent added sugar. In previous reports, high sucrose consumption was found to be associated with an increase in abdominal or visceral fat given its association with metabolic diseases (e.g., type 2 diabetes) [1,6, 7, 24, 25]. This can be explained by sucrose, which is further digested into glucose and fructose, being completely and rapidly absorbed by the body. Fructose is subsequently converted to fat (triglycerides), resulting in lipid deposition in the visceral adipose tissue and reduced insulin sensitivity [26, 27, 28, 29]; therefore, sucrose has a harmful effect on type 2 diabetes. Surprisingly, our results demonstrated that some milk tea samples were supplemented with non-dairy creamer instead of milk as a tea whitener. In experimental animal models fed non-dairy creamer (an enriched high-fat diet), an increased triglyceride concentration and visceral fat accumulation were observed [30]. Therefore, the consumption of iced milk tea may lead to a high calorie intake owing to the inclusion of ingredients containing both sugar and fat, leading to an increased waist circumference and BMI, and adverse health outcomes. Our results imply that the excess consumption of freshly prepared iced tea containing high amounts of sucrose may contribute to overweight and obesity, in particular increased fat storage in the abdominal area (visceral and subcutaneous adipose tissue).

According to the binary logistic regression analysis, the relationship between BMI and metabolic diseases (diabetes, hypertension, and hyperlipidemia) revealed that participants who have obesity (BMI >30 kg/m^2) were 15 times more likely to develop type 2 diabetes than those with a normal weight (BMI 18–23 kg/m^2). This is consistent with a previous report that excess visceral adipose tissue accumulation is associated with type 2 diabetes [24]. Moreover, we found that an increased BMI was associated with an increased waist circumference, indicating that abdominal fat may play a role in the development of type 2 diabetes. The possible mechanism may be explained by a previous study by *Lin* et al. that found that the excess consumption of SSBs may elevate the c-reactive protein concentration, which causes individuals with obesity to experience chronic low-grade inflammation [31]. In the case of adipose tissue inflammation, the remodeling of fat cells plays a crucial role in the development of insulin resistance and diabetes [31, 32, 33, 34]. It is possible that the consumption of SSBs may contribute to weight gain and the development of type 2 diabetes; however, information on SSB consumption prior to the development of type 2 diabetes is lacking. Therefore, the relationship between SSB consumption and the change in visceral adipose tissue need to be further elucidated through longitudinal studies.

Limitations

Many factors contribute to the development of overweight and obesity, such as dietary intake, individual metabolic rate, genetic factors, and SSB consumption; however, this study only focused on the pattern of SSB consumption, leading to uncontrolled confounding. Therefore, a regression analysis for the estimation of the relationship between SSB consumption and overweight/obesity that is adjusted for potentially confounding variables is required to further elucidate this issue. Moreover, the use of a 24-hour dietary recall to record the consumption frequency of SSBs may lead to recall bias. Repeating the 24-hour dietary recall by using an electronic questionnaire, which is a low-burden method, may reduce recall bias.

Implications and future research

Our findings provide evidence-based information on the sugar profile and amount of sugar in freshly prepared iced milk tea beverages, of which the consumption has increased among university staff during the COVID-19 pandemic. Sugar (sucrose) consumption exceeding 24 g/day may be associated with overweight and obesity owing to increasing waist circumference, leading to type 2 diabetes. Further research is necessary to determine the relationship between a) SSB consumption and the change in visceral fat deposition over time, to elucidate the effect of sugar intake on long-term health outcomes, and b) the amount of sucrose obtained via the consumption of SSBs and insulin sensitivity, to facilitate a reduction in sugar content per serving.

CONCLUSIONS

Our study finding found that among 19 types of SSBs consumption during COVID-19 pandemic, the consumption of sugar-containing tea-based beverages, especially freshly prepared milk tea and lemon tea without nutrition facts labels were associated with BMI status. Total sugar content and sugar profile of freshly prepared milk tea and lemon tea were determined using direct method LC-MS/MS. This is due to these beverages containing large amounts of sucrose (approximately 35 g/100 mL) which is further metabolized to synthesize triglycerides, resulting in visceral fat accumulation and adverse health outcomes (Type II diabetes). To minimize the risks related to SSBs, a warning label policy should be implemented on relevant products and in the shops that sell these products.

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Authors' contributions

J.P, L.C, and P. Pouyfung performed the study, analyzed the data, conducted the data interpretation, and drafted the manuscript. A.S, P.K, T.D, and P. Pornpitayalaud performed the study. J.P, and P. Pouyfung designed the study and reviewed the manuscript. All authors proofread and approved the final manuscript.

Declaration of competing interest

The authors declare that they have no conflict of interest.

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ORIGINAL ARTICLE

COMPARISON OF MONOAMINE OXIDASE AND SELECTED HEAVY METALS LEVELS IN THE BLOOD AND THE WORKPLACE AMONG E-WASTE SORTING WORKERS IN UBON RATCHATHANI PROVINCE, THAILAND

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ABSTRACT

Background. E-waste sorting workers usually separate electronic waste. Therefore, they can be exposed to heavy metals.
Objectives. This study compared monoamine oxidase (MAO) levels affected by the levels of lead (Pb), cadmium (Cd), and nickel (Ni) in the blood and their workplace among e-waste sorting workers (EWSW).
Material and methods. The exposed group included 76 EWSW, and the non-exposed group included 49 village health volunteers. An interview form was used to assess the risk factors. We measured Pb, Cd, and Ni on the work surfaces and in the blood, and MAO levels as a neurological enzymes.
Results. Among the EWSW, 42 were males (55.3%), and the mean age (SD) 48.0 (12.64) years, and income were 156.37 ± 88.08 USD. In the work areas of the exposed group, the concentration of Pb, Cd, and Ni were 245.042 (± 613.910), 0.375 (± 0.662), and 46.115 (± 75.740) µg/100 cm2, respectively, while the non-exposed group, the concentration of Pb, Cd, and Ni were 0.609 (± 0.934), 0.167 (± 1.171) and 1.020 (± 0.142) µg/100 cm2. Pb and Ni concentrations in the workplace of the exposed groups were statistically different from that of the non-exposed group. Pb, Cd, and Ni concentrations in serum were 6.411 ± 1.492 µg/dL, 0.9480 ± 0.350 µg/L, 2.568 ± 0.468 µg/L, respectively, while in the non-exposed group, the heavy metal concentrations were 6.411 ± 1.620 µg/dL, 0.909 ± 0.277 µg/L, 2.527 ± 0.457 µg/L. The MAO in the exposed group was 362.060 ± 97.981 U/L, while that in the non-exposed group was 369.771 ± 86.752 U/L. Moreover, MAO concentration was significantly different from Ni concentration ($p < 0.05$).
Conclusion. The electronic waste sorting workers should clean their work areas to reduce the Pb, Cd, and Ni levels on the working surfaces, and health surveillance should be performed.

Key words: *monoamine oxidase (MAO), lead, cadmium, nickel, work area, e-waste sorting workers, Ubon Ratchathani*

INTRODUCTION

Electronic waste sorting workers (EWSW) are informal workers in the northeastern region of Thailand, including Ubon Ratchathani Province. They usually separate electronic waste (EW) around their house for sorting and exporting for further distribution to the EW disposal plant [1]. Therefore, they can be exposed to chemicals and heavy metals [2] such as lead (Pb), cadmium (Cd), and nickel (Ni) [3, 4, 5] during electronic waste sorting [2, 6, 7].

Due to improper hygienic practices, the workers are likely exposed to Pb, Cd, and Ni from e-waste segregation, through inhalation, ingestion, and skin contact [5, 8]. Exposure to these substances causes acute and chronic health implications. If the exposure to these three substances is continued even in low doses, chronic symptoms, especially affecting the central nervous system, will result [9] due to the disruption of neurotransmitters.

The toxicity mechanisms of Pd, Cd, and Ni, as studied in animals with Pb [10], Cd [11], and Ni [12], and in human studies, have shown that Pb [8, 9],

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Cd [13], and Ni [14] can enter the blood and brain to activate enzymes in the central and peripheral neurotransmitters including monoamine oxidase neurotransmitter type A (MAO-A) and serotonin (Serotonin: 5-Hydroxytryptamine, 5-HT). Pd, Cd, and Ni can also interfere with the mechanism of calcium ion signaling ($Ca2^{+}$) [15,16] and enter the Raphe nuclei neurons to produce the neurotransmitter serotonin in the hippocampus [17] and secreted from the brain stem by the serotonin messenger which is responsible for controlling the cognitive system, helping in learning and memory [18].

Exposure to Pd, Cd, and Ni may increase the activation of the enzyme MAO-A in the neurotransmitter [19], which regulates metabolism and catalyzes oxidizing reactions into the metabolism of neurotransmitters. Monoamines include doptopinephrine, epinephrine, and serotonin [20,21] by *Jaya Parasanthi* et al. [22]. In mice, damage to serotonin-producing neuron tissues was found, so MAO-A may play an essential role in activating several neurotransmitters, including serotonin [23]. When exposed to Pd, Cd, and Ni for longer, these heavy metals affect neurotransmitters damaging the central and peripheral nervous systems responsible for perception, comprehension, and memory [24, 25, 26].

Many risk factors may affect the biological indicators and the health effects of EWSW exposed to Pd, Cd, and Ni. These include personal characteristics such as gender, age, monthly income, education level, and body mass index (kg/m^2) [3, 5, 27, 28, 29, 30]; behavioral factors such as smoking and drinking alcohol [31]; and job characteristics factors such as year of working [32] number of working hours [33], and working area size [34]; personal hygiene factors such as improper hand washing, delay to change their clothes after work, washing the body immediately after home arrival [32, 35], lack of wearing personal protective equipment [36], and the amount of exposure to Pd, Cad, and Ni [4, 37].

Environmental and health monitoring must provide appropriate and timely health care for these workers. Moreover, health surveillance should be performed by collecting dust samples to assess these contaminated substances in the air in working areas [38] by measuring the surface wipe [39,40]. Therefore, we conducted the health surveillance study and primary health screening, such as detecting Pd, Cd, and Ni levels in the blood among the EWSW in the Bangkok Subdistrict Khueang Nai District, Ubon Ratchathani Province [5].

Recent studies that measured blood Pb levels among the EWSW in Ghana [41] found that the effects of Pd, Cd, and Ni exposure caused acute and chronic neurologic symptoms [15]. Moreover, a study of Pb blood levels of rats in India showed that low Pb levels activate neurotransmitter enzymes such as monoamine oxide (MAO) [10]. However, no similar study in humans was documented [8]. Similarly, no data have been reported on exposure to Pd, Cd, and Ni and their effects on the nervous system among the EWSW in Thailand. Therefore, this study compared the monoamine oxidase (MAO) levels in the nervous system classified by Pb, Cd, and Ni levels in the blood among EWSW in Ubon Ratchathani Province.

MATERIALS AND METHODS

Study site and population

For this analytical cross-sectional study, data were collected from November 2020 to April 2021. The study population included an exposure group, EWSW whose nature of work was sorting, disassembling, and incinerating parts, and electronic waste collection to wait for distribution within the housing area, and the group was out of reach by village volunteers in the Ubon Ratchathani Province. We calculated the sample size according to the following formula, $n = (Z_2\alpha/2\ \sigma_2)/e^2$ in which the exact population of *Dupont* and *Plummer* [42] is unknown, the confidence level ($Z\alpha$) = 1.96, e = 0.05, and the variance (σ) = 0.22 according to the findings of *Kshirsagar* et al. [43]. The required sample size was at least 74.37. Therefore, we used the estimated error of less than 5% at the 95% confidence level to prevent discrepancies in data collection by purposive sampling and analysis. Therefore, our study included 76 people in the exposure group and 49 non-exposed village health volunteers.

Data collection procedures

In this study, we used questionnaires and sample collection to quantify Pb, Cd, and Ni substances in the work surface. Blood samples were also collected to measure the levels of Pb, Cd, Ni, and MAO enzymes.

1. *Questionnaire:* It included five personal factors such as gender, age (years), monthly income (in USD), educational level, body mass index (BMI), congenital disease; three behavioral health factors, and job characteristics factors such as the number of working years, working hours, working area size. The legitimacy and validity of the structure and content of the interview questionnaires were verified by three independent experts. Moreover, the index of concordance (IOC) was determined using the formula $IOC = \sum R/N$. The interview form of this study had a coefficient of conformity of 0.726.

2. *Surface wipes:* We used the set of equipment comprised of heavy metal dust sampling paper such as Pb, Cd, Ni (Ghost wipes), sample tube, paper frame (Template), size 10 × 10 cm, powder-free rubber gloves label paper, permanent pen, plastic bag, adhesive tape, scissors, shoe cover bag storage box. Ghost wipes

sample submission form was sent to the lab every time with the collected samples. Every batch of the samples included quality control (field blank). We wiped to collecting samples in the work area. The sample collection per field blank was 10 to 1 by opening the wipe paper envelope, then unfolding the sample collection area and packing it back in a tightly closed plastic tube, amounting to one sample per sample collection. We collected eight blank field samples and 76 samples in the EW sorting sites. In the comparison group of 5 samples, field blanks were collected for a total of 49 samples [44].

Pb, Cd, and Ni in the working surface were measured by surface wipe. We collected the samples at the waste sorting area by using paper to wipe in an S-shape from left to right and around the edge of the paper frame (Template), then folded the paper in half, ensuring the sample inside, then placed sampling papers in the sample tube, labeled and sent the samples for particulate composition analysis to determine the content of Pb, Cd, Ni according to method ID-125G metal and metalloid particulates in workplace atmospheres (ICP Analysis) [45] at a laboratory in Bangkok.

3. *Blood sample collection to measure the levels of Pb, Cd, Ni, and monoamine oxidase (MAO) in the blood:* The registered nurse collected the blood samples from the participants at THPH according to the guideline provided [46]. The collected blood 8 mL was divided into two tubes: 5 mL in EDTA tubes for analysis of Pb, Cd, and Ni in the blood, and tubes without EDTA (3 mm doses) to analyze MAO type A.

After proper labeling, the samples were kept at 4°C. Then, the blood samples for analysis of Pb, Cd, and Ni in blood were sent to Khueang Nai Hospital Khueang Nai District, Ubon Ratchathani Province, within 24 hours after collection [35]. Blood samples for MAO-A level [8] were delivered to the laboratory in Chonburi Province within 24 hours [47]. For quality control, the analysis of heavy metals and MAO-A was repeated triplicate, with 10% of all samples re-analysis. However, the results of all field blank heavy metal content analyses must be lower than the Limit of detection.

Data analysis

Descriptive statistics included number, percentage, arithmetic mean, geometric mean, and standard deviation for personal factor, behavioral health factor, working factor, and Pb, Cd, and Ni concentration. Moreover, the median concentration of Pb, Cd, and Ni were analyzed between the exposure and non-exposure groups. We used multivariate analysis of variance to compare the mean Pb, Cd, and Ni concentration in the working surface waste sorting between the exposed and the non-exposed group and the concentrations of Pb, Cd, and Ni between their work surface and these in their blood, and the MAO-A level between the exposed and non-exposed groups or risk factors.

RESULTS

Demographic data

Of the 76 participants in the exposed group, most (55.3%) were male with mean age (SD) of 48 (± 12.645) years. Most of them completed primary school education (55, 72.4%). The average monthly income (SD) was 156.37 (± 88.08) USD, and the mean BMI was 23.00 (± 5.124) kg/m^2. Among them, 34.2% used medication that included diabetes (9, 11.8%), lipid reduction (9, 11.8%), and hypertension (6, 7.9%).

Health behaviors and job characteristics

Among the participants, 51.3% drank alcohol, smoking of 1.276 ± 0.450 cigarettes per day, and ate in the workplace (92.1%). In the exposed group, the average number of working years for EW sorting was 6.08 ± 3.973 years, and the average working hours per day was 7.80 ± 0.980 in the average area of e-waste sorting of 180.16 ± 306.185 squared meters. Most of their past work was farming (77.6%). Moreover, 92.1% and 96.1% wore gloves and arm protection while sorting EW.

The concentration of Pb, Cd, and Ni in the surface wipe (µg/100 cm^2) of the exposed and non-exposed groups

We measured the Pb, Cd, and Ni in dust content in the working surface (µg/100 cm^2) of 76 exposed groups and 49 in the non-exposed group. The median amount of particulate matter containing Pb greater than 2.0 µg/100 cm^2 was observed in 62 samples (49.6%) with the mean concentration of 149.224 (± 492.250) µg/100 cm^2. The standard value by OSHA [48] defines the Pb value in the operating surface area as 500.00 µg/100 cm^2.

The median Cd concentration in the operating surface area less than or equal to 0.000 µg/100 cm^2 was found in 89 samples (71.2%), with a mean concentration of 0.293 (± 0.898) µg/100 cm^2. At the same time, OSHA defines the Cd value in the operating surface area as 50.00 µg/100 cm^2.

The median Ni concentration in the operating surface area was within the standard range according to the OSHA, i.e., the amount was greater than 1 µg/100 cm^2 (49.6%), with a mean concentration of 28.1970 (± 63.022). However, there is no standardized value for Ni in the operating surface area (Table 1).

The blood level of heavy metals and monoamine oxidase (MAO-A)

The mean blood levels of Pb in the exposed and non-exposed groups were 6.4112 ± 1.49274 µg/dL and

Table 1. Concentration of Pb, Cd, and Ni in the surface wipe of the exposed and non-exposed groups

Concentration of heavy metals in dust at operating surface (μg/100cm²)	Exposed group		Non-exposed group		Total		Standard (μg/100cm²)	F	*p*-value
	n	%	n	%	n	%			
	76	100	49	100	125	100			
Lead (Pb)							500.00	19.512	<0.001*
≤ 2	17	22.4	46	93.9	63	50.4			
> 2	59	77.6	3	6.1	62	49.6			
Mean ± SD	245.042±613.910		0.609±0.934		149.224±492.250				
Min-Max	0.170-3,412.00		ND-3.80		ND -3,412.00				
GM ± GSD	24.888±12.159		0.3877±3.886		6.3694±18.839				
Cadmium (Cd)							50.00	0.675	0.207
≤ 0.00	41	53.9	48	98.0	89	71.2			
> 0.001	35	46.1	1	2.0	36	28.8			
Mean ± SD	0.375±0.662		0.1673±1.171		0.2938±0.898				
Min-Max	ND -3.20		ND -8.20		ND -8.20				
GM ± GSD	0.565±2.375		8.199±1		0.608±2.617				
Nickel (Ni)							No standardized value for Ni in the operating surface area.		
≤ 1	16	21.1	47	95.9	63	50.4		35.802	<0.001*
> 1	60	78.9	2	4.1	62	49.6			
Mean ± SD	46.115±75.740		1.020±0.142		28.1970±63.022				
Min - Max	0.180-368.0		1-2		ND -368.00				
GM ± GSD	11.040±7.555		0.3071±2.984		3.0262±11.608				

Note *Standard values are determined by the OSHA Tech manual method [48] because the amount of Cd on the surface of the workplace was below all standard values, and there is no standard value for nickel exposure on surfaces. Therefore, we grouped them according to the median values for these substances as follows: Pb = 2.00 μg/100 cm², Cd = 0.00 μg/100 cm², Ni = 1.00 μg/100 cm².

6.411 ± 1.620 μg/dL, respectively. Similarly, the mean blood Cd values of exposed and non-exposed groups were 0.974 ± 0.389 μg/dL and 0.909 ± 0.277 μg/dL, respectively. The mean blood Ni values of the exposed and non-exposed groups were 2.5958 ± 0.476 μg/dL and 2.527 ± 0.457 μg/dL, respectively. Moreover, the mean serum MAO in exposed and non-exposed groups were 362.060 ± 97.981 μg/dL and 369.771 ± 86.752 μg/dL, respectively (Table 2).

Factors influencing the blood Pb, Cd, and Ni levels

We compared the levels of Pb, Cd, and Ni in the blood of exposed and non-exposed groups classified by personal factors, health behavior, nature of work, and the concentration of these metals in the dust at the work surface.

Demographic factors: Income (USD) was significantly associated with the blood Pb level (F = 1.818, p = 0.041). However, behavioral health factors and job characteristics were not significantly different with blood Pb, Cd, and Ni concentrations. Similarly, the concentration of heavy metals in the dust on work surfaces (μg/100 cm²) showed no significant difference with blood Pb, Cd, and Ni (Table 3).

Comparison of the concentration of monoamine oxidase (MAO) classified by factors

We compared the participants' MAO enzyme levels with their demographic factors, health behavior, job characteristics, and the concentration of Pb, Cd, and Ni in the dust at the operating surface (μg/100 cm²). All variables, including sex, age, monthly income, education level, and BMI, were not statistically significantly associated with MAO enzyme level.

Moreover, the multivariate covariance analysis indicated that the MAO level in the blood was significantly different from the blood concentration of Ni (F = 4.282, Sig. = 0.041) (Table 4).

Table 2. Blood levels of Pb, Cd, and Ni and monoamine oxidase in the exposed and non-exposed groups

Levels of Pb, Cd, and Ni in blood	Exposed group		Non-exposed group		Total		OSHA Standard	Unit
	n	%	n	%	n	%		
	76	100	49	100	125	100		
Lead (Pb)							0-20	µg/dL
≤6.31	40	52.6	23	46.9	63	50.4		
>6.32	36	47.4	26	53.1	62	49.6		
Mean ± SD	6.411±1.492		6.411±1.620		6.411±1.537			
GM ± GSD	6.235±1.272		6.1972±1.310		6.2201±1.286			
Median IQR	6.285 (7.412)		6.670 (7.690)		6.310 (7.475)			
Min-Max	3.01 - 10.84		3.61-9.74		3.01-10.84			
Cadmium (Cd)							0-5	µg/L
≤ 0.91	38	50.0	28	57.1	66	52.8		
> 0.91	38	50.0	21	42.9	59	47.2		
Mean ± SD	0.974±0.389		0.909±0.277		0.948±0.350			
Median IQR	0.915 (1.152)		0.870 (1.050)		0.910 (1.130)			
Min-Max	0.20-2.10		0.30-1.15		0.20-2.10			
GM± GSD	0.894±1.545		0.865±1.387		0.883±1.484			
Nickel (Ni)							0-10	µg/L
≤2.53	37	48.7	26	53.1	63	50.4		
>2.53	39	51.3	23	46.9	62	49.6		
Mean ± SD	2.5958±0.476		2.527±0.457		2.568±0.468			
Median IQR	2.545 (2.817)		2.520 (2.720)		2.53 (2.785)			
Min-Max	1.55-4.05		1.24-3.61		1.24-4.05			
GM± GSD	2.555±1.1953		2.481±1.220		2.525±1.205			
Monoamine Oxidase (MAO)							< 650	U/L
≤353.000	42	55.3	24	49.0	66	52.8		
>353.001	34	44.7	25	51.0	59	47.2		
Mean ± SD	362.060±97.981		369.771±86.752		365.083±93.457			
Median IQR	340.95(415.30)		364.00(417.85)		353.800(415.30)			
Min-Max	175.30-615.20		153.80-610.10		153.80-615.20			
GM± GSD	349.462±1.308		359.666±1.274		353.427±1.294			

Table 3. Comparison of blood Pb, Cd, and Ni with personal factors, behavioral health factors, job characteristics, and the concentration of heavy metals in the dust at the operating surface

Factors	n	Blood Pb (µg/L)		Blood Cd (µg/dL)		Blood Ni (µg/dL)	
		GM ± GSD	F, p-value	GM ± GSD	F, p-value	GM ± GSD	F, p-value
Income (USD)			1.818, 0.041*		1.394, 0.163		0.367, 0.985
≤151.68	73	6.085±1.315		0.168±1.487		2.520±1.223	
>151.68	52	6.h415±1.240		0.942±1.472		2.533±1.179	
Concentration of heavy metals in the dust at the operating surface (µg/100 cm^2)							
Pb			0.750, 0.861				
≤ 2	63	6.231±1.293					
> 2	62	6.208±1.281					
Cd					1.483, 0.079		
≤ 0	89			0.874±1.440			
> 0.001	36			0.903±1.594			

Ni							0.888, 0.681
≤ 1	58					0.388±3.376	
> 1	62					54.663±7.47	

Remark: Independent variables that are insignificant to dependent variables are 1) individual factors such as sex, age (year), educational level, weight, and height; 2) health behavior factors such as alcohol consumption, smoking, and eating at the workplace; 3) job characteristics factors such as the number of working years, working hours working area size, past work history and use of personal protective equipment.

Table 4. Comparison of monoamine oxidase enzymes level with personal factors, behavioral health factors, job characteristics, and the concentration of heavy metals in the dust at the operating surface

Factors (µg/dL)	Monoamine oxidase: MAO (U/L)				
	SS	df	MS	F	*p-value*
Blood Pb	0.135	1	0.135	0.538	0.465
Blood Cd	0.102	1	0.102	0.406	0.525
Blood Ni	1.077	1	1.077	4.282	0.041*
Blood Pb and Cd	0.340	1	0.340	1.352	0.247
Blood Pb and Ni	0.021	1	0.021	0.083	0.773
Blood Cd and Ni	0.007	1	0.007	0.030	0.863
Blood Pb, Cd and Ni	0.092	1	0.092	0.364	0.547
Error	29.440	117	0.252		
Total	317.00	125			

Note Sig, $p < 0.05$*

Independent variables that are insignificant to dependent variables are as follows: personal factors, including sex, age, educational level, and BMI; behavioral health factors such as alcohol consumption, smoking, and eating at their workplace. The job characteristics included the number of working years, working hours, working area size, past working history, use of personal protective equipment, and Pb, Cd, and Ni contamination on work surfaces.

DISCUSSION

In this study, the majority of the exposed group was male (42; 55.3%), with a mean age of 48.00 ± 12.645 years, which was consistent with the study of *Thanthisawapop* et al. [27], who found that the mean age of the exposed group was 48.07 ± 13.19 years. Moreover, most participants completed primary school education (55, 72.4%), consistent with the study by *Kuntawee* et al. [3], which found that most of the EWSW in Thailand were primary school level. *Suraraks* and *Nawwan* [49] described that different education levels affect employees' financial compensation. As a result, workers who segregated EW took a longer working time to increase their monthly income, with an average monthly income of 156.37 (± 88.08) USD.

The minimum wage of Ubon Ratchathani Province is 325 baht (9.09 USD) per day [50], which was consistent with the findings of *Amankwaa* et al. [5]. Their study observed that the average daily income was approximately 6.96–18.10 USD among the EWSW in Ghana.

The mean BMI of the participants was 23.00 (± 5.1247) kg/square meter, which was the lower margin for obesity according to the World Health Organization's body mass index standard of 23.0–24.99 kg/square meter [51]. Therefore, a weight loss program should be considered for obese workers to minimize the risk of non-communicable diseases. Despite no history of underlying diseases in 50 participants (55.8%), 26 (34.2%) had drug treatment for metabolic diseases such as diabetes 9 (11.8%), blood pressure 6 (7.9%), and lipid-lowering 9 (11.8%). This is consistent with the report by *Burns* et al. [52] that found potential cardiovascular damage with abnormal heart rate in a group of workers exposed to e-waste.

In this study, 39 participants (51.3%) drank alcohol and smoked an average of 1.276 ± 0.450 cigarettes per day, which may impair cognitive abilities among these groups [53]. Moreover, EWSW is prone to exposure to toxins that enter the body and may have several adverse health effects, disrupting biochemical mechanisms and affecting decreased brain command. Therefore, educational programs are needed to raise awareness among these workers to abstain from alcohol and smoking. Moreover, 70 participants (92.1%) reported eating in the workplace, and 75 (98.7%) ate breakfast, lunch, and dinner in their workplace.

The exposure group had an average of 6.08 (± 3.9736) years in EW sorting with an average working hour per day of 7.80 (± 0.980) hours, which was consistent with the study of *Akormedi* et al. [33] that found the average working hour of 10 to 12 per day.

In this study, the average e-waste sorting work area was 180.16 (± 306.185) square meters. Although no study observed the relationship between working area size and the health status of the EWSW, a study by *Xue* et al. [54] indicated that heavy metal contamination was found elsewhere in their working area. Due to the diversity of the electronic e-wastes, the workers had to separate and organize e-waste into categories and clean the working area after every operation to minimize exposure to threats.

Regarding their working history, most were farmers (59, 77.6%) and mainly engaged in farming, but e-waste was also sorted throughout the year [55]. Interestingly, 70 participants (92.1%) wore hand protection such as gloves, 73 (96.1%) wore arm protection such as armbands or long-sleeved shirts 67 (88.2%) used safety shoes, such as sneakers or sneakers while working.

Comparison of Pb, Cd, and Ni exposure in a surface wipe (μg/100 cm^2) of exposed and non-exposed groups

The median of all levels of Pb, Cd, and Ni from a surface wipe (μg/100 cm^2) of 76 exposed groups and 49 in the non-exposed groups did not exceed the US OSHA standard [48]. However, a statistically significant difference in the Cd and Ni concentrations in the surface wipe was observed between the exposed and non-exposed groups ($p < 0.001$). Workers may be exposed to Cd and Ni long term, resulting in multi-system illnesses [56]. In the past decade, informal e-waste processing and disposal have taken place in many parts of Thailand [57]. This causes environmental contamination and threatens the health of EW sorters. Therefore, measures for health surveillance in these workers should be conducted according to the Occupational and Environmental Diseases Control Act B.E. 2562 [58]. Additionally, some measures on environmental management, such as cleaning the working area, should be performed regularly after completing their work to reduce Pb, Cd, and Ni contamination [59].

The comparison of concentrations of Pb, Cd, and Ni in the blood between the exposed and the non-exposed groups

In our study, the mean concentrations of the blood Pb, Cd, and Ni in 76 exposure groups and 49 non-exposed groups were within the standard [58]. Moreover, the concentrations of the three substances in the blood were not significantly different between the two groups (F = 1.830, 3.966, 0.535; p = 0.999, 0.284, 0.426).

The concentration of Pb in the blood was consistent with the study by *Kuntawee* et al. [3], which examined the blood lead levels of the exposure group, EWSW in Thailand, and the non-exposed group, farmers. In this study, no statistically significant difference in the blood lead concentrations was identified between the exposed and non-exposed groups. The e-waste sorting area in Ban Kok and Ban Klang in Thailand had insufficient levels of Pb to be assessed, or villagers in the area may be exposed to Pb because of the fertilizers used for agriculture.

Similarly, the serum Cd concentration in this study was consistent with the findings by *Wittsiepe* et al. [41]. They examined the blood Cd concentration of 75 e-waste segregation workers and 40 controls in Ghana. Their study had limitations on the exposed groups because of different food and preparation related to their religion. As the food habits differ among different ethnicities, the cross-sectional study design was not adequate to assess the relationship of Cd exposure in EWSW.

Sirichai et al. [57] examined the blood levels of cadmium in the exposed group, workers sorting EW in Daeng Yai Subdistrict Ban Mai District of Buriram Province, Thailand, and found that the mean blood cadmium level (exposed group vs. non-exposed group) was 1.00±0.33 μg/L vs. 1.17±0.39 μg/L. Separating EW, the EWSW had Cd concentrations slightly lower than those in the no-exposure group.

A study in Ubon Ratchathani Province found the blood concentration of Ni in EWSW was deficient, which was similar to the results by *Li* et al. [60], that observed no significantly different in the blood concentration of the median (range) of Ni between two groups (exposed group vs. non-exposed group): 4.49 (2.64–10.55) vs. 1.88 (0.6–22.22). However, the blood concentration of Ni was higher in the exposed group than in the non-exposed group.

In this study, we observed the normal range of the mean concentrations of neurotransmitter MAO levels (<650 U/L) in the exposed and non-exposed groups (exposed group vs. non-exposed group: 362.060±97.981 vs. 369.771±86.752). Moreover, Comparisons of neurotransmitter MAO concentrations between the exposed and non-exposed groups were not significantly different, consistent with the study by *Shin* et al. [61].

A similar finding was reported by *Marianti* et al. [8], which measured the MAO level among brass workers with heavy metal contamination in Indonesia. However, in their study, heavy metal contamination of Pb was found in the air below the OSHA standard (2005) among the workers with over 8 hours of work daily. In our study, the blood

Pb levels of brass technicians were 24.21± 98.61 µg/dL, which was within 80% of the standard range. Brass technicians had average MAO (SD) levels of 6.72±5.78 IU/ml or 6,720 ± 5,780 U/L. Moreover, elevated MAO-A level was significantly associated with blood lead levels.

The MAO enzyme levels in the nervous system of EWSW can indicate exposure to Ni. However, health screening should be done among EWSW for confirmation. Therefore, further analytical studies should be conducted to explore a cause-and-effect relationship.

Risk factors for serum Pb, Cd, and Ni concentrations

We performed the risk factor assessment for blood Pb, Cd, and Ni levels. Health behaviors, work characteristics, and concentrations of heavy metals in the dust at the operating surface (µg/100 cm^2) were included in this analysis. The monthly income (USD) and the blood Pb level (F = 1.818, p = 0.041) were significantly different. The workers received an average daily wage of 9.09 USD (321.28 baht), which was comparable to the minimum wage rate of Ubon Ratchathani, Thailand, 9.19 USD (325 baht). However, the workers may have an average daily income lower than the minimum wage rate [62], which is consistent with the study by *Amankwaa* et al. [5]. They found that EWSW earned approximately 6.96–18.10 USD per day or 169–450 USD per month. The longer time of working in e-waste sorting may result in higher exposure to lead, cadmium, and nickel.

The concentration of Pb in the dust at the operating surface was a statistically significant difference with the blood Cd levels (p = 0.028) that was consistent with a study by *Ceballos* et al. [63]. The worker touched the scraps of electronic components containing metal during their work, and heavy metal dust on the work surface contaminated the skin and clothing of workers' Pb blood level of more than 10 µg/dL. In addition, a high Ni blood level between the exposed group and the non-exposed group was not exposed to blood cadmium dust on work surfaces

However, the tendency of heavy metal contamination in EW sorting among these workers is higher than that in the general population. Therefore, the Department of Disease Control, Ministry of Public Health, Thailand [59], should establish proper e-waste management by adopting clean and easy-to-implement e-waste processing technology. Additionally, the working area should always be kept clean, and the workers should be aware of the importance of personal hygiene such as bathing, not re-dressing, wearing masks, and appropriate personal protective equipment [44].

Multivariate covariance analysis of the monoamine oxidase (MAO) enzyme level related to the serum heavy metals levels

The multivariate covariance analysis of the activity of levels of MAO enzymes in neurotransmitters indicated no significantly different synergistic effect of the Pb and Cd blood concentrations (F=1.045, p=0.426). The combined analysis of quantitative blood concentrations of Pb and Ni with MAO enzymes in the neurotransmitter found that the blood Pb and Ni levels significantly differed from neurotransmitter MAO levels (Pb: F = 2.5553, p = 0.098 and Ni F = 3.89587, Sig. = 0.040, respectively). However, as a cross-sectional study, the results cannot assume causality.

MAO is a neurotransmitter used as a biomarker for monitoring neurochemical effects. The lead, cadmium, and nickel in the blood cause inflammatory changes and affect the balance of neurotransmitters. MAO can be used to assist in the diagnosis of brain abnormalities in combination with brain imaging [64]. The MOA-B analysis identifies changes from the molecular level to the effect of altered behavior. Moreover, the MAO-A/B ratio was an indicator of Alzheimer's disease [65].

The results of the study are consistent with an investigation by *Zhicheng* et al. [14] that assessed the activity of MAO enzymes in neurotransmitters. The workers exposed to nickel carbonyl results in acute toxicity, causing respiratory and nervous systems damage [66]. The prolonged exposure to nickel carbonyl may cause abnormal symptoms such as excitement, insomnia, variable dreams, headache, dizziness, weakness, poor memory, tightness in the chest, excessive sweating, hair loss, and decreased sexual desire.

In humans, high levels of the neurotransmitter MAO affect the central and peripheral nervous system, especially in nerve endings, where MAO is located on the outer membrane of the mitochondria, to catalyze oxidative deaminization reactions of monoamine and 5-hydroxytryptamine. Therefore, workers exposed to nickel carbonyl over the long term result in biochemical and electrical changes in the nervous system [67].

Our findings on the activity of MAO enzymes among the EWSW in Ubon Ratchathani Province working with Pb, Cd, and Ni, were consistent with *Martínez-Martínez* et al. [68] who studied the behaviors change in exposed individuals. Exposure to Ni^{2+} can change (both inhibition and activation) neurotransmitters serotonin which alters behavior. Similarly, exposure to Ni^{2+} in rodents altered motor activity, learning, and memory and caused anxiety and depression-like symptoms. However, no dose-

dependent relationship was analyzed between these effects [69].

One of the limitations of this study is a cross-sectional design. We only collected the information from the EWSW during the survey period. Moreover, there are limitations in describing other information. Similarly, the quantitative assessment of the heavy metals and MAO were performed only for a certain period. However, the data obtained from this study can be used for future health surveillance in EWSW in Thailand. Additionally, further studies should be investigated the relationship between heavy metal exposure and neurological health conditions in these workers.

CONCLUSION AND RECOMMENDATIONS

In this study, blood levels of heavy metals such as Pb, Cd, and Ni and MAO among the EWSW did not exceed the standard. Moreover, Pb, Cd, and Ni levels in the operating surface did not exceed the normal values. However, a statistical difference in the Pb and Ni concentrations was identified between exposed and non-exposed groups. Similarly, the concentrations of MAO were significantly different from blood Ni levels. Therefore, these workers should promote personal hygiene, and their working areas should be cleaned to reduce the Pb, Cd, and Ni content. Moreover, health surveillance should be encouraged by examining the blood heavy metal levels among the EWSW in Thailand.

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Authors' contributions:

Kornwika Harasarn and Anamai Thetkathuek decided to conduct this study and collected data. Kornwika Harasarn wrote the first draft of the manuscript. Anamai Thetkathuek, Wanlop Jaidee, Nantaporn Phatrabuddha, and Pratchaya Kaewkaen planned the design of the study. Wanlop Jaidee also helped with the research methodology. All authors read and approved the final manuscript.

Disclosure statement

All authors declare that they have no competing interests in this work.

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ORIGINAL ARTICLE

KNOWLEDGE, ATTITUDES AND PRACTICES RELATED TO COVID-19 AMONG HEALTH PROFESSIONALS IN EL JADIDA PROVINCE, MOROCCO

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ABSTRACT

Background. During the COVID-19 pandemic, concerns were raised about the lack of knowledge and awareness of health workers (HW) in hampering the implementation of COVID-19 preventive strategies in hospitals.
Objective. This cross-sectional study aims to explore the knowledge, attitudes, and practices (KAP) of the health workers related to COVID-19 in Moroccan hospitals and health facilities.
Materials and methods. We administered an adapted questionnaire to 242 HW working in Azemmour and El Jadida hospital (two sites) and in 41 health centers in El Jadida province. We carried out a bivariate analysis and used contingency tables and logistic regression models to identify factors associated with different KAP levels.
Results. We found that 90.1%, 8.3% and 60.3% of HW had respectively high levels of knowledge, risk perception attitudes and preventive practices towards COVID-19. High level of knowledge was associated with gender (OR: 0.267; 95% CI: 0.113-0.634; p=0.002), and professional profile (p<0.001). Levels of attitudes were associated with gender (OR: 17.143; 95% CI: 5.450-53.932; p<0.001) whereas levels of preventive practices were associated with position of the HW in COVID-19 (frontline or not frontline) (OR: 0.404; 95% CI: 0.236-0.691; p=0.001) and the overworked status of the HW (OR: 0.421; 95% CI: 0.242-0.730; p=0.002).
Conclusion. Professionals' knowledge and practice levels were higher than their COVID-19 risk perception attitudes. Therefore, efforts should be made to improve the attitudes of health professionals.

Key words: *knowledge, attitude, practice, coronavirus disease 2019, Covid-19, health care workers*

INTRODUCTION

Coronavirus disease 2019 (COVID-19) was declared on 30 January, 2020 by the World Health Organization (WHO) as an international public health emergency. On 11 March 2020, it quickly spread as a global health pandemic [11, 24, 32, 38, 40]. Managing the consequences of COVID-19 pandemic requires resilient health systems that are capable of adapting to diverse global political, economic, social and health systems challenges [25, 28]. Building resilient health systems requires qualified, motivated, and knowledgeable human resources for health (30, 34, 35, 43).

Frontline healthcare workers are considered to be at high risk of contracting and spreading COVID-19 within healthcare facilities [23, 30, 33, 35]. They suffered from increased occupational health risks (extended working hours, stress, burnout, and fatigue) with an impact on their mental health and psychological well-being [4, 16, 20, 23, 30, 34, 36, 42]. Consequences of increased occupational health risk are increased rate of medication errors, staff injuries (13,18) delayed diagnosis. In addition, poor compliance of health workers [22, 27] with COVID 19 control and preventive measures is responsible for increased HW contamination and spread of COVID-19 in healthcare facilities [10, 29, 34]. This was attributed to lack of

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knowledge and awareness of HW about COVID-19 prevention and protective measures [22, 27].

In Morocco, concerns were raised about the lack of knowledge and awareness of HW about COVID-19 measures in hampering the implementation of COVID-19 preventive strategies in hospitals and primary health care. However, limited attention has been placed to measuring the knowledge, attitudes and practices of health workers regarding COVID-19 prevention and control measures. This study aimed at filling this gap by measuring COVID-19 related knowledge, attitudes and practices of health professionals in El Jadida Province in Morocco.

MATERIAL AND METHODS

Method

We conducted a cross-sectional study between 1 and 30th November to 2021, in El Jadida health province, Casa Settat region, Morocco.

Setting

The province of El Jadida is among the provinces that recorded the highest number of cases of COVID-19 in the Casablanca Settat Region in Morocco. El Jadida health province serves a population of 847 994 inhabitants mostly living in rural areas. The provincial health system comprises a provincial hospital center 360 of beds (Azemmour and El Jadida hospital) and 41 health centers, including 29 rural health centers.

Target population and sampling

Our total population of health workers comprises 650 health professionals (doctors, nurses). To calculate our sample, we use STATCALC. We selected a sample of 241 participants with CI of 95%. We adopted a random sampling strategy to select participants.

Data collection methods and tools

To measure the extent of COVID-19 related knowledge of HW, we constructed our questionnaire on the basis of World Health Organization [41] guidelines and two previous validated scales [9, 43]. We collected data using an adapted questionnaire that comprising 17 items measuring the levels of knowledges, risk perception attitudes and preventive practices (KAP) of HW regarding COVID-19. Each response was scored "1" as correct and "0" as incorrect, with scores ranging from 1 to 7. We set a threshold at a score of 5. Below 5 health workers knowledge about COVID-19 was scored as low. Above 5, knowledge about COVID-19 was considered to be high.

We measured risk-perception attitudes by items such as "level of fear of COVID-19", "confidence in defeating the virus" and "feelings of fatigue". Responses were formulated on a Likert scale and then ranked on a dichotomous "yes" or "no" scale. One point was assigned to a yes response and zero points to a no response, with score ranging from 0 to 4 points. Attitude level ≤ 2 was considered to indicate a low level of COVID-19 risk perception, whereas a level > 2 was considered a high level of COVID-19 risk perception.

HW preventive practices were assessed by four questions related to "their participation in training workshops", "use of personal protective equipment (PPE) ", "use of WHO guidelines for hand washing and practices related to quarantine" and "isolation of patients with COVID-19". Each response was scored as "1" correct and "0" incorrect, with scores ranging from 1 to 4. A practice level ≤ 2 was considered to indicate low preventive practices against COVID-19, whereas a level > 2 was considered high preventive practices against COVID-19.

Operational definitions

Frontline health workers: are professionals directly involved in the prevention and treatment of COVID-19 and having direct contact with confirmed or suspected cases via patient intake, screening, inspection, testing, transport, treatment, nursing, specimen collection, pathogen detection, pathological examination, or pathological anatomy of medical and health care professionals and technical personnel.

Overworked status: in this study, healthcare professionals were considered to be overworking if they worked more than an average of 8 hours per day in the previous week.

Statistical analysis

We first performed a descriptive analysis using frequencies categorical variables. We then performed a bivariate analysis to assess the association between the variables using means in contingency tables, using odds ratio (OR) with 95% CI confidence interval, Significant associations are considered if the p value less than 0.05. We finally performed a binary logistic regression to identify factors associated with different levels of COVID-19 related knowledge, risk perception attitudes and preventive practices. We used SPSS version 20 for data analysis.

Ethical considerations

The study respected the ethical considerations, in this case: having the permission and agreement of those in charge of the study environment; having the consent of the participants, after having explicitly communicated to them the purpose and objectives of the research as well as the fate of the information given; openness; transparency and respect towards the participants and guaranteeing their anonymity and confidentiality. The agreement is obtained from

the Ethics Committee for Biomedical Research of the Faculty of Medicine and Pharmacy of the University Mohammed V Rabat, (M/21).

RESULTS

In this study we aimed at exploring the levels of COVID-19 related the knowledge, attitudes and practices of health professionals regarding COVID-19 among 242 HW in the province of El Jadida. In the following sections, we will present the sociodemographic characteristics of study participants, their respective levels of COVID-19 knowledge, attitude, and practices.

Characteristics of study participants

Socio professional characteristics of study participants are listed in Table 1. 76% of the participants were female (CI 95%: 70.7-81.4), with a male sex ratio of 24%. Nurses represents 75.2% of participants (CI 95%: 70.2-80.6) followed by physicians 19.8% (CI 95%: 15.3-24.8) then 3.3% of administrators and 1.7% of technicians. The majority of HW had more than nine years of professional experience (81%), 15.7% of participants had between five and nine years of professional experience, and 3.3% of professionals had less than five years of experience. Frontline health professionals during the COVID-19 pandemic were 62.8%. Finally, about two-thirds of the participants in the study had burnout during COVID-19 (67.8%), while 32.2% of the participants did not.

COVID-19 related knowledge

90.1% of the participants had a high level of knowledge about COVID-19. Of the participants with a high level of knowledge, 8 out of 10 (78.9%) were female. The bivariate analysis presented in Table 2 shows statistically significant association between gender and the level of knowledge (OR: 0.267; CI: 95%: 0.113-0.634; p=0.002).

Doctors participating in the study presented the highest level of knowledge (95.83%) followed by nurses (91.75%) and technicians (75%) and then administrators (50%). The bivariate analysis revealed that the association between the participants' profile and the level of knowledge was statistically significant (p<0.001).

The majority of HW with a high level of knowledge had more than nine years of professional experience (82.1%), followed by professionals with five and nine years of experience (15.1%) and finally professionals with less than five years of experience (2.8%).

Two-thirds of HW with a high level of knowledge were frontline professionals during the COVID-19 pandemic (66.5%) while one-third of the professionals were not front-line (33.5%) with an OR of 0.523 (CI of 95%: 0.188-1.456). 61.5% of HW with a high level of knowledge, were overworked (OR: 0.532; CI 95%: 0.203-1.393).

Three quarters of HW participated in conferences about COVID-19 (73.6%). They also consulted official government websites (75%), news and media (69%), family members and colleagues (80%) and social networks (62%).

COVID-19 related attitudes

91.7% of HW had a low level of COVID-19 risk perception attitude while only 8.3% of HW had a high level COVID-19 risk perception attitude. The majority of female HW (97.82%) had a low level of COVID-19 risk perception attitude, as did male professionals (72.41%). The association between gender and attitude level was statistically significant (p<0.001).

Table 1. Socio-demographic and professional characteristics of participants

Socio-demographic and professional variables		Workforce	Percentage %	CI at 95%
Gender	Male	58	24	18.6-29.3
	Woman	184	76	70.7-81.4
Profile	Doctor	48	19.8	15.3-24.8
	Nurse	182	75.2	70.2-80.6
	Administrator	8	3.3	1.2-5.8
	Technician	4	1.7	0.4-3.3
rofessional experience	<5 years	8	3.3	1.2-5.8
	5 < 9 years	38	15.7	10.7-20.2
	>9 years	196	81	75.6-86.0
Position in Covid-19	Frontline HW	152	62.8	56.6-69.0
	Not Frontline HW	90	37.2	31.0-43.4
Overworked status	Yes	164	67.8	62.0-73.6
	No	78	32.2	26.4-38.0

Table 2. Association between variable and level of knowledge, level of attitudes and level of practice

Socio-demographic and professional variables		Level of knowledge				Level of attitudes				Level of practice			
		Low	High	OR (CI 95%)	P value	Low	High	OR (CI 95%)	P value	Low	High	OR (CI 95%)	P value
Gender	Male	12 (50%)	46 (21.1%)	1 0.267 (0.113-0.634)	0.002	42 (18.9%)	16 (80%)	17.143 (5.450-53.932)	<0.001	28 (29.2%)	30 (20.5%)	1 1.592 (0.878-2.898)	0.124
	Woman	12 (50%)	172 (78.9%)			180 (81.8%)	4 (20%)			68 (70.8%)	116 (79.5%)		
Profile	Doctor	2 (8.3%)	46 (21.1%)	-	<0.001	44 (19.8%)	4 (20%)	-	0.335	14 (14.6%)	34 (23.3%)	-	0.380
	Nurse	15 (62.5%)	167 (76.6%)			168 (75.7%)	14 (70%)			76 (79.2%)	106 (72.6%)		
	Administrator	4 (16.7%)	4 (1.8%)			6 (2.7%)	2 (10%)			4 (4.2%)	4 (2.7%)		
	Technician	3 (12.5%)	1 (0.5%)			4 (1.8%)	0 (0%)			2 (2.1%)	2 (1.4%)		
Professional experience	<5 years	2 (8.3%)	6 (2.8%)	-	0.244	8 (3.6%)	0 (0%)	-	0.613	4 (4.9%)	4 (2.7%)	-	0.168
	5<9 years	5 (20.8%)	33 (15.1%)			34 (15.3%)	4 (20%)			10 (10.4%)	28 (19.2%)		
	>9 years	17 (70.8%)	179 (82.1%)			180 (81.1%)	16 (80%)			82 (85.4%)	114 (78.1%)		
Position in Covid-19	Frontline HW	19 (79.2%)	145 (66.5%)	1 0.523 (0.188-1.456)	0.208	140 (63.1%)	12 (60%)	1 0.879 (0.345-2.238)	0.786	48 (50%)	104 (71.2%)	1 0.404 (0.236-0.691)	0.001
	Not Frontline HW	5 (20.8%)	73 (33.5%)			82 (36.9%)	8 (40%)			48 (50%)	42 (28.8%)		
Overworked status	Yes	18 (75%)	134 (61.5%)	1 0.532 (0.203-1.393)	0.193	154 (69.4%)	10 (50%)	1 0.442 (0.176-1.110)	0.076	54 (56.3%)	110 (75.3%)	0.421 (0.242-0.730)	0.002
	No	6 (25%)	84 (38.5%)			68 (30.6%)	10 (50%)			42 (43.7%)	36 (24.7%)		

About three quarters of the professionals with high attitude level were nurses (70%), followed by doctors (20%) and finally administrators (10%). Professionals with a high level of COVID-19 risk perception attitude had more than nine years of experience (80%). The majority of frontline professionals had a low level of attitudes (92.1%), while 7.9% of frontline professionals had a high level of COVID-19 risk perception attitude (OR: 0.879; CI 95%: 0.345-2.238) indicating a protective significance between professional position and level of attitudes.

50% of HW with a high COVID-19 risk perception attitude level had overwork (OR: 0.442; CI 95%: 0.176-1.110) indicating protective significance (p=0.076).

COVID-19 related practices

60.3% of professionals had a high level of COVID-19 preventive practice while 39.7% had a low level of COVID-19 preventive practices. Female HW had a high level of COVID-19 preventive practices (63.04%) compared to male professionals (51.72%). HW with a high level of practice were nurses (72.6%) and doctors (23.3%).

78.1% of HW with a high level of COVID-19 preventive practices had more than nine years of professional experience. The proportion of health professionals with a high level of knowledge and occupying the first line during the COVID-19 pandemic was 71.2%. The association between the position of professionals during COVID-19 and the level of practice was statistically significant (OR: 0.404; CI 95%: 0.236-0.691; p=0.001).

Finally, the professionals with a high level of COVID-19 preventive practices and developing an overworked status were 75.3%. The association between overworked status and practice level was statistically significant (OR: 0.421; CI 95%: 0.242-0.730; p=0.002).

Logistic regression and potential risk factors

Binary logistic regression analysis of knowledge level in Table 3 predicted that male gender was a risk factor for low knowledge level five times more than female gender (adjusted OR: 5.205, CI 95%: 1.786-15.174). Participants' work experience of less than five years was a risk factor for low knowledge ten times more than work experience of more than nine years (adjusted OR: 10.865, CI 95%: 1.694-69.664). Work experience between five and nine years was a risk factor for low knowledge three times more than work experience greater than nine years (adjusted OR: 3.254, CI 95%: 0.813-13.020).

The different professionals' profiles participating in the study illustrated by physicians (adjusted OR: 0.12, CI 95%: 0.001-0.184), nurses (adjusted OR: 0.54, CI 95%: 0.005-0.601) and administrators (adjusted OR: 0.593, CI 95%: 0.35-10.055) were protective factors for COVID-19 knowledge level.

Binary logistic regression of the level of COVID-19 risk perception attitudes in Table 4 predicted that male gender (adjusted OR: 0.058, CI 95%: 0.19-0.183) was a protective factor for the level of COVID-19 risk perception attitude. Binary logistic regression of preventive practice level in Table 5 predicted that frontline health professional position (adjusted OR: 2.309, CI 95%: 1.336-3.990) and professional burnout status (adjusted OR: 2.196, CI 95%: 1.250-3.859) were factors emphasizing practice level.

Table 3. Predictors of professionals' knowledge of COVID-19

Socio-demographic and professional variables		Wald's statistics	p value	Adjusted OR (95% CI)
Gender	Male	9.134	0.003	5.205 (1.786-15.174)
Profile	Doctor	18.228	<0.001	0.12 (0.001-0.184)
	Nurse	10.084	0.001	0.54 (0.005-0.601)
	Administrator	5.642	0.018	0.593 (0.35-10.055)
	Technician	0.131	0.718	-
Professional experience	<5 years	7.395	0.025	10.865 (1.694-69.664)
	5<9 years	6.331	0.012	3.254 (0.813-13.020)
	>9 years	2.782	0.095	- -

Table 4. Predictors of the level of attitudes regarding the perception of COVID-19 risks by professionals

Demographic variables		Wald's statistics	p value	Adjusted OR (95% CI)
Gender	Male	23.619	<0.001	0.058 (0.19-0.183)

Table 5. Predictors of the level of professional practices with respect to COVID-19

Professional variables		Wald's statistics	p value	Adjusted OR (95% CI)
Position in Covid-19	Frontline health professional	8.989	0.003	2.309 (1.336-3.990)
Overwork status	Yes	7.479	0.006	2.196 (1.250-3.859)

DISCUSSION

This study allowed us to explore the knowledge, attitudes, and practices of health professionals related to COVID-19 in El Jadida Province, Morocco. The analysis of health professionals' knowledge and factors affecting their attitudes and practices may be a starting point to design prevention strategies to reduce the spread of the pandemic among health professionals [43].

This study showed that this study revealed that health professionals had a high level of knowledge about COVID-19. This was consistent with similar studies conducted in China, Egypt, Vietnam, Pakistan, Uganda, Iran, and Nigeria that showed that health care workers had a high level of knowledge about COVID-19 [2, 17, 21, 26, 33, 37, 43]. Nevertheless, other studies have reported a low level of knowledge among health care professionals [9, 30].

The results of this study demonstrated the significant association between gender and the level of knowledge about COVID-19. In addition, the analysis allowed us to categorize male gender as a risk factor for low COVID-19 knowledge level. Our research, in line with other researchers [2, 10, 21, 43] found a significant association between the professional profile and the level of knowledge. Doctors have highest Covid-19 related knowledge than nurses and administrators. Other studies showed no significant difference between the levels of knowledge and the different professional profiles.

This study showed the status of frontline health professionals significantly increased their level of knowledge. This finding was supported by other studies that argued that being in direct contact with COVID patients made health professionals more motivated to learn about the disease and to seek scientific materials and guidelines [2, 43].

This study highlighted, in line with other studies [2, 3, 35, 43, 44] the importance of HW experience, the seniority and age of the HW gaining higher level of COVID-19 related knowledge. These findings support the widely held assumption that greater age and professional experience lead practitioners to adopt a rational, evidence-based approach to dealing with any situation [6].

In addition, this study showed similarly to other studies [2, 7, 9, 16, 17, 26] that the most used sources of information by HW were official government websites followed by news and media and social networks. Other scholars reported other sources of information such as the WHO (7,26), seminars and workshops [1].

This study found that the majority of HW had low levels of COVID-19 risk perception attitude in contrast to their knowledge levels, with no significance between the two levels. This support the assumption having knowledge about COVID-19 and actual attitude are not necessarily correlated [1]. In practice, knowledge is not considered to be determinant in the development of COVID-19 risk-perceived attitudes [4,31,39]. These contrasts with finding from other studies that found, in other settings, a significant association between the level of knowledge and the level of risk perception attitudes of COVID-19 (2,3,9,17,21,26,33,37,43,44)

Our research highlighted, in line with other studies [43], the significant association between the position of the professionals and their longer professional experience (over 9 years) and their level of preventive practice.

This study showed, in line with *Zhang* et al. [43], the association between the level of COVID-19 practice and their working time. In summary, knowledge may lead to better practices [30, 35] but could not be considered as the driver of health workers attitudes and behaviors. Thus, policy makers need not to rely only on COVID-19 continuing education programs [14] to change the attitudes and behaviours of health workers. They need to develop supervisory practices and evaluation in real world settings [8, 12, 19].

Limitation: The study was conducted in a single hospital in Morocco, so the generalizability of the results is limited.

CONCLUSION

Successful management of any pandemic requires an adequate level of knowledge, a high level of risk perception attitude, and an appropriate level of evidence-based practice. The knowledge levels and practice levels of the professionals were higher than their Covid-19 risk perception attitudes. Therefore, efforts should be made to improve the attitudes of health care professionals.

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Declaration of conflict of interest
No authors declared any conflicts of interest.

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ORIGINAL ARTICLE

EVALUATION OF CARDIOVASCULAR DISEASES RISK FACTORS IN A GROUP OF MEN HOSPITALIZED AFTER MYOCARDIAL INFARCTION

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ABSTRACT

Background. Cardiovascular diseases (CVD) due to their large expansion and high mortality represent a serious problem for society. Ischemic heart disease and myocardial infarction is the leading cause of death and morbidity in both men and women in Europe, although is lower in women than in men.

Objective. To evaluate the occurrence of cardiovascular risk factors and the impact of selected dietary habits on lipid profile and body mass index in adult men hospitalized after myocardial infarction in the Cardiocenter Nitra in 2010-2020.

Material and Methods. This study was focused on a group of adult men (n = 193) in the age range of 25 to 85 years. Patients were selected using the method of random selection from the database of those hospitalized in the Cardiocenter Nitra in 2010-2020. We evaluated to influence of risk factors of cardiovascular diseases on lipid profile and BMI of men. The questionnaire for the detection of dietary habits and life style of respondents was used. It was applied individually by interviewer and was compiled by the Institute of Nutrition and Genomics. Data collection was carried out simultaneously with a somatometric and biochemical examination of the respondents ensured by the Cardiocenter Nitra. The following parameters were tested: total cholesterol (T-C), LDL cholesterol (LDL-C), HDL cholesterol (HDL-C) and triacylglycerols (TAG) and glucose (GLU) by automatic biochemical analyzer BioMajesty® JCA-BM6010/C. We used statistical analysis of Statistica Cz version 10 and one-way ANOVA, followed by Tukey's post hoc test.

Results. The most important risk factor is clearly the lifestyle of the respondents. Only 11% of the respondents had an optimal BMI, 51% were classified as overweight and up to 38% had a BMI higher than 30 $kg.m^{-2}$. Improper dietary habits and lack of physical activity contributed to the development of hypertension and hypercholesterolaemia in the majority of respondents. Statistically significant changes in HDL-cholesterol scores were found to be associated with respondents' BMI ($p < 0.01$).

Conclusions. Studied men after the myocardial infarction should attach particular importance to their diet and lifestyle, which significantly affect BMI, blood lipid parameters and the inflammatory process as risk factors responsible for the etiopathogenesis of cardiovascular diseases.

Key words: *myocardial infarct, risk factors, nutrition, lipid parameters, dietary habits*

INTRODUCTION

Cardiovascular diseases (CVD) are one of the leading causes of mortality and morbidity in the world [37]. Over the last decade, the number of CVD deaths worldwide has increased by 12.5%. There are various reasons for this progressive number of cardiovascular deaths. In 2016, the primary cause of the total CVD burden was coronary heart disease, which accounted for 49% of the total CVD burden, followed by stroke with 33% of the total CVD burden [32].

According to the WHO [41] the biggest danger in the world is coronary heart disease, which is responsible for 16% of all deaths in the world. The largest increase in deaths has been since 2000, rising by more than 2 million in 2019 to 8.9 million deaths. Stroke and chronic obstructive pulmonary disease are the leading causes of death, accounting for approximately 11% and 6% of total deaths in the world.

Ischemic heart disease and myocardial infarction are the leading cause of death and morbidity in both men and women in Europe, although the incidence and prevalence of coronary heart disease by age is lower in women than in men [36].

In addition to medical history and physical examination, myocardial ischemia may be associated with ECG changes and elevated biochemical markers such as cardiac troponins [29].

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Mortality after myocardial infarction has decreased significantly since the 1990s, while the number of patients recovering from myocardial infarction has increased. Nevertheless, in people who have recovered from the acute phase, myocardial infarction has a morbidity and mortality rate 1.5 - 15 times higher than in the general population, depending on gender and clinical manifestations. These individuals have a higher risk of subsequent myocardial infarction, angina pectoris, heart failure, and stroke [22, 25].

Risk factors are generally classified as modifiable (habits, environment, etc.) or non-modifiable (age, gender, genetic predisposition). Influenceable factors are considered critical for prevention because specific, targeted interventions may be able to alleviate the risk burden [9, 26]. The cardiac function of the human heart changes with age. An age-related change in systolic function is, under normal conditions, mild but sudden under stress or in a state of pathogenesis. Gradually with age are reduce the heart's tolerance to stress and increases susceptibility to ischemia [7]. Gender is characterized by the biological characteristics of the individual, which are determined by chromosomal complement and sex hormones. The influence of these biological factors on the development of cardiovascular diseases is well known. Testosterone deficiency is generally associated with an increase in serious cardiovascular adverse events, particularly myocardial infarction and stroke in men [8].

A positive (parental) family history of cardiovascular disease, especially at baseline, is a widely accepted risk factor for cardiovascular events in offspring [11, 34]. Obesity is associated with the development of various lifestyle-related diseases and is also known to be a strong risk factor for CVD [14]. Obesity is associated with an increased risk of developing cardiovascular disease, especially heart failure and coronary heart disease. Mechanisms by which obesity increases the risk of CVD include changes in body composition that can affect hemodynamics and alter heart structure. Pro-inflammatory cytokines produced by adipose tissue alone may induce cardiac dysfunction and may promote atherosclerotic plaque formation [5, 21].

Dyslipidemia is a common cause of atherosclerosis. It is manifested by cardiac, vascular disorders, sudden stroke, arterial hypertension, myocardial infarction [10]. Psychosocial factors, such as low socioeconomic status, acute or chronic stress, and depression or anxiety, are highly prevalent in cardiac patients and are associated with behavioral and biological risk factors. Thus, they are associated with a higher risk of cardiovascular disease and an unfavorable course of the disease [1, 45].

Nutrition plays an important role in the development of CVD. Choosing healthy foods reduces cardiovascular risk by weight loss, lowering blood pressure, affecting blood lipid levels, blood glucose levels [3, 13].

Tobacco smoking continues to be a major risk factor for CVD and the leading avoidable cause of death worldwide [2, 17].

Barry et al. [2] performed a meta-analysis regarding the association between cardiorespiratory fitness and BMI on mortality, and found that overweight unfit individuals showed more than double the risk of mortality compared with non-obese fit individuals, while overweight individuals who were fit did not experience significant risk. This is known as the "fat but fit" phenomenon, in which a higher level of fitness tends to negate the adverse cardiovascular effects of obesity. The authors of this study concluded that unfit individuals have twice the risk of death regardless of BMI, while overweight/obese individuals who are fit have a mortality risk similar to their normal weight counterparts.

The aim of this study is to evaluate the occurrence of cardiovascular risk factors and the impact of selected dietary habits on lipid profile and BMI in adult men hospitalized after myocardial infarction.

MATERIALS AND METHODS

This study was focused on a group of adult men (n = 193) in the age range of 25 to 85 years. In the age categories: < 40 years - 3.1%, 40 – 49 years - 8.8%, 50 – 59 years - 32.6%, 60 – 69 years - 40.4% and 70 and over -15.1%. Patients were selected from the database of those hospitalized in the Cardiocenter, Nitra (Slovakia) in 2010 – 2020.

This study was approved by the Ethics Committee of the Specialized Hospital St. Zoerardus Zobor (protocol number 10.6.2014). Participants signed the written consent before participating in the study.

Patients were selected using the method of random selection (those whose health condition allowed them to cooperate). We evaluated to influence of risk factors of cardiovascular diseases on lipid profile and BMI of men. In addition to basic anthropometric parameters, we also evaluated social aspects, respondents' medical history and biochemical parameters. We used the questionnaire method for the detection of dietary habits and life style of respondents. The questionnaire was applied individually by interviewer and was compiled by the Institute of Nutrition and Genomics. The first part questions concerned of socio-demographic situation of the subjects, physical activity, use of tobacco and medical history. The second part concerned the analysis of selected dietary habits, including the number of meals, regularity and the eating frequency of selected group of food products.

Data collection was carried out simultaneously with a somatometric and biochemical examination of the respondents ensured by the Cardiocenter in Nitra. The lipid profile in blood serum was measured by automatic biochemical analyzer BioMajesty® JCA-BM6010/C (DiaSys Diagnostic System GmbH). Parameters, considered to be one of the major risk factors for cardiovascular diseases, were evaluated: total cholesterol (T-C), LDLcholesterol (LDL-C), HDL cholesterol (HDL-C), triacylglycerols (TAG) and glucose (GLU). The anthropometric parameters - body weight (kg) and height (cm) were measured on outpatient electronic medical scales (Tanita WB-3000, Tanita Co., Tokyo, Japan). BMI was calculated by dividing the body weight in kilograms by the square of the height in meters.

Statistical Analysis

The data were checked for normality using the *Shapiro-Wilk* test. Statistical analysis of Statistica Cz version 10 (TIBCO Software Inc., Palo Alto, CA, USA) and MS Excel 2010 was used. Data were expressed in numbers as mean±standard deviation (SD) and statistical comparisons were made between groups using one-way analysis of variance (one-way ANOVA) followed by *Tukey's* post hoc test. Significance was accepted when $p < 0.05$.

RESULTS AND DISCUSION

Age is one of the main uncontrollable risk factors for cardiovascular disease. In men, the risk age is > 50 years. In the monitored group, we recorded up to 88.1% of respondents in the category over 50 years old and 11.9% of men were younger than 49 years old (Table 2). Similar results were recorded by *Lisowska* et al., that myocardial infarction in young adults under 45 represents approximately 10% of all cases [19].

The average body height of the respondents reached 1.76 m. The height of the respondents ranged from 1.59 m to 1.92 m. The average body weight was 89.75 kg. Respondents' body weight values ranged from 60 kg to 135 kg. BMI (body mass index) from the data on body height and weight was calculated. The National Institutes of Health uses BMI to define a person as being underweight, normal weight, overweight, or obese [40]. The BMI of the respondents ranged from 21.95 $kg.m^{-2}$ - 41.76 $kg.m^{-2}$, while the average BMI of the respondents was 29.08 $kg.m^{-2}$ (Table 1). 38.3% of the respondents had obesity >30 $kg.m^{-2}$. Our survey confirms high prevalence of overweight and obesity among men with cardiovascular disease.

Social conditions and education play an important role in the prevention and treatment of cardiovascular diseases. Our group was dominated 57% of respondents with secondary education and 32% respondents of higher education. The fewest respondents stated that they completed only basic education 11%. There were employed 37.3% respondents and retired were 48.6%, the others were not economically active. One of the factors that may be related to CVD is marital status. The benefits of marriage on health and mortality have been demonstrated for both sexes, in different ethnic groups. A better prognosis is known in married people after myocardial infarction and after a stroke [42]. The majority of respondents 80 % stated that they share their household with their family and 20% respondents live alone (Table 2).

In addition to myocardial infarction, several respondents from the selected group also suffered from other associated diseases. Cardiovascular disease, hypertension and hypercholesterolemia were the most common co-diagnoses, affecting 46% of respondents. The second most common disease was diabetes mellitus, which occurred in 21% of respondents. Gastrointestinal disorders occurred in 14%, musculoskeletal disorders (12%) and oncological diseases in 3% of respondents.

Hyperglycemia is fasting blood glucose in values higher than 6-7 $mmol.l^{-1}$. After a meal and during the day, a serum glucose value of more than 8-10 $mmol.l^{-1}$ is considered hyperglycemia [27]. We recorded the blood glucose values measured in the blood serum of the respondents 76% of the respondents from the group of patients who had not been treated before had a blood glucose higher than 5.6 $mmol.l^{-1}$. and KVO.

Table 1. Characteristics of study participants (n = 193)

Characteristics	Average ± SD	Min	Ma.
Age (years)	60.90 ± 10.86	25	85
Body height (m)	1.75 ± 0.07	1.59	1.92
Weight (kg)	89.56 ±13.32	60	135
BMI ($kg.m^{-2}$)	29.08 ± 3.58	21.95	41.67

Note: SD – standard deviation; Min – minimum value; Max – maximum value

Table 2. Demographic characteristics in study participants (n = 193)

Characteristics	%	Characteristics	%
Education:		*Family status:*	
basic	11.0	married	66.0
secondary	57.0	single	18.0
higher	32.0	widowed	16.0
Social status:		*Age categories*:	
employed	37.3	< 40 years	3.1
unemployed	16.1	40 – 49 years	8.8
retired	48.6	50 – 59 years	32.6
		60 – 69 years	40.4
		> 70 years	15.1

In the group of respondents who had previously been treated for cardiovascular disease, the blood glucose level was higher than the norm of 52.3% (Table 4).

Disorders of plasma lipid and lipoprotein metabolism (dyslipoproteinemia) represent a group of metabolic diseases characterized by elevated plasma lipid and lipoprotein levels or their inappropriate atherogenic composition. This is a disorder of synthesis or a disorder of their degradation. They are currently considered to be one of the most important risk factors for cardiovascular disease [12]. The optimal value of total cholesterol in an adult should not exceed 5.2 mmol.l^{-1}. An increased cholesterol level is considered to be from 5.2 to 6.2 mmol.l^{-1}. Values above 6.2 mmol.l^{-1} are considered high and above 7.8 mmol.l^{-1} a very high risk [27].

In the group of respondents without previous treatment, increased values of total cholesterol were measured in 24.4% and high-risk values in 13.4% respondents. In previous respondents, total cholesterol levels were elevated in 23.4% and very high cholesterol levels in 9.0% respondents. The optimal value of HDL-cholesterol in an adult male is 1.5 mmol.l^{-1}. If the values are lower than 1 mmol.l^{-1}, there is a greater presumption of the development of cardiovascular diseases [35]. In the case of people with a high cardiovascular risk, it is necessary to achieve LDL-cholesterol levels below 2.5 mmol.l^{-1} and in patients with a very high cardiovascular risk or diabetes, an even stricter value, less than 1.8 mmol.l^{-1} [35]. LDL-cholesterol levels > 2,5 were found in 36.1% respondents with previous treatment and 35.4% without previous treatment. The optimal value of TAG is considered to be <1.7 mmol.l^{-1}. The limit value is in the range of 1.7–2.3 mmol.l^{-1}. The high level of TAG is in the range of 2.3-5.6 mmol.l^{-1} [12]. We recorded the average, minimum and maximum value of lipid parameters of the respondents in Table 3.

Respondents stated that they regularly monitor blood pressure values. The optimal blood pressure value is considered to be a systolic blood pressure value of 120 mmHg and a diastolic blood pressure value of 80 mmHg. Hypertension (high blood pressure) is defined as systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg. Systolic blood pressure values below 90 mmHg and diastolic blood pressure values below 60 mmHg are considered low [16]. We observed high blood pressure 44.3% of respondents with previous treatment and 49.2% without treatment (Table 4).

Table 4 summarizes the most serious cardiovascular risk factors and percentages from the group of respondents after overcoming a myocardial infarction. Our survey confirms high prevalence of overweight (50.7%) and obesity (38.3%) among men with cardiovascular disease. Smoking, both active and passive, is an established vascular risk factor and one of the most serious global health problems and its harm to human health is of no doubt. It clearly leads to the progression of atherosclerosis. This risk increases with the number of cigarettes smoked per day [17]. The results of our research show that 38% of men currently smoke, up to 61 % of men smoked in the past and 23 % of men stopped smoking due to the disease.

Epidemiological data strongly suggest that the lack of physical activity significantly contributes to the increasing incidence of chronic diseases, especially cardiovascular. The main interventions in secondary prevention after overcoming an MI includes: smoking cessation, changing dietary habits and weight control, increasing physical activity to 30 minutes of moderate-

Table 3. Characteristics of lipid profile in study participants (n = 193)

Parameters	Average ± SD	Min	Max
TC (mmol.l^{-1})	4.74 ± 1.16	1.99	7.8
LDL-C (mmol.l^{-1})	3.05 ± 0.99	0.61	5.62
HDL-C (mmol.l^{-1})	1.14 ± 0.36	0.52	2.82
TAG (mmol.l^{-1})	1.67 ± 1.00	0.45	7.39
GLU (mmol.l^{-1})	6.89 ± 2.51	4.11	24.12

Note: SD – standard deviation; Min – minimum value; Max – maximum value

Table 4. CVD risk factors in study participants

Risk factors	%	Risk factors	T %	NT %
BMI > 25 (kg.m^{-2}) BMI > 30 (kg.m^{-2}) - obesity	50.7 38.3	TC > 5,2 (mmol.l^{-1})	32.4	37.8
Smoking	38.0	HDL-C < 1 (mmol.l^{-1})	44.1	39.0
Physical activity <30 min per day	45.0	TAG < 1,7 (mmol.l^{-1})	35.1	42.7
Positive family history	42.0	GLU > 5,6 (mmol.l^{-1})	52.3	64.6
Stres	42.0	Blood pressure > 130/85 (mmHg)	44.3	49.2

Note: BMI – body mass index; TC – total cholesterol; (LDL-C) – LDL cholesterol; (HDL-C) – HDL cholesterol; TAG – triacylglycerols; GLU – glucose; T- previously underwent treatment for cardiovascular disease, NT – non treatment before IM

intensity exercise at least five times a week and arterial pressure control [20].

Current physical activity of our respondents is very limited due to the bad health condition. 45% of men report moderate physical activity < 30 minutes per day. 23% of men adjusted their physical activity and increased it to 30-60 min 3 times a week, the rest have almost no physical activity.

A family history of premature CVD is a simple indicator of the risk of developing CVD, which is a reflection of genetic influence and shared environmental influence among members households. In men, the family history of CVD in relatives of the first is monitored degree, before the age of 55 [31]. Our survey confirms a high genetic predisposition to CVD in 45% of men.

Obesity is one of the most common risk factors for cardiovascular diseases and diabetes. We compared the biochemical parameters of respondents with BMI below and above 30 $kg.m^{-2}$ in table 5. According to the average values, LDL-cholesterol and triacylglycerols were considered risk values. There were statistically significant changes in the evaluation of HDL-cholesterol in connection with the BMI of respondents ($p<0.01$). In the association between the age and the lipid profile of the respondents, we can state that almost 57.5% of the respondents were treated with statins before the myocardial infarction, therefore the lipid profile adjusted with age in average values in the reference range without statistically significant changes ($p>0.05$) (Table 5).

Among the many known risk factors affecting CVD, it plays a role nutrition plays an important role. In recent decades, numerous studies have allowed us to understand the relationship between diet and cardiovascular health. American Heart Association guidelines in the primary prevention of cardiovascular disease diseases emphasize the connection with CVD mortality of the most common way of eating with high intake of simple sugars, low-calorie sweeteners, trans-fats, higher intake of sodium and red meat, especially their products (bacon, salami, ham, sausages, sausages) [38]. Reducing excess calories and improving composition diet can prevent many primary and secondary cardiovascular events. In the monitored group of patients, 103 patients did not follow any diets and 90 patients followed diets (diabetic 46.79%, low-fat 34.85% and salt-restricted diet 18.36%).

Wang et al. [39] indicates in their meta-analysis that higher consumption of red meat and processed meat is associated with an increased risk of total, cardiovascular, and cancer mortality. Increased cardiovascular risk related to high consumption of red and processed meat has been linked to their high content of saturated fatty acids (SFA) and cholesterol [15, 33]. Nevertheless, findings from randomized controlled trials assessing the effect of red meat intake on CVD risk factors are inconsistent [28, 43].

We evaluated the impact of respondents' red meat consumption. Table 6 shows the effect of the frequency of consumption of meat on the lipid profile. Pork was consumed most often. 57.5% of the participants indicated that they consumed this meat 1 – 2 times per week, 10.9% consumed 3 – 4 times per week, 30.1% did not consume pork and only 1.5% of respondents ate pork occasionally. The majority of respondents (53.4%) did not consume beef at all or sometimes. Of the meat products, sausages and salami were the most consumed. 21% of respondents consumed sausages daily.

The results show, that most respondents consume red meat 1 – 2 times per week, while we did not notice a significant effect ($p >0.05$) of the type of pork and beef on the lipid profile. The highest TAG values were seen in respondents who consume pork 3 – 4 times per week. The effect of pork meat on LDL-C was the only

Table 5. Effect of BMI and age on respondents' lipid parameters

Respondents' BMI	TC $mmol.l^{-1}$ average ± SD	TAG $mmol.l^{-1}$ average ± SD	HDL-C $mmol.l^{-1}$ average ± SD	LDL-C $mmol.l^{-1}$ average ± SD
≤ 30 $kg.m^{-2}$	4.72±1.10	1.74±1.12	1.19± 0.42	3.02±1.05
> 30 $kg.m^{-2}$	4.83±1.34	1.83±1.10	1.10±0.32	3.11± 1.04
p-value	> 0.05	> 0.05	< 0.01	> 0.05
Age categories				
< 40 years	5.53±0.71	2.10±1.20	0.81±0.12	2.58±0.69
40 – 49 years	4.89±0.81	1.34±0.56	1.21±0.27	3.16±0.66
50 – 59 years	4.75±1.14	1.68±0.90	1.10±0.33	3.08±0.98
60 – 69 years	4.72±1.26	1.75±1.12	1.19±0.43	2.95±1.05
> 70 years	4.85±1.11	1.55±0.98	1.10±0.20	3.25±1.04
p-value	> 0.05	> 0.05	> 0.05	> 0.05

Note: BMI – body mass index; TC – total cholesterol; (LDL-C) – LDL cholesterol; (HDL-C) – HDL cholesterol; TAG – triacylglycerols; SD – standard deviation

statistically significant ($p < 0.05$). Of the meat products, frankfurters (hot dogs) and salamis were consumed the most, 3 – 4 times per week (61%). Approximately 10% of respondents consume frankfurters daily, which is associated with higher LDL-C and lower HDL-C levels. In the questionnaire we also asked about eating Slovak brand products such as sausages and head cheese. These products were less popular with respondents. They appeared in the respondents' menus only occasionally.

We recorded a significant effect ($p<0.05$) of the consumption of frankfurters on the LDL-C, HDL-C and TAG. Processed meats such as sausages have a higher content of saturated fatty acids and cholesterol than fresh red meat; reaching the proportion of fat in sausages more than 50% of weight [18]. 24% of respondent state that they did not consume sausage and head cheese, 33% respondents consume this product sometimes and 31% in frequency 3 – 4 times per week. However, respondents who did not consume sausage have, on average, a significantly higher TAG compared to less frequent consumption (Table 6).

Consumption of protective foods as fish, fruits and vegetables reduces the risk of cardiovascular disease. Increasing evidence links fish consumption to a low risk of CVD and mortality among the general population [6]. The evidence also shows an inverse relationship between fish consumption and the incidence of sudden cardiac death [23, 24]. The benefits to the heart associated with consuming fatty fish are likely to be associated with beneficial effects on a number of CVD risk factors, such as lowering triacylglycerols and improving HDL-C levels [4].

Fish consumption in Slovakia is low, which is confirmed by this research. Alarmingly up to 37% of respondents followed the recommended intake of fish (twice a week), the others consumed fish 1 – 3 times per month and occasionally. In the consumption of freshwater fish, we found a statistically significant effect ($p < 0.05$) on the level of triacylglycerols between

Table 6. Effect of frequency of red meat and processed meat consumption on lipid profile

Frequency of consumption	n (%)	TC mmol.l^{-1} average ± SD	LDL-C mmol.l^{-1} average ± SD	HDL-C mmol.l^{-1} average ± SD	TAGmmol.l^{-1} average ± SD
Pork					
1-2 times per week	98(50.7)	4.69±1.12	3.00±0.96	1.15±0.38	1.63±0.99
3-4 times per week	8 (4,1)	4.94±1.49	3.14±1.05	1.10±0.30	1.72±0.73
no consumption	0	4.84±1.12	3.19±1.03	1.10±0.32	1.61±1.12
p-value		>0.05	<0.05[b]	>0.05	>0.05
Beef					
1-2 times per week	49 (25.4)	4.82±1.18	3.14±0.09	1.14±0.34	1.61±0.90
3-4 times per week	6 (3.1)	4.55±0.99	2.86± 1.07	1.23±0.50	1.46±0.41
no consumption	10 (5.2)	4.79±1.26	3.03±0.97	1.10±0.30	1.88±1.30
p-value		>0.05	>0.05	>0.05	>0.05
Salami					
1-2 times per week	96 (49.7)	4.70±1.19	2.98±1.04	1.15±0.39	1.71±0.95
3-4 times per week	23 (11.9)	4.72±1.24	3.12±0.97	1.15±0.24	1.44±0.89
sometimes	11 (5.7)	5.21±1.00	3.45±0.92	1.04±0.26	1.70±0.68
no consumption	13 (6.7)	4.92±1.16	3.16±0.83	1.11±0.83	1.96±1.75
p-value		>0.05	>0.05	>0.05	>0.05
Frankfurters					
daily	30 (15.5)	5.04±0.85	3.48±0.91	1.03±0.14	1.50±0.51
3-4 times per week	28 (14.5)	4.68±1.14	2.95±1.03	1.17±0.42	1.74±0.87
3-4 times per month	56 (29.0)	4.40±1.04	2.79±0.78	1.23±0.78	1.27±0.53
no consumption	11 (5.7)	5.02±1.39	3.24±1.05	1.02±0.28	1.99±1.55
p-value		>0.05	<0.05[c]	<0.05[d]	<0.05[d]
Slovak brand products (sausage, head cheese)					
3-4 times per week	58 (30.0)	4.64±1.01	3.00±0.85	1.14±0.34	1.61±0.75
sometimes	31 (16.1)	4.87±1.22	3.16±1.08	1.14±0.32	1.39±0.53
no consumption	33 (17.1)	4.86±1.24	3.03±1.09	1.09±0.45	2.05±1.15
p-value		>0.05	>0.05	>0.05	<0.01[d]

Note: TC – total cholesterol; (LDL-C) – LDL cholesterol; (HDL-C) – HDL cholesterol; TAG – triacylglycerols; SD – standard deviation; [b] Significant difference between 1 – 2 times per week and no consumption, [c] Significant difference between daily consumption and 3-4 times per month, [d] Significant difference between non consumption and 3-4 times per month

the respondents who did not consume fish and the respondents who consumed it 1 – 3 times per month. We also found a statistically significant effect ($p < 0.05$) on the level of HDL-C between the respondents who consumed it 1 – 3 times per month and sometimes. We found the highest statistically significant effect ($p < 0.01$) on the level of HDL cholesterol between of respondents who consumed freshwater fish 1 – 2 times per week and sometimes. The different frequencies of sea fish consumption showed non-significant changes regarding the lipid profile (Table 7).

Fruits are similarly recommended on various heart-healthy diets due to their antioxidant and anti-inflammatory effects, high satiety profile and generally low glycemic index. In particular, berries (blueberries, currants) are associated with flavonoids called anthocyanins, which regulate endothelial function and glycemic metabolism. More than 3 portions of berry consumption per week are associated with a reduction in blood pressure and a reduced risk of diabetes type 2 [30]. The fruit was in the menu of each of the respondents. 60% of respondents consume fruit every day, 21% of respondents stated that they consume fruit 1 – 2 times a week, 17% of respondents consume fruit 3 – 4 times a week and the others consume fruit only occasionally (Table 7).

According to *Yahia* et al. [44] a diet rich in vegetables is an important factor in the prevention of cardiovascular diseases. 3 portions of vegetables and fruits a day achieved a positive effect. The relative risk can be minimized to a large extent by increasing the consumption of vegetables and fruits by up to 10 servings per day. The inverse relationship between vegetable and CVD intake was more evident in smokers who consumed at least 2.5 servings of fruits and vegetables per day compared to less than 1 serving/day. The level of fruit and vegetable intake showed a significant inverse relationship with CVD risk factors.

The frequency of vegetable consumption in the monitored group of respondents was as follows: 55% of respondents consume vegetables daily, 22% of respondents consume vegetables 3 – 4 times a week, 17% of respondents consume vegetables 1 – 2 times a week and others (6%) consume vegetables occasionally. The different frequencies of consumption fruit and vegetables showed non-significant changes regarding the lipid profile.

Table 7. Effect of frequency of protective food consumption on lipid profile

Frequency of consumption	n (%)	TC mmol.l^{-1} average ± SD	LDL-C mmol.l^{-1} average ± SD	HDL-C mmol.l^{-1} average ± SD	TAG mmol.l^{-1} average ± SD
Freshwater fish					
1-2 times per week	81 (41.7)	4.66±3.25	2.99±0.89	1.11±0.29	1.58±1.06
1-3 times per month	73 (37.8)	4.80±1.31	3.11±1.10	1.11±0.35	1.53±0.92
sometimes	24 (12.4)	5.17±1.04	3.16±1.11	1.37±0.53	2.00±0.82
no consumption	14 (7.3)	4.27±0.68	2.81±0.74	1.10±0.32	2.29±1.03
p-value		>0.05	>0.05	<0.01[b], <0.05[c]	<0.05[d]
Sea fish					
1-2 times per week	49 (25.4)	4.74±1.15	2.95±0.99	1.15±0.45	1.86±1.31
1-3 times per month	34 (17.6)	4.72±1.38	3.05± 1.15	1.09±0.32	1.47±0.83
sometimes	27 (14.0)	4.77±1.01	3.02±0.84	1.17±0.35	1.46±0.66
no consumption	29 (15.0)	4.81±1.10	3.27±0.94	1.15±0.24	1.95±0.93
p-value		>0.05	>0.05	>0.05	>0.05
Fruit					
daily	116 (60.1)	4.77±1.23	3.06±1.00	1.10±0.31	1.64±0.85
3-4 times per week	33 (17.1)	4.60±1.14	3.03±0.86	1.12±0.29	1.86±1.64
1-2 times per week	40 (20.7)	4.83±1.04	3.06±1.11	1.26±0.51	1.66±0.79
p-value		>0.05	>0.05	>0.05	>0.05
Vegetables					
daily	106 (54.9)	4.73±1.17	3.05±1.06	1.13±0.40	1.65±0.98
3-4 times per week	42 (21.8)	4.75±1.06	3.07±0.88	1.12±0.25	1.57±0.63
1-2 times per week	32 (16.6)	4.79±1.27	3.01±0.94	1.18±0.35	1.84±1.30
p-value		>0.05	>0.05	>0.05	>0.05

Note: TC – total cholesterol; (LDL-C) – LDL cholesterol; (HDL-C) – HDL cholesterol; TAG – triacylglycerols; SD – standard deviation; [b] Significant difference between consumption 1 – 2 times per week and sometimes, [c] Significant difference between consumption 1-3 times per month and sometimes, [d] Significant difference between non consumption and 1-3 times per month

CONCLUSION

A detailed examination of all the facts reported by the patients in the questionnaire led us to the conclusion that the development of cardiovascular diseases is mainly due to the influence of controllable risk factors. The most important risk factor is clearly the lifestyle of the patients. Only 11% of the respondents had an optimal BMI. 51% were classified as overweight and up to 38% had a BMI higher than 30 $kg.m^{-2}$. Improper dietary habits and lack of physical activity contributed to these unfavorable results, which also contributed to the development of hypertension and hypercholesterolaemia in the majority of respondents. The statistically significant changes in HDL cholesterol scores were found to be associated with respondents' BMI ($p < 0.01$). Nutrition and lifestyle play an important role in the prevention of cardiovascular diseases, which significantly affect blood lipid parameters, the inflammatory process, vascular endothelial elasticity and factors determining the etiopathogenesis of cardiovascular diseases.

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Conflict of interest statement

The authors declare no conflict of interest.

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ORIGINAL ARTICLE

EVALUATION OF ANTHROPOMETRIC METHODS FOR FAT MASS MEASUREMENT IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE PATIENTS

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ABSTRACT

Background. Chronic obstructive pulmonary disease (COPD) is a chronic inflammatory lung disease that causes obstructed airflow from the lungs. The obesity is a global problem, which is set to increase over time. Chronic obstructive lung disease is the third-leading cause of death globally, and both obesity and diet appear to play roles in its pathophysiology (e.g., role in the development of obstructive sleep apnoea and obesity hypoventilation syndrome). However, the effects of obesity on the respiratory system are often underappreciated.

Objective. The objective of this study was to compare three anthropometric methods to evaluate of fat mass in COPD patients.

Material and Methods. Three anthropometric methods of evaluation fat mass in a group of 60 patients with COPD were compared. To the measurement of fat mass were used: (1) Dual Energy X-ray Absorptiometry method (DEXA), specifically by DEXA densitometer QDR Discovery Wi (S/N 80227) with additional software (Body Composition Analysis); (2) four-frequency bioelectrical impedance analysis (BIA) device Bodystat Quadscan 4000 (Bodystat Ltd, British Isles); (3) skin folds measurement (SFM) with caliper (Harpenden Lange Skinfold Caliper, Cambridge Scientific Industries, Inc. Cambridge, Maryland). The measured values were statistically processed and evaluated in a statistical program Statistica Cz. version 7.1 and Microsoft Office Excel 2010 (Los Angeles, CA, USA). Differences among anthropometric methods of measurement fat mass were tested with one-way analysis of variance (ANOVA). The data were presented as mean ± standard deviation (SD).

Results. DEXA method, generally accepted for assessing body composition, showed an average value of 22.48 ±11.32 kg of fat mass, which corresponds in percentage terms to the value of 29.62±9.28. BIA method for the parameter fat mass in the monitored group of COPD patients was found the mean value 25.08±10.14 kg (in percentages 30.85±8.15). An average value 28.50±8.08% of fat mass, was determined from the skinfolds measurements (SFM) and subsequent calculations. When comparing these methods (DEXA, BIA and SFM) used to determine body composition, a statistically insignificant difference was found (P >0.05).

Conclusions. In this study a good correlation between three anthropometric methods (DEXA, BIA, SFM) for measuring fat mass in patients with COPD and statistically insignificant differences between them were observed. To better define changes in the nutritional status of patients with COPD using anthropometric methods over time, further studies are needed that also monitor the consequences of clinical status, rehabilitation, and nutritional treatment.

Key words: *anthropometric methods, body fat content, obesity, COPD patients*

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a common, preventable, and treatable disease known to be a leading cause of morbidity and mortality worldwide and inducing a substantial economic and social burden [11, 34]. COPD is a prevalent and disabling chronic health condition associated with abnormally high morbidity and mortality [42, 17]. Patients with COPD present chronic airflow obstruction and respiratory symptoms; however, there is a substantial variation in risk of exacerbations, exercise capacity, level of physical activity and other characteristics among patients [11]. COPD is now recognized as a systemic disease affecting many extra-pulmonary tissues and organs [1, 3]. Important quantifiable extrapulmonary findings in COPD include coronary artery calcification, cardiac morphology, intrathoracic and extra thoracic fat, and osteoporosis. Current active research includes identification of novel quantitative measures for

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emphysema and airway disease, evaluation of dose reduction techniques, and use of deep learning for phenotyping COPD [4]. Skeletal muscle dysfunction is a common and particularly important systemic consequence (or extra-pulmonary manifestation) of COPD because of its adverse effect on clinical and patient-reported outcomes [24]. Muscle wasting is often shown [40] predominantly in the patients with emphysema [9]. Identifying causes and treatment of skeletal muscle wasting received a lot of attention [13] as it is negatively associated with exercise capacity [2], quality of life [26] and survival [31]. A joint statement by the American Thoracic Society and European Respiratory Society identified several structural and morphological alterations that combine to contribute to skeletal (limb) muscle dysfunction in people with COPD, including: abnormally low muscle strength and endurance; mitochondrial dysfunction; poor oxidative capacity; shift in muscle fiber-type (i.e. abnormally low and high percentage of type I and type II fibers, respectively); and muscle atrophy or loss of fat-free mass (FFM) [24].

In contrast, the contribution of fat mass (FM) and its distribution in the systemic pathology of COPD have reached only just some attention. Available data indicate a prevalence of obesity (defined by BMI >30 $kg.m^{-2}$) in mild-to-moderate COPD patients of about 20% [36]. Indeed, clinical studies mainly evaluated either obesity or severe muscle wasting, termed sarcopenia, in COPD. The prevalence of obesity in COPD ranges between 18% and 54% and seems higher in early COPD stages [38, 6]. The prevalence of obesity among COPD patients is variable [29]; however, obesity seems to be more common in global initiative for chronic obstructive lung disease (GOLD) stages I–II and less prevalent in GOLD IV [36]. Combining obesity with COPD leads to an interesting paradox. While on one hand, obesity seems to be associated with increased morbidity [20], overweight and obese COPD patients tend to have lower mortality rates compared to their normal weight counterparts [21]. Several studies have shown that low body mass index (BMI) is associated with worse outcomes in COPD [16, 14]. Nevertheless, malnutrition can occur at any BMI, and important changes in body composition can occur in patients with COPD, even with a normal BMI [41, 44]. Moreover, it has been recognized that fat-free mass (FFM), seems to be a stronger predictor of mortality and disease severity than does BMI [18, 32]. All of these evidences are actually justifying the routine assessment of body composition during COPD.

In some chronic conditions, body mass index (BMI) and the percentage of weight loss do not provide any insight about the respective contributions of FFM and FM in the body mass changes. Body compartments, such as FFM, fat mass and body water, can be measured quantitatively. Numerous methods of body composition measurement have been developed through time: anthropometry, including the 4-skinfold method, hydro densitometry, the measurements of mid-arm muscle circumference, nuclear magnetic resonance (NMR), dual-energy X-ray absorptiometry (DEXA) and other [39].

Single-frequency bioelectrical impedance analysis (BIA) is recognized as an appropriate measurement of body composition during COPD [33].

DXA system provides detailed measurements of the body by looking at bone density, lean mass, and fat mass. This information is critical for accurately assessing the state of a patient health and defining successful treatment plans and training programs [30]. Skinfold measurements allow the assessment of body composition due to the strong relationship between the amount of subcutaneous fat and total body fat. SF is a non-invasive method, easy to be measured and has low operating costs [12].

The objective of this study was to compare the anthropometric methods DEXA, BIA and SFM to evaluate of fat mass in COPD patients.

MATERIALS AND METHODS

The study was conducted on 60 patients with chronic obstructive pulmonary disease from Specialized St. Svorad Hospital Nitra Zobor, Slovakia, who were treated by means of hospitalization or outpatient basis. Observation group (48 men i.e., 80% and 12 women i.e., 20%) consisted of clinically stable patients' acute deterioration of the patients was excluded from the reference file. Inclusion criteria for including patients in the study were: women and men over 18 years of age; fulfilment of criteria for COPD according to GOLD, clinical signs of COPD, FEV1/FVC less than 70%, negative bronchodilation test. Exclusion criteria in this study were: known malignant disease; other known chronic lung disease; other acute inflammatory disease at the time of DEXA, BIA, SFM; postoperative state (within six weeks of surgery); conditions after organ transplantation or hematopoietic cell transplantation; long-term use of immunosuppressive treatment, except for glucocorticoids alone; known active specific process (TB), treatment with antituberculosis drugs; pregnancy; asthma bronchiale; inability to accept food per vias naturales; disagreement with anthropometric measurements.

The experiment was carried out in the Specialized Hospital of St. Svorada Zobor, n.o., Nitra, on I. and II. Departments of Pneumology and Phthisiology.

Three anthropometric methods (DEXA, BIA, SFM) for evaluation fat mass in a group of 60 randomly selected patients with COPD were compared. The research was approved by the Ethics Committee

(Approval number 4/071220/2020). Study Protocol Title: Long-term strategic research of prevention, intervention and mechanisms of obesity and its comorbidities. Approval for inclusion in the study and the performance of relevant examinations was signed by all subjects.

The examination of the functional state of the lungs of COPD patients was performed using spirometry and Bodyplethysmographic to confirm the diagnosis and determine the stage of the disease. Patients were classified into different groups according to the severity of the disease (Gold I to IV). Lung function was evaluated using spirometer ©2005 ZAN® Meßgeräte, GmbH Germany.

To the body weight measure of patients, a BRUTUS Tanita digital personal scale (Tanita Corporation, Tokyo, Japan) was used. Body weight was determined in underwear (digital scale, accuracy of measurement: 0.1 kg). To the measurement of body height, was used an ultrasonic height measuring unit BODYSON (Ultrasound Height Measuring Unit MZ10020) (ADE GmbH & Co., Hamburg, Germany). The measuring range is 500 - 2500 mm with a division of 5 mm and its weight is 330 g. The meter is characterized by high accuracy, can be checked (spirit level) and its operation is simple. Both were used to calculate body mass index (BMI).

FFM (fat-free mass) and FM (fat mass) examinations were performed by Dual Energy X-ray Absorptiometry method (DEXA), specifically by DEXA densitometer QDR Discovery Wi (S / N 80227) with additional software (Body Composition Analysis). If the patient is pregnant, the DEXA measurement must be postponed. The use of radiological contrast agents that are used for X-ray and CT in the previous 7 days may have an interfering effect on DEXA scans. Before the DEXA measurement, the patient undresses and is dressed only in underwear. It must not have anything metallic in the scanned field. The weight limit for the measurement is 277 kg.

To the measurement of body fat was used a device Bodystat Quadscan 4000 (Bodystat Ltd, British Isles). The device works by using four-frequency bioelectrical impedance analysis (BIA). The basic principle of the method is that lean tissue, which consists essentially of electrolyte-containing water, conducts the electrical current, whereas the fat acts as an insulator. The impedance of the body is therefore determined largely by the low-impedance lean tissues. Regression equations are then derived which relate impedance to FFM or TBW measured by independent techniques. Probands were informed about the measurement procedure, explained the possible risks of measuring in the case of pregnancy or having an artificial pacemaker at the heart. The measurement is performed on an empty stomach, after emptying. First, the basic values of the proband's body (body height, body weight, waist circumference, hip circumference) are measured. Then the proband is asked, to remove your shoes and socks and lie on a non-conductive mat on your back with your arms and legs slightly apart yourself. The patient should lie relaxed. To stabilize the fluids in the proband's body, wait 4-5 minutes before starting the measurement. Personal data of the proband are entered into the device: sex, age, height, weight, waist circumference, hip circumference and level of physical activity from 1-5 of the proband. The measurement will then start.

To skin folds measurement (SFM), we used a caliper (Harpenden Lange Skinfold Caliper, Cambridge Scientific Industries, INC. CAMBRIDGE, MARYLAND). To reduce the technical error of measurement (TEM), which is described by Perini [28] among other authors, the measurement was carried out by a trained and experienced person. We also tried to achieve the reduction of TEM by the following measures. Measurement of skin folds was performed on the right side of the patient's body. In measuring, we tried to create equal conditions and ensure maximum measurement in the measuring technique accuracy. The measurements were always performed by the same person. For evaluation of SFM, were taken in four standard places: triceps (back side middle upper arm); biceps (front side middle upper arm); subscapular (under the lowest point of the shoulder blade); suprailia (above the upper bone of the hip). Three measurements were taken at each anatomical site of skinfold measurement, the resulting skinfold value was the average of these three measurements. For this measurement the patient must be able to sit or stand in an upright position. Body density equations was calculated from the sum of these four skin folds, by calculation according to *Durnin* and *Womersly* method [8] and Body Fat (%) was calculated with the Siri questions [33]. The measured values were statistically processed and evaluated in a statistical programs STATISTICA Cz. Version 7.1 and Microsoft Office Excel 2010 (Los Angeles, CA, USA). All parameters were evaluated by descriptive statistic. The data were presented as mean ± standard deviation (SD). Differences among anthropometric data were tested with a one-way analysis of variance (ANOVA).

RESULTS AND DISCUSSION

Patients with moderate to severe COPD often present with multiorgan involvement with severe respiratory distress, reduced physical activity, right-sided heart failure, and reduced quality of life [20].

The measurement of body composition is of value in the nutritional assessment of patients with chronic obstructive pulmonary disease (COPD) [35].

Anthropometric measurements were performed in the Specialized Hospital of St. Svorada Zobor, n.o., Nitra, on I. and II. Department of Pneumology and Phthisiology. Based on the clinical stage of the disease according to GOLD (stage I - IV), were patients with COPD in the following stages of the disease: stage I 26.67%; stage II. 71.67%; stage III. 0% and stage IV. 1.66%.

The average age of COPD patients was 69.25±9.90 years (age range from 49 to 87 years; median 68 years). The average body weight of patients was 76.73±20.23 kg. Body height in patients with COPD averaged 164.04 ± 8.03 cm. Subsequently we calculated the Body Mass Index (BMI) from body height and body weight. In the monitored group was the mean BMI 28.51±7.05 $kg.m^{-2}$. From the obtained individual values, were calculated the data and statistical characteristics (Table 1).

A body mass index value higher than 25 $kg.m^{-2}$ to a value of 29.9 $kg.m^{-2}$ indicates overweight (mild obesity), BMI values from 30 $kg.m^{-2}$ to 34.9 $kg.m^{-2}$ indicate significant obesity, BMI values from 35 $kg.m^{-2}$ up to 39.9 $kg.m^{-2}$ indicate severe obesity, and values above 40 $kg.m^{-2}$ indicate extreme obesity, which is also reported by literary sources [27].

In the group of COPD patients, based on BMI was found: cachexia (BMI <17 $kg.m^{-2}$) in 1 case (1.67%), underweight (BMI <18.5 $kg.m^{-2}$) in 4 cases (6.67%), normal BMI in 17 cases (28.33%), overweight in 15 cases (25%), significant obesity in 7 patients (11.67%), severe obesity in 14 patients (23.33%) and morbid obesity in 2 patients (3.33%). Although BMI does not indicate the amount of fat mass in the proband's body, it is still used as a criterion for the classification of obesity. However, from the point of view of health risks or the presence of COPD and its associated diseases, it is very important to know the actual amount of fat mass. Fat mass has many metabolic consequences in both patients and healthy people.

Fat mass (%) from BMI calculated according to *Durnin* and *Womersley* [8] reached an average value of 25.50% in a group of patients with COPD. As we can see when comparing with measurements methods of fat mass (by DEXA it was 29.62%; by BIA 30.85%, and by SFM 28.50%) the value derived from BMI is significantly underestimated.

Other studies have reached similar conclusions. For example, BMI together with other anthropometric measurements (e.g., waist circumference, waist-hip ratio - WHR, percentage of body fat) in relation to obesity and ABSI (A Body Shape Index) were monitored by *Gažarová* et al. [10]. The authors of this study found that the diagnosis of obesity among participants showed considerable variation according to used anthropometric measurements and indices (BMI, WHR). In practice, many different determination methods and calculated indices are used to assess fat mass. Their use depends on several factors, such as the concept of the study, monitored probands, equipment, etc. [5].

A generally accepted method of assessing body composition is the DEXA (Dual Energy X-ray Absorptiometry) method. The DEXA method showed an average value of 22.48±11.32 kg of fat mass, which corresponds in percentage terms to the value of 29.62±9.28.

Table 1. Characteristics of COPD patients and fat mass measurement methods comparison

Characteristic	COPD patients (n=60)			
	average ± SD	min. – max.	med	mod
Age (yrs)	69.25 ± 9.90	49.00 – 87.00	68.00	62.00
Body weight (kg)	76.73 ± 20.23	38.60 – 136.80	72.70	65.10
Body height (cm)	164.04 ± 8.03	141.00 – 177.00	165.50	168.00
BMI ($kg.m^{-2}$)	28.51 ± 7.05	15.30 – 46.80	27.50	37.00
Fat Mass (%) by DEXA	29.62 ± 9.28	12.40 – 49.50	29.63	31.30
Fat Mass (%) by BIA	30.85 ± 8.15	15.10 – 49.30	30.30	24.90
Statistical difference between "gold standard" method DEXA (%) and BIA (%)				P>0.05
Fat Mass by SFM (%)	28.50 ± 8.08	13.80 – 50.06	28.80	17.40
Statistical difference between "gold standard" method DEXA (%) and SFM (%)				P> 0.05
Fat Mass (kg) by DEXA	22.48 ± 11.32	5.53 – 56.05	20.67	19.50
Fat Mass (kg) by BIA	25.08 ± 10.14	10.30 – 57.10	22.45	21.30
Statistical difference between "gold standard" method DEXA (kg) and BIA (kg)				P > 0.05

Data are expressed as average ± standard deviation (SD); min. – max.; med – median; mod – modus;
BMI – body mass index; DEXA – Dual Energy X-ray Absorptiometry; BIA – bioelectrical impedance analysis;
SFM – skin folds measurement

DEXA scans can also be used to measure total body composition and fat content with a high degree of accuracy comparable to hydrostatic weighing [37]. From the DEXA scans, a low resolution "fat shadow" image can also be generated, which gives an overall impression of fat distribution throughout the body [25].

Bioelectrical impedance analysis (BIA) is a method for estimating body composition, in particular body fat and muscle mass, where a weak electric current flows through the body and the voltage is measured in order to calculate impedance (resistance) of the body. Most body water is stored in muscle. Therefore, if a person is more muscular there is a high chance that the person will also have more body water, which leads to lower impedance. BIA determines the electrical impedance, or opposition to the flow of an electric current through body tissues which can then be used to estimate total body water (TBW), which can be used to estimate fat-free body mass and, by difference with body weight, body fat [19].

In this research was used the BIA method also. For the parameter fat mass in the monitored group of patients was found the mean value 25.08±10.14 kg. Bodystat Quadscan 4000 also calculates the amount of fat mass in percentages. The average value of the percentage of fat mass in COPD patients was 30.85±8.15%.

BIA method is a simple, inexpensive, quick and non-invasive technique for assessing body composition and its changes over time. This method is largely used in clinical trial settings and there is a whole series of literature on the theory and methodology of several different BIA techniques [19, 22, 23].

Values of fat mass (%) using SFM were obtained by calculation (methodology is given in the chapter material and methodology). An average value 28.50 ± 8.08 % of fat mass, was determined from the measurements of skinfolds and subsequent calculations.

The reliability of anthropometrics depends on standardizing the caliper and site of measurement, and upon the measuring skill of the anthropometrist. A reproducibility of ± 2% for C and ± 10% for SF measurements usually is required to certify the anthropometrist [43].

By statistically comparing these methods of determining body composition (DEXA, BIA and SFM methods), was found a statistically insignificant difference ($P > 0.05$), which means that the methods are correlated and suitable for monitoring body composition (Table 1).

Differences in the accuracy of determining body composition between these methods (professional literature states 5-7%) were also confirmed by measurement in patients with COPD (Figure 1).

Despite good statistical agreement among values obtained with dual-energy x-ray absorptiometry, skinfold thickness measurement, and bioelectrical impedance analysis, the study findings indicate that skinfold thickness measurement and bioelectrical impedance analysis, above all, tended to overestimate fat-free mass compared with dual-energy x-ray absorptiometry [7].

Fat mass and fat mass index, measured by skin-fold anthropometry and bioelectrical analysis were well correlate, with a small non-significant mean bias [15].

There are significant inter-method differences in the measurement of body composition in chronic obstructive pulmonary disease patients. The choice of measurement method will have implications for nutritional assessment in chronic obstructive pulmonary disease [35].

However, the BIA and SFM methods are less burdensome for the patient in terms of radiation and are also less expensive and time-consuming.

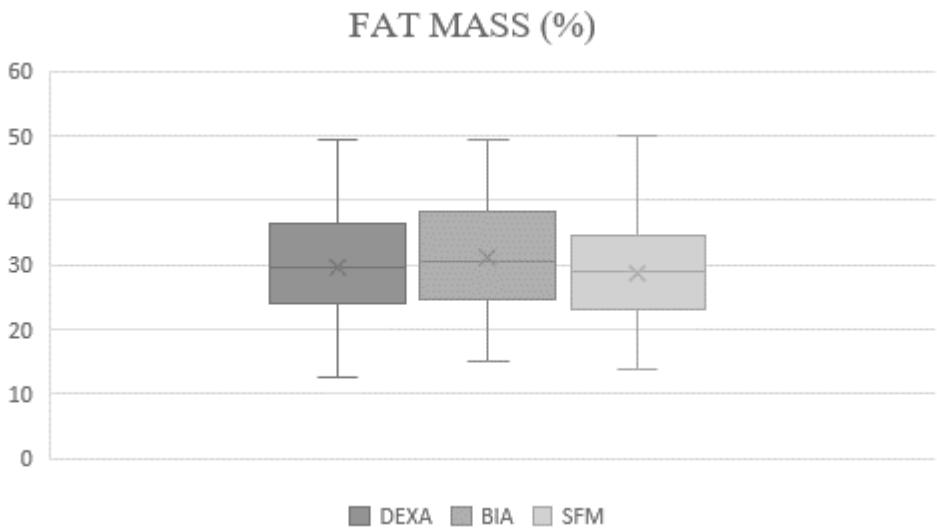

Figure 1. Comparison of the DEXA, BIA and SFM methods for measuring fat mass parameter

Therefore, it would be appropriate to use the BIA method for initial screening (or SFM - however, it is more time-consuming than BIA and has a higher risk of measurement error) and in later and more severe disease states, or in appropriate cases when the most accurate monitoring of the body structure would be necessary, used measurement with DEXA method.

CONCLUSION

1. In this study, associations between three anthropometric methods for measuring fat mass in patients with COPD were observed. The study showed a good correlation of anthropometric methods DEXA, BIA and SFM, and statistically insignificant differences between them.
2. In order to better define changes in the nutritional status of patients with COPD using anthropometric methods over time, further studies are needed that also monitor the consequences of clinical status, rehabilitation and nutritional treatment.

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Conflict of interest statement

The author declares no conflict of interest.

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