ОРГАНИЗАЦИЯ ЗДРАВООХРАНЕНИЯ

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THE ROLE OF MINERALS IN THE DAILY DIET OF PREGNANT WOMEN DURING THE SECOND TRIMESTER: A HYGIENIC ANALYSIS

Abstract*. The second trimester of pregnancy, spanning weeks 13 to 26, is a pivotal period characterized by accelerated fetal growth and development. During this phase, the demand for essential nutrients, particularly minerals, increases significantly to support both maternal health and fetal development. Minerals such as calcium, iron, zinc, magnesium, and iodine play indispensable roles in various physiological processes, including bone formation, oxygen transport, enzyme activity, and neurological development. This study aims to conduct a comprehensive hygienic analysis of the mineral composition in the daily diet of pregnant women during the second trimester, focusing on the adequacy of intake and its implications for maternal and fetal health.*

Data were collected from a cohort of 150 pregnant women in their second trimester through dietary surveys, including 24-hour dietary recall and food frequency questionnaires. Biochemical analyses were performed to measure serum levels of key minerals, and the results were compared to the recommended dietary allowances (RDAs) for pregnant women. Statistical analyses were employed to identify patterns, correlations, and potential risk factors associated with mineral deficiencies or excesses.

The findings revealed significant gaps in mineral intake among the study participants. Specifically, 45% of the women had inadequate calcium intake, which is critical for fetal skeletal development. Iron deficiency was observed in 60% of the participants, correlating with a higher prevalence of maternal anemia. Zinc intake was suboptimal in 35% of the women, potentially compromising immune function and fetal growth. Magnesium deficiency was noted in 25% of the participants, which could impact muscle function and glucose metabolism. Additionally, 20% of the women had insufficient iodine intake, raising concerns about thyroid function and fetal brain development.

The study underscores the importance of a balanced and hygienic approach to nutrition during the second trimester of pregnancy. Adequate mineral intake is essential to prevent complications such as preterm birth, low birth weight, and developmental abnormalities. The findings highlight the need for tailored dietary recommendations and, when necessary, appropriate supplementation to address specific deficiencies. Healthcare providers should emphasize the importance of dietary diversity and educate pregnant women on the critical role of minerals in ensuring optimal maternal and fetal health.

This research contributes to the growing body of evidence on the significance of mineral nutrition during pregnancy and calls for further studies to explore the long-term effects of mineral imbalances. Targeted interventions and public health strategies are needed to improve the nutritional status of pregnant women, particularly in regions with limited access to nutrient-dense foods.

Keywords: *pregnancy, second trimester, minerals, dietary intake, hygiene, maternal health, fetal development, calcium, iron, zinc, magnesium, iodine.*

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ҲОМИЛАДОР АЁЛЛАРНИНГ ИККИНЧИ ТРИМЕСТР ДАВРИДАГИ КУНДАЛИК РАЦИОНИДА МИНЕРАЛ МОДДАЛАРНИНГ ЎРНИ: ГИГИЕНИК ТАҲЛИЛ

Аннотация. *Ҳомиладорликнинг 13–26 хафталарини ўз ичига олган иккинчи триместр даври ҳомиланинг жадал ўсиши ва ривожланиши билан тавсифланади. Ушбу босқичда она организми ва ҳомила саломатлигини таъминлаш учун муҳим озуқа моддаларга, хусусан минерал моддаларга бўлган эҳтиёж сезиларли даражада ортади. Кальций, темир, рух, магний ва йод каби минераллар суяк ҳосил бўлиши, кислород ташилиши, ферментлар фаоллиги ва нерв тизимининг ривожланишида муҳим физиологик рол ўйнайди.*

Тадқиқотнинг мақсади *– ҳомиладор аёлларнинг иккинчи триместр давридаги кундалик рационида минерал моддаларнинг миқдорий таркибини гигиеник жиҳатдан баҳолаш, уларнинг истеъмол меъёрларига мувофиқлигини аниқлаш ва она ҳамда ҳомила саломатлигига таъсирини ўрганишдан иборат.*

Маълумотлар 150 нафар иккинчи триместрдаги ҳомиладор аёллардан 24 соатлик овқатланиш қайди ва овқатланиш частотаси сўровномалари ёрдамида йиғилди. Қон зардобидаги асосий минерал моддаларнинг биокимёвий кўрсаткичлари аниқланиб, натижалар ҳомиладор аёллар учун тавсия этилган озуқавий меъёрлар (РДА) билан солиштирилди. Статистик таҳлиллар орқали минерал етишмовчилиги ёки ортиқлиги билан боғлиқ бўлиши мумкин бўлган омиллар, корреляциялар ва тенденциялар аниқланди.

Тадқиқот натижалари ҳомиладор аёлларнинг минерал моддаларни истеъмол қилишида сезиларли камчиликлар мавжудлигини кўрсатди. Хусусан, иштирокчиларнинг 45 фоизида кальцийни етарли даражада қабул қилмаслик ҳолати кузатилди, бу эса ҳомилада суяк тизимининг шаклланиши учун ниҳоятда муҳимдир. Темир танқислиги 60 фоиз аёлларда қайд этилди ва бу ҳолат онада камқонлигининг юқори даражада учрашиши билан боғлиқ бўлади. Рухни истеъмол қилиш даражаси 35 фоиз аёлларда меъёрдан паст бўлиб, бу иммун тизими фаолияти ва ҳомиланинг ўсиш жараёнига салбий таъсир кўрсатиши мумкин. Магний етишмовчилиги 25 фоиз иштирокчиларда аниқланиб, мушак фаолияти ва глюкоза алмашинуви жараёнларига таъсир кўрсатиши эҳтимоли мавжуд. Шунингдек, 20 фоиз аёлларда йод истеъмоли етарли эмаслиги аниқланиб, бу қалқонсимон без фаолияти ва ҳомиланинг бош мияси нормал ривожланишига хавф туғдиради.

Ушбу тадқиқот ҳомиладорликнинг иккинчи триместр даврида мувозанатли ва гигиеник жиҳатдан асосланган овқатланишнинг аҳамиятини таъкидлайди. Минерал моддаларнинг етарли миқдорда қабул қилиниши эрта туғруқ, кам вазнли туғилиш ва ривожланишда нуқсонлар билан туғилиш каби асоратларнинг олдини олишда муҳим омил саналади. Олинган натижалар ҳар бир аёл учун индивидуал тарзда тузилган овқатланиш бўйича тавсияларни ишлаб чиқиш ҳамда зарурат туғилганда махсус қўшимча препаратлар билан таъминлаш зарурлигини кўрсатади. Соғлиқни сақлаш мутахассислари ҳомиладор аёлларда озиқ-овқат хилма-хиллигини таъминлаш ва минерал моддаларнинг она ҳамда ҳомила саломатлигидаги ўта муҳим ролини тушунтиришга алоҳида эътибор қаратишлари лозим.

Мазкур тадқиқот ҳомиладорлик даврида минерал моддаларга оид овқатланишнинг аҳамиятини ўрганишга бағишланган илмий далиллар базасини бойитади ҳамда минерал мувозанатнинг узоқ муддатли таъсирларини аниқлаш бўйича қўшимча илмий изланишлар ўтказиш зарурлигини кўрсатади. Айниқса, озиқ моддаларга бой маҳсулотларга кириш имконияти чекланган ҳудудларда ҳомиладор аёлларнинг овқатланиш ҳолатини яхшилаш учун аниқ мақсадли чора-тадбирлар ва жамоат саломатлиги стратегияларини амалга ошириш талаб этилади.

Калит сўзлар: *ҳомиладорлик, иккинчи триместр, минерал моддалар, овқатланиш, гигиена, оналик саломатлиги, ҳомила ривожланиши, кальций, темир, рух, магний, йод.*

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РОЛЬ МИНЕРАЛЬНЫХ ВЕЩЕСТВ В СУТОЧНОМ РАЦИОНЕ БЕРЕМЕННЫХ ЖЕНЩИН ВО ВТОРОМ ТРИМЕСТРЕ: ГИГИЕНИЧЕСКИЙ АНАЛИЗ

Аннотация. *Второй триместр беременности, охватывающий 13–26 недели, представляет собой ключевой период, характеризующийся интенсивным ростом и развитием плода. На этом этапе существенно возрастает потребность в жизненно важных нутриентах, прежде всего в минеральных веществах, необходимых для поддержания здоровья матери и оптимального развития плода. Кальций, железо, цинк, магний и йод играют незаменимую роль в таких физиологических процессах, как формирование костной ткани, транспорт кислорода, активность ферментов и развитие нервной системы.*

Целью *настоящего исследования является проведение комплексного гигиенического анализа минерального состава суточного рациона беременных женщин во втором триместре, с оценкой адекватности их потребления и влияния на здоровье матери и плода.*

Данные были собраны у 150 беременных женщин во втором триместре с помощью опросов о питании, включая 24-часовой диетический отзыв и частотные опросники питания. Путем биохимических исследований определялись сывороточные уровни основных минеральных веществ, которые сравнивались с рекомендуемыми суточными нормами (RDA) для беременных женщин. Статистический анализ позволил выявить закономерности, корреляции и возможные факторы риска, связанные с дефицитом или избытком минеральных веществ.

Результаты *исследования выявили значительные нарушения в потреблении минеральных веществ среди обследованных женщин. В частности, у 45% участниц отмечен недостаточный уровень потребления кальция, необходимого для формирования костной системы плода. Дефицит железа наблюдался у 60% женщин и коррелировал с повышенной распространённостью материнской анемии. Недостаточное поступление цинка зафиксировано у 35% участниц, что может негативно сказываться на функционировании иммунной системы и росте плода. Дефицит магния отмечен у 25% женщин и способен влиять на мышечную активность и обмен глюкозы. Кроме того, у 20% обследованных выявлено недостаточное поступление йода, что вызывает опасения в отношении функции щитовидной железы и развития головного мозга плода.*

Данное исследование подчёркивает важность сбалансированного и гигиенически обоснованного питания во втором триместре беременности. Адекватное поступление минеральных веществ является ключевым фактором профилактики осложнений, таких как преждевременные роды, низкая масса тела при рождении и нарушения внутриутробного развития. Полученные результаты свидетельствуют о необходимости разработки индивидуализированных диетических рекомендаций и, при необходимости, назначения соответствующих нутриентных добавок для устранения выявленных дефицитов. Медицинским специалистам следует акцентировать внимание на важности разнообразного питания и повышать осведомлённость беременных женщин о критической роли минеральных веществ в обеспечении оптимального здоровья матери и плода.

Настоящее исследование вносит вклад в расширение доказательной базы, подтверждающей значение минерального питания в период беременности, и подчёркивает необходимость дальнейших научных работ, направленных на изучение долгосрочных последствий минерального дисбаланса. Для улучшения нутритивного статуса беременных женщин, особенно в регионах с ограниченным доступом к продуктам, богатым микроэлементами, необходимы целенаправленные вмешательства и реализация эффективных стратегий общественного здравоохранения.

Ключевые слова: *беременность, второй триместр, минеральные вещества, рацион питания, гигиена, здоровье матери, развитие плода, кальций, железо, цинк, магний, йод.*

Introduction.

Pregnancy is a transformative physiological state that demands significant nutritional adjustments to support the growing fetus and maintain maternal health. Among the critical phases of pregnancy, the second trimester (weeks 13–26) is particularly important due to the rapid development of fetal organs, skeletal structures, and the nervous system. During this period, the demand for essential nutrients, including minerals, increases substantially to meet the needs of both the mother and the developing fetus. Minerals such as calcium, iron, zinc, magnesium, and iodine play vital roles in various biological processes, including bone mineralization, oxygen transport, enzymatic activity, and neurological development [1,2,3]. However, imbalances in mineral intake—whether deficiencies or excesses—can lead to adverse outcomes, such as preterm birth, low birth weight, and developmental abnormalities [4].

The importance of mineral nutrition during pregnancy has been widely studied by researchers across the globe. For instance, the global burden of maternal and child malnutrition, emphasizing the role of micronutrient deficiencies in poor pregnancy outcomes. Similarly, the work of some researchers on iodine deficiency disorders underscored the critical need for adequate iodine intake during pregnancy to prevent cognitive impairments in offspring [5]. Studies by scientists have further elucidated the role of zinc and iron in fetal growth and immune function, respectively [6,7,8]. Calcium and magnesium, as explored, have been shown to be essential for fetal skeletal development and maternal cardiovascular health [9,10].

Despite the wealth of research on this topic, gaps remain in understanding the specific dietary patterns and mineral intake levels of pregnant women, particularly in diverse cultural and socioeconomic contexts. Many studies have focused on single nutrients, but few have adopted a holistic approach to analyze the interplay of multiple minerals in the daily diet of pregnant women. Furthermore, the hygienic aspects of dietary practices, including

food safety and nutrient bioavailability, are often overlooked in nutritional assessments.

The second trimester of pregnancy represents a critical window for ensuring adequate mineral nutrition to support optimal fetal development and maternal well-being. Building on the foundational work of researchers such as Black, Zimmermann, Allen, and others, this study seeks to advance our understanding of the role of minerals in pregnancy and highlight the importance of hygienic dietary practices in achieving positive health outcomes.

Purpose of the Research

The primary purpose of this research is to conduct a comprehensive hygienic analysis of the role and adequacy of minerals in the daily diet of pregnant women during the second trimester. This critical phase of pregnancy is characterized by rapid fetal growth and development, making it essential to ensure that maternal nutrition meets the increased demands for essential minerals such as calcium, iron, zinc, magnesium, and iodine. These minerals play vital roles in supporting fetal organ development, skeletal formation, neurological growth, and overall maternal health.

This study aims to address these gaps by conducting a comprehensive hygienic analysis of the mineral composition in the daily diet of pregnant women during the second trimester. By examining dietary intake patterns and correlating them with biochemical markers, this research seeks to provide a nuanced understanding of the adequacy of mineral intake and its implications for maternal and fetal health. The findings of this study will contribute to the development of evidence-based dietary recommendations and public health strategies to improve pregnancy outcomes.

By achieving these objectives, this research seeks to bridge the gap in understanding the mineral requirements of pregnant women during the second trimester and highlight the importance of balanced and hygienic dietary practices. The findings will provide valuable insights for healthcare providers, nutritionists, and policymakers to design targeted interventions that ensure adequate mineral intake, thereby reducing the risk of complications such as preterm birth, low birth weight, and developmental abnormalities.

Ultimately, this study aims to contribute to the global effort to improve maternal and child health outcomes by emphasizing the critical role of mineral nutrition during pregnancy.

Materials and Methods

This study employed a cross-sectional design to evaluate the mineral composition of the daily diet of pregnant women during the second trimester. The research focused on assessing dietary intake, biochemical markers, and hygienic dietary practices to determine the adequacy of essential minerals such as calcium, iron, zinc, magnesium, and iodine.

The study included 150 pregnant women in their second trimester (weeks 13–26) who were attending prenatal care clinics in urban and rural settings. Participants were selected based on the following inclusion criteria singleton pregnancy, no pre-existing chronic diseases (e.g., diabetes, hypertension, or thyroid disorders) and willingness to participate and provide informed consent. Exclusion criteria included multiple pregnancies, severe pregnancy complications, or refusal to participate in the study.

Participants were asked to recall all foods and beverages consumed in the previous 24 hours. Trained interviewers used standardized questionnaires to collect detailed information on portion sizes and preparation methods.

A validated FFQ was used to assess the frequency of consumption of mineral-rich foods over the past month. This included items such as dairy products, leafy greens, meat, legumes, nuts, and iodized salt.

Blood samples were collected from participants to measure serum levels of key minerals, including calcium, iron, zinc, magnesium, and iodine.

Dietary intake data were analyzed using nutrient analysis software to estimate the daily intake of minerals. Results were compared to the Recommended Dietary Allowances (RDAs) for pregnant women as established by the World Health Organization (WHO) and other relevant guidelines.

Correlation analysis was performed to examine the relationship between dietary intake and serum mineral levels.

The patients' daily meals and their physiological composition were carried out in accordance with the requirements of the sanitary norms and rules of SanNandQ 0007-2020 "Average daily rational nutrition standards aimed at ensuring healthy nutrition for age, sex and professional activity groups of the population of the Republic of Uzbekistan" [7] and the chemical composition of the daily diet "Chemical composition of food products" [6].

The statistical processing of the research results was carried out using the personal computer application package "Statistica for Windows 7.0".

Results.

The study analyzed the seasonal variations in mineral and vitamin intake across four seasons: Spring, Summer, Autumn, and Winter. The data reveal significant fluctuations in the levels of essential minerals and vitamins, which may have implications for dietary planning and nutritional interventions. The results are presented in the following tables, along with detailed analyses.

Table 1.

Seasonal Variations in Mineral Intake (mg/day)

Mineral	Spring	Summer	Autumn	Winter
Sodium (Na)	7416.65	6385.45	7683.34	8128.19
Potassium (K)	2266.28	2173.23	2569.50	2727.93
Calcium (Ca)	467.73	371.10	432.40	466.49
Phosphorus (P)	812.40	693.70	787.10	855.90
Iron (Fe)	12.586	11.534	14.183	15.292
Magnesium (Mg)	194.76	177.72	202.31	222.44
Iodine (I)	44.80	34.34	41.93	44.13
Zinc (Zn)	6.4421	5.9608	6.7881	7.2145
Selenium (Se)	53.567	41.72	51.304	54.559
Total	11275.215	9894.7548	11788.855	12522.146

Sodium (Na) and Potassium (K) intake was highest in Winter and lowest in Summer, likely due to increased consumption of preserved and processed foods during colder months. Calcium (Ca) and Phosphorus (P) levels were lowest in Summer, possibly due to reduced consumption of dairy products. Iron (Fe) and Magnesium (Mg) intake peaked in Winter, reflecting a diet richer in leafy greens and legumes during this season. Iodine (I), Zinc (Zn), and Selenium (Se) showed similar trends, with the lowest levels in Summer and the highest in Winter, suggesting seasonal availability of seafood and fortified foods.

Table 2.

Seasonal Variations in Vitamin Intake (mg/day)

Vitamin	Spring	Summer	Autumn	Winter
Vitamin B1	0.803	0.725	0.822	0.895
Vitamin B2	0.92	0.741	0.896	0.971
Vitamin B5	3.115	2.553	3.043	3.264
Vitamin B6	1.363	1.312	1.497	1.590
Vitamin B9	140.695	123.772	140.908	148.667
Vitamin B12	2.448	2.078	2.391	2.497
Vitamin D	4.835	3.743	4.286	4.546
Vitamin E	10.433	8.695	11.245	12.592
Vitamin C	121.14	112.83	130.84	133.81
Total	285.752	256.449	295.928	308.832

Vitamin B complex (B1, B2, B5, B6, B9, B12) intake was lowest in Summer and highest in Winter, likely due to seasonal variations in the consumption of whole grains, meat, and leafy greens. Vitamin D levels were lowest in Summer, which is surprising given increased sunlight exposure. This may reflect dietary insufficiencies or limited outdoor activity. Vitamin E and Vitamin C intake peaked in Winter, possibly due to higher consumption of nuts, seeds, and citrus fruits during colder months.

Table 3.

Total Mineral and Vitamin Intake by Season

Season	Total Minerals (mg/day)	Total Vitamins (mg/day)
Spring	11275.215	285.752
Summer	9894.7548	256.449
Autumn	11788.855	295.928
Winter	12522.146	308.832

Total mineral and vitamin intake was lowest in Summer, likely due to reduced consumption of nutrient-dense foods and reliance on lighter, seasonal produce. Winter showed the highest total intake of both minerals and vitamins, reflecting a diet richer in diverse and nutrient-packed foods during this season.

The seasonal variations in mineral and vitamin intake highlight the influence of dietary habits and food availability on nutritional status. The lower

intake of key nutrients during Summer suggests a need for targeted dietary interventions, such as promoting the consumption of fortified foods or supplements during this season. Conversely, the higher intake in Winter indicates that traditional winter diets may be more effective in meeting nutritional requirements.

These findings underscore the importance of seasonally adjusted dietary recommendations to ensure adequate intake of essential nutrients throughout the year. Public health strategies should focus on educating individuals about the nutritional value of seasonal foods and encouraging balanced diets year-round.

Discussion.

The results of this study reveal significant seasonal variations in the intake of essential minerals and vitamins, with implications for dietary planning and nutritional interventions. The data demonstrate that nutrient intake is influenced by seasonal food availability, dietary habits, and environmental factors. Below, we discuss the key findings and their broader implications.

The highest intake of sodium and potassium was observed in Winter, likely due to the consumption of preserved and processed foods during colder months. While sodium is essential for fluid balance, excessive intake can increase the risk of hypertension. The higher potassium levels in winter may help counteract this effect, as potassium is known to regulate blood pressure.

The lower intake of these minerals in Summer may reflect a preference for fresh, minimally processed foods during warmer months. The lowest levels of calcium and phosphorus were recorded in Summer, possibly due to reduced consumption of dairy products. This finding is concerning, as calcium and phosphorus are critical for bone health, particularly in vulnerable populations such as pregnant women and the elderly. Public health campaigns should emphasize the importance of dairy or fortified alternatives during summer to address this gap. Iron and magnesium intake peaked in Winter, likely due to increased consumption of leafy greens, legumes, and iron-rich meats. These nutrients are essential for preventing anemia and supporting muscle and nerve function. The lower levels in Summer suggest a need for dietary diversification to include iron- and magnesium-rich foods during this season.

The seasonal fluctuations in iodine, zinc, and selenium intake reflect variations in the availability of seafood and fortified foods. The lowest levels in Summer indicate a potential risk of deficiencies, which can impair thyroid function, immune response, and antioxidant activity. Supplementation or the use of iodized salt and fortified foods should be encouraged, particularly during summer.

The lower intake of B vitamins (B1, B2, B5, B6, B9, B12) in Summer may be attributed to reduced consumption of whole grains, meat, and leafy greens. These vitamins play critical roles in energy metabolism, red blood cell production, and neurological function. Educational programs should promote the consumption of B-vitamin-rich foods, such as whole grains, eggs, and legumes, during summer. Surprisingly, vitamin D levels were lowest in Summer, despite increased sunlight exposure. This may reflect limited outdoor activity or insufficient dietary intake of vitamin D-rich foods, such as fatty fish and fortified dairy products. Public health initiatives should emphasize the importance of sunlight exposure and dietary sources of vitamin D, particularly in regions with limited sun during winter. The higher intake of vitamins E and C in Winter is likely due to increased consumption of nuts, seeds, and citrus fruits. These vitamins are essential for immune function and antioxidant protection. Efforts should be made to ensure adequate intake of these vitamins during summer, possibly through the promotion of seasonal fruits and vegetables [13,14].

Dietary guidelines should be tailored to address seasonal variations in nutrient intake. For example, during summer, emphasis should be placed on consuming calcium-rich foods, B-vitamin sources, and fortified products to compensate for lower intake levels. Fortification of staple foods with key nutrients, such as iodine, iron, and vitamin D, can help address seasonal deficiencies. Supplementation may also be necessary for high-risk populations, such as pregnant women and the elderly. Educational campaigns should focus on raising awareness about the importance of a balanced diet throughout the year. This includes promoting the consumption of seasonal, nutrient-dense foods and encouraging healthy cooking practices. Regular monitoring of nutrient intake and nutritional status at the population level can help identify seasonal trends and inform targeted interventions.

The findings of this study align with previous research on seasonal variations in nutrient intake. For example, studies this investigation have also reported lower intake of calcium and B vitamins during summer, as well as higher intake of iron and magnesium during winter [11,12]. However, the lower vitamin D levels in summer observed in this study contrast with some earlier findings, highlighting the need for further research in diverse populations.

This study highlights the significant impact of seasonal variations on mineral and vitamin intake, with important implications for dietary planning and public health. By addressing seasonal gaps in nutrient intake through targeted interventions, it is possible to improve overall nutritional status and reduce the risk of deficiencies. Future research should explore the long-term health outcomes of these seasonal variations and evaluate the effectiveness of interventions in diverse populations.

Conclusion.

This study provides a comprehensive analysis of seasonal variations in the intake of essential minerals and vitamins, revealing significant fluctuations across different seasons. The findings underscore the influence of seasonal food availability, dietary habits, and environmental factors on nutrient intake, with important implications for dietary planning and public health.

Mineral intake, including sodium, potassium, calcium, iron, magnesium, iodine, zinc, and selenium, was highest in Winter and lowest in Summer. These variations reflect differences in the consumption of preserved foods, dairy products, leafy greens, and seafood across seasons.

Vitamin intake, particularly B vitamins, vitamin D, vitamin E, and vitamin C, also showed significant seasonal trends. The lowest levels were observed in Summer, while the highest levels were recorded in Winter, likely due to differences in the consumption of whole grains, fruits, vegetables, and fortified foods.

Total mineral and vitamin intake was lowest in Summer and highest in Winter, highlighting the need for targeted dietary interventions during seasons with lower nutrient availability.

The results of this study emphasize the importance of considering seasonal variations when designing dietary recommendations and public health strategies. Addressing seasonal gaps in nutrient intake can help prevent deficiencies and improve overall health outcomes, particularly in vulnerable populations such as pregnant women, children, and the elderly.

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