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DIETARY SUPPLEMENT USE AMONG CHILDREN WITH DOWN SYNDROME IN CROATIA

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Summary

Caregivers of children with Down syndrome may use dietary supplements in response to perceived nutritional, developmental, or health-related needs, but patterns of use and physician consultation remain insufficiently described. This secondary analysis examined supplement-related responses from a cross-sectional online survey conducted in 2023 among parents and caregivers of 104 children with Down syndrome aged 6 months to 19 years in Croatia. Dietary supplement use was classified as current use, previous use, no previous use despite awareness, or no previous use or awareness. Associations with child sex, parental education, maternal employment, and household food expenditure were examined using exact statistical tests. Current supplement use was reported for 34 children (32.7%), while 22 (21.2%) had used supplements previously. Overall, 56 children (53.8%) had used supplements currently or in the past. Thirty-six children (34.6%) had never used supplements although their caregivers were aware of them, while 12 (11.5%) had never used them and their caregivers reported no previous awareness. Among 101 respondents with valid consultation data, 59 (58.4%) reported that they had consulted the child's physician about supplement use. Neither supplement-use category nor physician consultation was significantly associated with the examined child and family characteristics. The findings indicate that caregiver-reported supplement use is common among children with Down syndrome and highlight the importance of identifying the exact products used and discussing them with health care professionals. Because the questionnaire did not record individual products, ingredients, doses, indications, or duration of use, the clinical appropriateness, effectiveness, and safety of supplementation could not be evaluated.

Keywords: Down syndrome; dietary supplements; children; caregivers; physician consultation; Croatia

Introduction

Down syndrome is a genetic condition caused by the presence of a complete or partial extra copy of chromosome 21. Its expression varies among children, but common features include hypotonia, recognizable craniofacial characteristics, developmental delay and variable intellectual disability. Congenital heart disease, thyroid dysfunction, gastrointestinal disorders, sleep-disordered breathing, and hearing or vision problems are also more common and require coordinated health surveillance throughout childhood (Antonarakis et al., 2020; Bull et al., 2022).

Several of these features have direct nutritional consequences. Hypotonia and delayed oral-motor development can make sucking, chewing and swallowing less efficient, while dysphagia may restrict safe progression to more complex food textures (Nordstrøm et al., 2020; Bull et al., 2022). Gastrointestinal disease, constipation, celiac disease, thyroid dysfunction and prescribed treatment may influence appetite, absorption or nutrient requirements (Nordstrøm et al., 2020; Bull et al., 2022). Sensory differences and delayed feeding skills can narrow dietary variety, whereas excess weight may become a concern from early childhood (Nordstrøm et al., 2020; Ergović Ravančić et al., 2025). A varied diet remains the foundation of nutritional care, but diet alone may not meet a child's needs when safe intake is restricted, major food groups are persistently excluded, malabsorption is present, or a deficiency or age-specific prophylactic indication has been confirmed (Nordstrøm et al., 2020; Bull et al., 2022).

It is important to distinguish between targeted and general supplementation. A systematic review and meta-analysis indicated group-level differences in the levels of zinc, selenium, copper, vitamin B12, sodium, and calcium in children and adolescents with Down syndrome compared to those without the condition; however, results varied significantly depending on the specific studies, participants, and laboratory methods involved (Barišić et al., 2023). While such differences may justify assessing the diet, growth, clinical status, and laboratory findings of an individual child, they do not prove that every child with Down syndrome has a deficiency in specific nutrients or requires the same dietary supplement.

A combination of developmental differences, frequent health issues, feeding difficulties, and uncertain micronutrient status may explain why some parents view dietary supplements as a practical way to support their child. In a study of 1,167 parents of children with Down syndrome under the age of 18, 49% reported currently using or having previously used dietary

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supplements, with users administering an average of three different products. Nutrivene, curcumin, and green tea extract were the most frequently cited, although more than 150 different products were mentioned. Most users perceived improvements, particularly in speech, immunity, and attention, while 17% reported side effects, primarily gastrointestinal issues. In nearly one-fifth of cases, the pediatrician was unaware of the use of dietary supplements (Lewanda et al., 2018). These observations by parents and caregivers help identify the outcomes families wish to influence, but they do not prove that these specific products caused the observed improvements.

Clinical evidence regarding children with Down syndrome is specific to individual products and outcomes. In a randomized trial, the use of antioxidant and folinic acid supplements did not lead to improvements in developmental outcomes, and a systematic review of the literature found no consistent developmental benefit from antioxidant intake (Ellis et al., 2008; Jafri et al., 2022). Smaller studies on the use of vitamins C and E noted changes in certain markers of oxidative stress, but such biochemical findings do not indicate improved development or daily functioning (Mustafa Nachvak et al., 2014; Parisotto et al., 2014). Long-term use of coenzyme Q10 did not reduce systemic nucleic acid oxidation, and a trial of epigallocatechin gallate (EGCG) supplementation in children showed no improvement in cognitive abilities or adaptive functioning compared to placebo (Larsen et al., 2018; Cieuta-Walti et al., 2022). Therefore, current evidence supports the use of dietary supplements for specific clinical indications rather than as a general regimen for the syndrome as a whole (Nordstrøm et al., 2020).

Safety also depends on the specific product, ingredients, dosage, duration of use, concomitant diet and medication, and the child's health status. Given the potential for adverse effects and the finding that pediatricians were unaware of supplement use in almost one-fifth of cases, caregivers and health care professionals should discuss the exact preparations administered to the child (Lewanda et al., 2018). Evidence from the general pediatric population also shows that dietary supplements can increase the risk of excessive micronutrient intake (Christensen et al., 2023), supplement-related adverse events may result in emergency department visits, including visits following unsupervised ingestion by children (Geller et al., 2015), reported pediatric melatonin ingestions increased markedly between 2012 and 2021 (Lelak et al., 2022) and the measured melatonin content of gummy products can differ substantially from the amount stated on the label (Cohen et al., 2023).

Despite this clinical significance, few studies describe the prevalence of dietary supplement use among children with Down syndrome or whether parents discuss such use with physicians. Studies in the general pediatric population have reported dietary supplement use by approximately one-third of children and adolescents in the United States (Stierman et al., 2020; Recio et al., 2026). Supplement use has also been associated with family income, food security, and household educational attainment (Jun et al., 2018), whereas a Polish study identified child educational level and several health, dietary, and institutional factors as predictors of use (Piórecka et al., 2024). These findings cannot necessarily be generalized to families of children with Down syndrome.

The Croatian survey used in the present analysis previously provided findings on dietary habits, nutritional status and food-purchasing practices, whereas supplement-related responses were not included in the published report (Ergović Ravančić et al., 2025). The present secondary analysis therefore examines patterns of supplement use among children with Down syndrome, distinguishing between current, previous and never users, while also considering caregiver awareness and communication with the child's physician. Possible differences according to the child's sex and selected family characteristics, including parental education, maternal employment and household food expenditure, were also explored. Because the questionnaire did not record product composition, dosage, reasons for use or perceived effects, the findings describe patterns of use and consultation but cannot be used to assess the effectiveness or safety of individual products.

Materials and methods

Study Design and Participants

This secondary analysis used data from a cross-sectional online survey conducted during the first half of 2023 using Microsoft Forms (Microsoft Corporation, Redmond, WA, USA). Parents and caregivers of children with Down syndrome aged 6 months to 19 years and living in Croatia were recruited through social-media support groups. Participation was anonymous and voluntary. The survey included 104 children, of whom 72 were male and 32 were female. The general survey methodology was described previously (Ergović Ravančić et al., 2025), while the present analysis focuses on supplement-related responses that were not previously reported.

The study was approved by the Ethics Committee of the Faculty of Tourism and Rural Development in

Požega, Josip Juraj Strossmayer University of Osijek (classification code 602-06/25-01/7; approval number 2177-1-20-01/11-25-3), and informed consent was obtained from all respondents.

All 104 respondents answered the question on dietary supplement use. Responses were classified as current use, previous use, no previous use but awareness of supplements, or no previous use or awareness. Current and previous users were also combined into an "ever use" category. The consultation question was presented to all 104 respondents; 101 answered it, while three nonresponses were treated as missing data only in analyses involving physician consultation.

Child sex, parental education, maternal employment and household food expenditure were examined as grouping variables, while age, residence and number of children in the family were used to describe the sample. The questionnaire did not record specific products, ingredients, doses, indications or perceived effects. Therefore, reported products could not be independently classified as dietary supplements, medicines or foods for special medical purposes.

Data Analysis

Categorical data were summarized using absolute and relative frequencies. To assess differences in categorical variables between groups, the chi-square test was initially employed using Microsoft Excel (Microsoft Corporation, Redmond, WA, USA). However, due to the presence of small, expected frequencies (less than 5 or, in some cases, less than 1), the application of the chi-square test was inappropriate in many instances. Consequently, we reported results of the chi-square test in the discussion section only where its use was justified and yielded statistically significant differences between groups. Given the limitations of the chi-square test, Fisher's exact test was subsequently applied on a row-by-row basis using the "all others" comparison principle. In addition, Fisher's exact test with Monte Carlo simulation with 10000 permutations, was conducted at a 95% confidence level using R version 4.4.3 for Windows (R Foundation for Statistical Computing, Vienna, Austria). For Monte Carlo simulation rows containing only zero values were excluded from the analysis prior to computation.

Results and discussion

Patterns of Dietary Supplement Use

The study included 104 children with Down syndrome aged between 6 months and 19 years. Participant characteristics are presented in Table 1. All participants were included in the analysis of dietary supplement use. At the time of the survey, 34 children (32.7%) were using dietary supplements, while 22 (21.2%) were not current users but had used them previously. Thus, 56 children (53.8%) had used supplements either currently or in the past. Among children who had never used supplements, the caregivers of 36 (34.6%) were aware of such products, while the caregivers of 12 children (11.5%) reported that they had not previously heard about them.

Distinguishing current from previous use provides more information than a simple classification into users and nonusers. Previous use may represent a completed period of supplementation or discontinuation following changes in the child's needs, professional advice, cost, perceived lack of benefit, or adverse effects. However, because the questionnaire did not examine the reasons for starting or discontinuing supplementation, these explanations cannot be confirmed from the present data. Similarly, awareness without use may reflect a deliberate decision not to use supplements, lack of a perceived indication, or limited access to such products.

The proportion of children with current or previous supplement use was broadly comparable to that reported by Lewanda et al. (2018). In their survey of 1,167 parents of children with Down syndrome younger than 18 years, 49% reported current or previous supplement use. The numerical similarity between the studies suggests that supplement use is not uncommon among families of children with Down syndrome. Nevertheless, the results are not directly comparable because the studies differed in sample size, recruitment, age distribution, health care context, and the information collected about individual products.

Current use in the Croatian sample was also numerically similar to the prevalence of 34.0% reported among children and adolescents in the general United States population (Stierman et al., 2020). This comparison should be interpreted cautiously because the United States survey involved a probability sample of the general pediatric population and defined use within a specific recall period. The present study involved a self-selected sample of families of children with Down syndrome and asked about supplement use "in any form" without specifying a recall period. Furthermore, the Croatian questionnaire did not collect product names, making it impossible to determine whether respondents were referring to vitamins, minerals, probiotics, melatonin, herbal preparations, multi-ingredient products, or other preparations.

The findings therefore describe caregiver-reported supplement use rather than exposure to verified

products. They cannot be used to determine the nutritional or clinical appropriateness of supplementation. This distinction is relevant because children with Down syndrome may experience feeding difficulties, restricted dietary variety, or particular micronutrient abnormalities, but these do not occur uniformly in all children. The systematic review and meta-analysis by Barišić et al. (2023) identified differences in the status of several micronutrients in children and adolescents with Down syndrome, but the findings varied across studies and nutrients. Such evidence supports individual assessment of diet, health status, and laboratory findings rather than routine supplementation based solely on the diagnosis of Down syndrome.

Table 1. Characteristics of the study participants (N = 104)

Characteristic	n	%
Age group		
6–11 months	7	6.7
1–3 years	41	39.4
4–7 years	28	26.9
8–15 years	23	22.1
16–19 years	5	4.8
Sex		
Female	32	30.8
Male	72	69.2
Place of residence		
Urban	59	56.7
Rural	45	43.3
Maternal education		
Secondary	55	52.9
Higher or university	49	47.1
Paternal education		
Secondary	72	69.2
Higher or university	32	30.8
Maternal employment		
Unemployed	39	37.5
Employed	65	62.5
Household income spent on food		
<50%	69	66.3
>50%	35	33.7
Number of children in family		
1	25	24.0
2	46	44.2
3	19	18.3
≥4	14	13.5

Supplement use according to child and family characteristics

The distribution of current use, previous use, and the two categories of nonuse was not significantly associated with child sex (P = 0.795), maternal education (P = 0.101), paternal education (P = 0.744), maternal employment (P = 0.151), or the proportion of household income spent on food (P = 0.179), as shown in Table 2. The study therefore did not demonstrate that supplement use differed according to the examined characteristics. However, the absence of statistical significance should not be interpreted as evidence that the groups were equivalent, especially because some response categories included relatively few participants.

Current use was reported for 34.4% of girls and 31.9% of boys, while previous use was reported for 25.0% of girls and 19.4% of boys. The overall distribution was similar between sexes and provides no evidence that supplement use was associated with child sex in this sample.

Some descriptive differences were observed according to maternal education. Current use was reported for 36.7% of children whose mothers had higher or university education and 29.1% of those whose mothers had secondary education. In addition, 18.2% of mothers with secondary education reported that they had neither used nor previously heard about supplements, compared with 4.1% of mothers with higher or university education. Despite this difference in awareness, the global association between maternal

education and supplement-use category did not reach statistical significance. The percentages may therefore be useful for formulating hypotheses for future studies but should not be presented as evidence of a confirmed educational effect.

Paternal education was not associated with supplement use, and the distribution of responses was relatively similar between the two educational groups. Current use was reported for 37.5% of children whose fathers had higher or university education and 30.6% of those whose fathers had secondary education. The corresponding proportions for previous use were 21.9% and 20.8%.

Maternal employment showed different descriptive patterns for current and previous use. Current use was reported for 35.4% of children of employed mothers and 28.2% of children of unemployed mothers. In contrast, previous use was more common among children of unemployed mothers than among those of employed mothers (30.8% vs. 15.4%). Because the overall association was not statistically significant and the questionnaire did not record reasons for discontinuation, these differences cannot be attributed to employment status or related financial and organizational circumstances.

Current use was reported for 37.7% of children in families spending less than half of their income on food and 22.9% of children in families spending more than half of their income on food. Lack of both use and awareness was reported by 7.2% and 20.0% of these groups, respectively. Nevertheless, the global association was not statistically significant. The proportion of income spent on food is also an indirect indicator of a family's economic circumstances and may be affected by total income, household size, food prices, and the child's dietary needs. It should therefore not be interpreted as a direct measure of socioeconomic status or the affordability of supplements.

In the general pediatric population, Jun et al. (2018) reported associations between supplement use and family income, food security, and household educational attainment. Piórecka et al. (2024) identified different predictors, including child educational level, special diet, medication for chronic disease, meal regularity, and school type. These findings provide context for the descriptive differences observed in the present study but cannot be directly transferred to families of children with Down syndrome. The present sample was relatively small, and the four supplement-use categories produced sparse cells in several comparisons. A larger sample would be required to determine whether family characteristics remain associated with use after accounting for the child's age, health status, and other potential confounding factors.

Table 2. Dietary supplement use according to child and family characteristics (N = 104)

Characteristic	Current, n (%)	Previous, n (%)	Never, aware, n (%)	Never, unaware, n (%)	*p* value
Sex					
Female (n = 32)	11 (34.4)	8 (25.0)	9 (28.1)	4 (12.5)	0.795
Male (n = 72)	23 (31.9)	14 (19.4)	27 (37.5)	8 (11.1)	
Maternal education					
Secondary (n = 55)	16 (29.1)	9 (16.4)	20 (36.4)	10 (18.2)	0.101
Higher/university (n = 49)	18 (36.7)	13 (26.5)	16 (32.7)	2 (4.1)	
Paternal education					
Secondary (n = 72)	22 (30.6)	15 (20.8)	25 (34.7)	10 (13.9)	0.744
Higher/university (n = 32)	12 (37.5)	7 (21.9)	11 (34.4)	2 (6.3)	
Maternal employment					
Unemployed (n = 39)	11 (28.2)	12 (30.8)	10 (25.6)	6 (15.4)	0.151
Employed (n = 65)	23 (35.4)	10 (15.4)	26 (40.0)	6 (9.2)	
Household income spent on food					0.179
<50% (n = 69)	26 (37.7)	15 (21.7)	23 (33.3)	5 (7.2)	
>50% (n = 35)	8 (22.9)	7 (20.0)	13 (37.1)	7 (20.0)	

Statistical significance $p < 0.05$

Consultation with the child's physician

Among the 101 respondents who answered the consultation question, 59 (58.4%) reported that they had consulted the child's physician about dietary supplement use, whereas 42 (41.6%) reported that they had not. Because the consultation question was presented to the entire sample, the proportion who had not consulted a physician cannot be interpreted as the proportion of supplement users who failed to disclose

supplement use. The group also included caregivers whose children had never used supplements and who may therefore have had no reason to discuss supplementation with a physician. The available aggregate data did not allow consultation to be examined separately among current, previous, and never users.

Consultation was not significantly associated with child sex (P = 0.666), maternal education (P = 0.068), paternal education (P = 0.274), maternal employment (P = 0.536), or household food expenditure (P = 0.286; Table 3). Consultation was reported by 60.0% of respondents for boys and 54.8% of respondents for girls. It was also reported by 61.3% of employed mothers and 53.8% of unemployed mothers.

The largest descriptive difference was observed in relation to maternal education. Consultation was reported by 68.8% of respondents with higher or university education and 49.1% of those with secondary education. Although this difference may warrant examination in a larger sample, it did not reach the predefined level of statistical significance and should not be described as a statistically significant effect or as evidence of an educational gradient. Consultation was also numerically more frequent among respondents with higher or university paternal education than among those with secondary paternal education (67.7% vs. 54.3%), but this association was not significant.

Among families spending less than half of their income on food, 62.7% reported consultation, compared with 50.0% of families spending more than half of their income on food. Again, the difference was not statistically significant and cannot be attributed to household economic circumstances on the basis of the present data.

Lewanda et al. (2018) reported that the pediatrician was unaware of supplement use in almost one fifth of children with Down syndrome who used supplements. However, their analysis specifically examined clinician awareness among supplement users, whereas the Croatian question was presented to all respondents. The two findings therefore address related but different aspects of communication and should not be directly equated.

Despite this limitation, the results show that discussion of dietary supplements is relevant in the care of children with Down syndrome. More than half of the children had used supplements currently or previously, while only 58.4% of all respondents with valid data reported previous consultation. Future analysis using respondent-level data should determine how many current and previous users had discussed supplement use with a physician. This would provide a more accurate assessment of professional involvement in decisions about supplementation.

Table 3. Physician consultation regarding dietary supplement use according to child and family characteristics (N = 101)

Characteristic	n	Consulted physician, n (%)	Did not consult physician, n (%)	*p* value
Sex				
Female	31	17 (54.8)	14 (45.2)	0.666
Male	70	42 (60.0)	28 (40.0)	
Maternal education				
Secondary	53	26 (49.1)	27 (50.9)	0.068
Higher or university	48	33 (68.8)	15 (31.3)	
Paternal education				
Secondary	70	38 (54.3)	32 (45.7)	0.274
Higher or university	31	21 (67.7)	10 (32.3)	
Maternal employment				
Unemployed	39	21 (53.8)	18 (46.2)	0.536
Employed	62	38 (61.3)	24 (38.7)	
Household income spent on food				
<50%	67	42 (62.7)	25 (37.3)	0.286
>50%	34	17 (50.0)	17 (50.0)	

Statistical significance $p < 0.05$

Interpretation, implications and study limitations

The results indicate that caregiver-reported dietary supplement use was common in this Croatian sample, but they do not demonstrate whether supplementation was clinically indicated, effective, or safe. The questionnaire did not collect product names, ingredients, doses, duration of use, reasons for use, source of recommendation, perceived benefits, or adverse effects. It was therefore not possible to determine whether reported products were dietary supplements, medicines, or foods for special medical purposes, nor whether

supplementation was intended to correct a confirmed deficiency or to influence immunity, sleep, cognition, speech, or general development.

This limitation is particularly important when interpreting supplement use in children with Down syndrome. Some caregivers may consider supplements because of feeding difficulties, limited dietary variety, associated health conditions, or concern about micronutrient status. Others may expect improvements in development or functioning. Lewanda et al. (2018) found that caregivers most frequently perceived improvements in speech, immunity, and attention, although their findings reflected caregiver observations and did not establish treatment effectiveness.

Available intervention evidence also does not support a general supplementation regimen for all children with Down syndrome. A systematic review found no consistent developmental benefit from antioxidant supplementation (Jafri et al., 2022), while a pediatric trial of EGCG did not demonstrate improvements in cognition or adaptive functioning compared with placebo (Cieuta-Walti et al., 2022). These findings do not exclude supplementation for a defined nutritional or medical indication. Rather, they support an individualized approach based on dietary assessment, clinical status, and, when appropriate, laboratory findings.

The principal strength of the study is its focused analysis of supplement-related responses from a sample of Croatian children with Down syndrome. The four response categories distinguished current use, previous use, awareness without use, and absence of both use and awareness. Exact statistical tests were used because several contingency-table cells contained small numbers. All 104 participants were retained in the analysis of supplement use, while the three missing consultation responses were excluded only from analyses involving that question

The study also has important limitations. Recruitment through online support groups resulted in a self-selected sample and limits the generalizability of the findings to all children with Down syndrome in Croatia. The information was caregiver-reported and could not be verified using medical records or product packaging. The broad age range may conceal substantial differences between infants, younger children, and adolescents, but age-specific analyses were not available. Finally, the available tables did not link supplement use with physician consultation at the individual level.

Future studies should record exact products and examine their use according to the child's age, dietary intake, feeding difficulties, health status, and laboratory findings. Consultation should be analyzed separately among current and previous users. Such information would allow a clearer distinction between supplementation for an established nutritional indication and the use of products with unproven developmental or general health claims.

Conclusions

The results of this research showed that approximately one-third of children with Down syndrome were taking dietary supplements at the time of the study, according to reports from parents and caregivers, while more than half were taking them at the time of the study or earlier. Among all respondents with valid consultation data, 58.4% reported previous consultation with the child's physician. Because the consultation question was presented to the entire sample, this percentage does not describe consultation specifically among current or previous supplement users. Supplement-use patterns and physician consultation were not significantly associated with child sex, parental education, maternal employment, or household food expenditure.

The results indicate that supplement use is a relevant component of care for many families of children with Down syndrome. However, because the questionnaire did not collect product names, ingredients, doses, duration, indications, reasons for use, or perceived effects, the findings do not establish whether supplementation was clinically indicated, effective, or safe. Health care professionals should therefore ask caregivers to identify the exact preparations given to the child and consider them in relation to dietary intake, clinical status, laboratory findings, and prescribed treatment. Future studies should verify product identity and regulatory category, examine differences according to age and clinical characteristics, and assess physician consultation separately among current and previous supplement users.

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