Relationships Among Screen Time, Nutrient Intake, and Eating Behaviors in Preschool and School-Aged Children: A Cross-Sectional Study

Okul Öncesi ve Okul Çağındaki Çocuklarda Ekran Süresi, Besin Alımı ve Yeme Davranışları Arasındaki İlişkiler: Kesitsel Bir Çalışma

İsmail Mücahit ALPTEKİN[1], Burçin Melike KÜÇÜKÖZKAN[2], Hüdanur DEMİR[3]

ABSTRACT

This cross-sectional study investigated the relationship between screen time and dietary intake in 580 preschool and school-aged children aged 4–10 years. Nutrient intakes were compared with European Food Safety Authority Dietary Reference Values, and eating behaviors were assessed using the Children's Eating Behaviour Questionnaire. Associations were examined using multivariable logistic regression, adjusting for sex, age, body mass index, maternal age, education, and household income. High screen time was more prevalent in older children (60% vs 37%) and clustered with personal device ownership and eating while using screens. Among 7–10-year-olds, ≥2 h/day of screen time was associated with higher total energy intake (1470 vs 1331 kcal/day, p=0.001), carbohydrate (175 vs 156.7 g/day, p<0.001), fiber, polyunsaturated fat, potassium, iron, and snack frequency, together with higher CEBQ "desire to drink". Among 4–6-year-olds, ≥2 h/day was not linked to greater energy (p=0.842) but was associated with lower protein %E, lower monounsaturated fat %E, and lower α-tocopherol intake, alongside lower "enjoyment of food" and higher snack frequency. Moreover, daily screen time ≥2 h/day was an independent predictor of higher total energy intake (B=109.33 kcal/day, p<0.05) and higher carbohydrate intake (B=19.30 g/day, p<0.001). Maternal education was inversely related to energy, protein, and carbohydrate intake (all p<0.05). The CEBQ Desire to Drink subscale was positively related to macronutrient intake. In conclusion, risks differ by age, suggesting the need for developmentally targeted interventions.

Keywords: Dietary Intake, Pediatric Nutrition, Screen Exposure

ÖZ

Bu kesitsel çalışmada, 4-10 yaş arası 580 okul öncesi ve okul çağındaki çocukta ekran süresi ile diyet alımı arasındaki ilişki araştırılmıştır. Besin ögesi alımları Avrupa Gıda Güvenliği Otoritesi Referans Değerleri ile karşılaştırılmış, yeme davranışları Çocuk Yeme Davranışları Anketi ile değerlendirilmiştir. İlişkiler cinsiyet, yaş, beden kütle indeksi, anne yaşı, anne eğitimi ve hane geliri için düzeltilmiş çok değişkenli lojistik regresyon ile analiz edilmiştir. Yüksek ekran süresi (≥2 saat/gün) daha çok büyük çocuklarda görülmüştür (%60 - %37) ve kişisel dijital cihaz sahipliği ile ekran karşısında yeme davranışıyla birlikte ortaya çıkmıştır. Yedi-on yaş grubunda ≥2 saat/gün ekran süresi, daha yüksek günlük enerji (1470 - 1331 kkal/gün, p=0.001), karbonhidrat (175 - 156.7 g/gün, p<0.001), lif, çoklu doymamış yağ asitleri, potasyum ve demir alımı, daha sık atıştırma ve daha yüksek "içme isteği" puanları ile ilişkili bulunmuştur. Dört-altı yaş grubunda ≥2 saat/gün ekran süresinin protein (% enerji), tekli doymamış yağ asidi (% enerji) ve α-tokoferol alımının ve "yemekten keyif alma" puanlarının düşük olması ve daha sık atıştırma ile ilişkili olduğu görülmüştür. Ayrıca, günlük ekran süresi ≥2 saat/gün olmasının daha yüksek enerji alımının (B=109.33 kkal/gün, p<0.05) ve daha yüksek karbonhidrat alımının (B=19.30 g/gün, p<0.001) bağımsız bir öngörücüsü olduğu görülmüştür. Anne eğitimi enerji, protein ve karbonhidrat alımıyla negatif; içme isteği makrobesin alımıyla pozitif ilişkili bulunmuştur. Sonuç olarak, riskler yaşa göre farklılık göstermektedir ve bu da gelişimsel odaklı müdahalelere ihtiyaç olduğunu ortaya koymaktadır.

Anahtar Kelimeler: Diyet Alımı, Pediatrik Beslenme, Ekran Maruziyeti

Highlights

* Ages 7–10 exceed 2-hour screen time more than ages 4–6.
* Both groups did not meet DRVs; screen time adds deficits, especially in 4–6.
* Age-based screen-time effects on diet; shaped by sociodemographics.

The study was approved by the Ministry of National Education. Ethical approval was obtained from the Ethics Committee at the Faculty of Health Sciences, Atatürk University (Ethics Committee Number: 2023/11/41, Date: 13 November 2023).

This study was financially supported by the Scientific and Technological Research Council of Türkiye (TÜBİTAK; project number: 1919B012304565).

[1]Asst. Prof., İsmail Mücahit ALPTEKİN, PhD, Nutrition and Dietetics, Atatürk University, Faculty of Health Sciences, Department of Nutrition and Dietetics, mucahit.alptekin@atauni.edu.tr, ORCID: 0000-0001-7089-6840

[2]Dietitian, Burçin Melike KÜÇÜKÖZKAN, Nutrition and Dietetics (Graduate Student), Atatürk University, Faculty of Health Sciences, Department of Nutrition and Dietetics, burcinmelikekucukozkan@gmail.com, ORCID: 0009-0001-9080-9916

[3]Dietitian, Hüdanur DEMİR, Nutrition and Dietetics (MSc Student), Atatürk University, Institute of Health Sciences, Department of Nutrition and Dietetics, hudanurd20@gmail.com, ORCID: 0009-0006-9768-4016

İletişim / Corresponding Author: İsmail Mücahit ALPTEKİN
e-posta/e-mail: mucahit.alptekin@atauni.edu.tr

Geliş Tarihi / Received: 26.09.2025
Kabul Tarihi/Accepted: 17.11.2025

INTRODUCTION

The increasing prevalence of screen time among children has raised public health concerns, particularly regarding its impact on eating behaviors and food intake. Early childhood is a critical period in which eating habits and dietary patterns are established, influencing growth, development, and long-term health.[1] Understanding how screen exposure interacts with nutrient intake and eating behaviors is essential for effective nutritional and behavioral interventions.

Screen time, time spent using digital devices such as televisions, tablets, smartphones, and computers, has been linked to altered food choices, portion sizes, and overall nutrient consumption.[2] Evidence indicates that exposure to digital food marketing increases preference for energy-dense, nutrient-poor foods while lowering intake of fruits, vegetables, and whole grains.[3]

Excessive screen use has been associated with dietary imbalances that may prevent children from meeting European Food Safety Authority (EFSA) Dietary Reference Values (2017)[4] with long-term consequences for growth, micronutrient adequacy, and metabolic health.

Eating behavior traits may moderate these effects. The Children's Eating Behavior Questionnaire (CEBQ) is widely used to assess attributes such as food responsiveness, emotional overeating, and satiety responsiveness.[5] Children high in food responsiveness are more likely to consume energy-dense snacks during screen use, while emotional overeating may be reinforced by media exposure, leading to unhealthy eating habits.[6]

The present study aimed to investigate associations between screen time and nutrient intake in children, comparing energy, macronutrient, and micronutrient intakes to EFSA reference values. We also examined age-specific patterns in preschool (4–6 years) and school-age (7–10 years) children and evaluated how eating behavior traits (via CEBQ) interact with nutrient intake in the context of screen exposure. We hypothesized that children with ≥2 hours of screen time would demonstrate less favorable dietary profiles and eating behaviors compared to those with <2 hours, with differences varying by age group.

MATERIAL AND METHOD

Study Design and Participants

This cross-sectional study was conducted between January 2 and December 2, 2024, in Erzurum, Türkiye, among preschool and schoolchildren aged between 4–10 years old (n=580) and their parents. Ten schools were selected using random sampling based on accessibility and administrative convenience from among public schools in the city centre districts to include students from different city areas (central, east, west, north, and south). After obtaining ethical approval, ten schools were visited. The schools were selected using random sampling approval. Approximately 3000 children and parents were invited to participate.

Inclusion criteria were: (a) children aged 4–10 years who were not diagnosed with any chronic illness, and (b) parents who voluntarily agreed to participate and completed all sections of the questionnaire. Children were excluded: (a) with a physical disability or having any chronic disease, (b) who had a food disorder such as anorexia nervosa, bulimia nervosa, etc., (c) who didn't speak Turkish, (d) lack of interest and/or were non-volunteering. Due to the study's design, we were unable to assess response rates or compare characteristics between participants and non-participants.

Ethical Considerations

The study was approved by the Ministry of National Education. Ethical approval was obtained from the Ethics Committee at the Faculty of Health Sciences, Atatürk University (Ethics Committee Number:

2023/11/41, Date: 13 November 2023). Informed consent was obtained from all parents and children before participation in the study. Moreover, this study was financially supported by the Scientific and Technological Research Council of Türkiye (TÜBİTAK; Project number: 1919B012304565).

Sample Size

Sample size was determined using G*Power (Version 3.1), assuming a large effect size (Cohen's d=0.8), which is considered large and thus indicates that a strong difference is expected between groups (screen time < 2 hours vs. ≥ 2 hours).[7] The required sample size was initially estimated as n=66 based on a priori power analysis (effect size=0.3, α=0.05, power = 0.80) for detecting differences in nutrient intake between screen time categories. However, considering the study's multi-group design (two age groups: 4–6 and 7–10 years) and the inclusion of multiple variables (dietary intake, eating behavior, and sociodemographic covariates) in regression analyses, the final sample was expanded to 580 children to ensure adequate representation across subgroups and statistical power for multivariate models. This sample size provides >95% power to detect small-to-moderate effect sizes (Cohen's d=0.25) at α=0.05. A total of 2850 children were initially assessed for eligibility. After excluding 1548 children due to lack of interest (n=1350), non-volunteering (n=175), or chronic diseases (n=23), 1302 participants proceeded to the next stage by providing more detailed information. Of these, 610 were excluded (314 not interested, 296 withdrew), resulting in 692 children being trained for the study protocol. Subsequently, 112 participants were excluded due to missing dietary records (n=60), incomplete questionnaires (n=27), or withdrawal (n=25). The final sample consisted of 580 children, divided into two age groups: 228 children aged 4–6 years and 352 children aged 7–10 years.

Data Collection

All participants were asked to complete a questionnaire. The questionnaire consisted of various components: demographic characteristics; screen time (television, tablet, computer, smart phone) (min/day); food consumption (3-day food record); food consumption frequency; anthropometric data; and the CEBQ. Child dietary intake and screen time were measured by parent report.

Data were collected using structured questionnaires administered by trained researchers during school visits. Additionally, we ensured that three recalls were conducted to improve the accuracy and estimation of variability on different days of the week. We used the average of three days in the statistical analysis and show this in the results.

Firstly, we visited the schools and provided the parents and children with information about the study. Parents who expressed interest in participating in the study were provided with more detailed information about the questionnaire. Subsequently, training was provided on the sections of the questionnaire. The parents who agreed to continue their participation in the study were provided with the questionnaires, and their contact details were recorded for follow-up purposes. Recalls were provided to all parents for food consumption and screen time records, and the completed questionnaires were subsequently collected through follow-up visits to the schools.

Technological Devices and Screen Time

Screen time was reported by parents over 3 days (2 weekdays and 1 weekend day), specifying duration (in minutes/day) and device type (television, tablet, computer, smartphone). Data were converted to hours/day. Screen time was categorized as <2 hours or ≥2 hours/day based on recommendations from the WHO and the American Academy of Pediatrics.[8,9] Parents also indicated whether devices were used during meals.

Dietary Intake Assessments

At the beginning of the study, trained and registered dietitians guided parents in completing a 3-day food record using food models and portion-size visuals. A food frequency questionnaire (FFQ) validated for children was used to assess weekly consumption of food groups (fruits, vegetables, snacks, dairy, meat, grains), rated on a 6-point Likert scale, rated from "never=1" to "every day=6".[10] In recall periods, we collected a 3-day food record (two weekdays and one weekend day). Dietary intake data were analyzed using the Beslenme Bilgi Sistemi (BeBiS) version 9.0.[11] Nutrient intakes were compared against DRVs to assess adequacy and identify deficiencies.[5] Intakes were displayed as % of DRVs (Median, 95.0% Lower - Upper for Median CI), derived from the individual intakes as % of sex- and age-specific DRVs. Similar with from the nationwide German KiESEL study[12] in this study, Average Energy Requirements (ARs) were used for energy, and the Adequate Intake (AI), Population Reference Intake (PRI), and Reference Intake (RI) were used related other nutrients. Moreover, multivariable linear regression analyses were performed to examine the association between screen time and major nutrient intakes, adjusting for potential confounders (age, sex, BMI, maternal education, and household income).

Anthropometric Measurements

Parents reported their child's weight (kg) and height (cm), measured at home in the morning before breakfast. BMI was calculated as weight (kg)/height (m²) and categorized according to WHO BMI-for-age z-scores: underweight (<-2 SD), normal weight (-2 to +1 SD), and overweight/obese (>+1 SD).[13]

Children's Eating Behavior Questionnaire (CEBQ)

The CEBQ was used to assess children's eating behavior traits across eight subscales: food responsiveness, enjoyment of food, emotional overeating, desire to drink, satiety responsiveness, slowness in eating, emotional undereating, and food fussiness. Parents rated behaviors on a 5-point Likert scale (1=never, 5=always). Although standardized clinical cut-offs are not available, changes greater than 0.3–0.5 points are considered behaviorally meaningful based on previous literature. The CEBQ is validated and widely used in dietary behavior studies.[7,14] The Turkish validity and reliability of the scale was conducted by Yılmaz et al.[15] and eight subscales explained 58.2% of variance. Moreover, reliability coefficients (Cronbach's Alphas) ranged from 0.61 to 0.84. Food responsiveness (0.69), enjoyment of food (0.84), emotional overeating (0.61), desire to drink (0.79), satiety responsiveness (0.76), slowness in eating (0.75), emotional undereating (0.67), and food fussiness (0.74).

Statistical Analysis

Data analysis was performed using IBM SPSS Statistics (v26.0).[16] Descriptive statistics (mean, SD, frequency, percentage) described the sample. Normality was assessed using the Kolmogorov-Smirnov test. Independent-sample t-tests and Mann-Whitney U tests compared nutrient intakes and CEBQ subscales between screen time groups. Chi-square tests examined categorical variable differences. The differences in daily energy and macronutrient and micronutrient intakes in the age of child participants defined by screen time use were analysed with the nonparametric Mann-Whitney U test. Subscale scores of CEBQ were compared between two groups of age using independent sample t-tests. To control for potential confounding, multivariable linear regression analyses were conducted. Nutrient intakes (energy, protein, carbohydrate, and fat) were entered as dependent variables, and screen time (<2 h vs. ≥2 h/day) as the main independent variable. All models were adjusted for age, sex, BMI, maternal education, and household income. The adjusted β coefficients and 95% confidence intervals were reported. A p-value <0.05 was considered statistically significant. Results were presented as 95% confidence intervals. Statistical significance was set at p<0.05.

Acknowledgments

The authors would like to thank all the children and their parents who participated in the study. Also, thanks to the Scientific and Technological Research Council of Türkiye (TÜBİTAK) for financial support.

RESULTS AND DISCUSSION

This study examined associations between screen time, eating behaviors, and nutrient intake among preschool and school-aged children in Türkiye. As hypothesized, higher screen time was associated with less favorable eating behaviors, though effects varied by age group. The findings reinforce global evidence that prolonged screen exposure is linked to suboptimal dietary patterns and nutrient inadequacies. Importantly, age-specific differences emerged, underscoring that developmental stage shapes how screen use interacts with eating behaviors and diet quality. These results highlight the need for age-tailored recommendations and interventions to reduce screen exposure in early childhood.

A description of the study sample is given in Table 1. The study included 580 children aged 4–10 years, with 228 (39%) aged 4–6 years and 352 (61%) aged 7–10 years. Sex distribution was balanced across both age groups. The mean age of participants was 5.6 ± 0.69 years in the 4-6 age group and 8.6 ± 0.99 years in the 7-10 age group. No differences were observed in mean BMI z-scores between child age groups. Mothers constituted the majority of respondents (87% for the 4-6 age group and 83% for the 4-6 age group). The proportion of mothers with a graduate education was higher in the 4-6 age group (55%) than in the 7-10 age group (44%). Anthropometric measurements showed a significant increase with age: mean body weight was 21.8 ± 4.9 kg and 28.7 ± 6.0 kg, and mean height was 116.5 ± 10.6 cm and 130.9 ± 9.2 cm in the 4-6 years and 7-10 years, respectively. Although the proportion of overweight children was similar across the 4–6 years (28%) and 7–10 years (29%) groups, the younger group had a higher prevalence of underweight status (with 11% compared to 7%). Sociodemographic characteristics revealed that most respondents were mothers (87% for 4–6 years; 83% for 7–10 years), with a higher proportion of mothers holding graduate or undergraduate degrees in the younger group (55% for 4–6 years and 44% for 7–10 years). The mean age of mothers was 34.6 ± 4.8 years in the 4–6 years and 36.9 ± 5.1 years in the 7–10 years, with a statistically significant difference. The average number of children per family was higher in the 7–10 years group (2.76 ± 0.94) than in the 4–6 years group (2.38 ± 0.82). Technological device ownership was more common among the 7–10 years (48%), with tablets being the most frequently owned device. The primary purpose of device use shifted markedly with age: educational use increased from 31% in the 4–6 years to 65% in the 7–10 years, while use for entertainment declined. The use of technological devices during meals was reported in 24% of the 4–6 years and 18% of the 7–10 years. The average daily screen time was significantly higher in the 7–10 years (2.77 hours) compared to the 4–6 years (1.94 hours). Notably, 60% of 7–10 years children had ≥2 hours per day of screen time compared to 37% of the 4–6 years.

Table 1. General Characteristics of the Study Sample

Characteristics	4-6 Years (n= 228, 39%)	7-10 Years (n= 352, 61%)
Sex (n (%))		
Girls	121 (53.1)	163 (46.9)
Boys	107 (46.3)	189 (53.7)
Age (Mean (SD))[4]	5.6 (0.69)	8.6 (0.99)
Body weight (kg) (Mean (SD))[4]	21.8 (4.9)	28.7 (6.0)
Body height (cm) (Mean (SD))[4]	116.5 (10.6)	130.9 (9.2)
BMI z-scores (Mean (SD))	0.07 (2.56)	0.133 (1.50)
BMI classification (n (%))[3]		
Overweight	64 (28.1)	102 (29.0)
Normal	140 (61.4)	225 (63.9)
Underweight	24 (10.5)	25 (7.1)
Mother age (Mean (SD))[4]	34.6 (4.8)	36.9 (5.1)
Parent (n (%))		
Mother	199 (87.3)	293 (83.2)
Father	29 (12.7)	59 (16.8)

Table 1. (Continued)

Characteristics	4-6 Years (n= 228, 39%)	7-10 Years (n= 352, 61%)
Mother education (n (%))		
Primary School	24 (10.5)	68 (19.3)
High school	78 (34.2)	128 (36.4)
Graduate/Undergraduate	125 (54.8)	156 (44.3)
Number of children in family (Mean (SD))[4]	2.38 (0.82)	2.76 (0.94)
Monthly income (n (%))[2]		
Low	12 (5.3)	28 (8.0)
Medium	28 (12.4)	59 (16.9)
High	186 (82.3)	262 (75.1)
Child's owned technological device (n (%))[4]		
Yes	74 (32.5)	168 (47.7)
No	154 (67.5)	184 (52.3)
Number of child's owned technological device[1] **(n (%))**		
Television	10 (10.5)	9 (4.2)
Tablet	59 (62.1)	137 (63.4)
Computer	9 (9.5)	24 (11.1)
Smart phone	17 (17.9)	46 (21.3)
Total	95 (100)	216 (100)
Purpose of the technological device (n (%))[4]		
Education	70 (30.7)	228 (64.7)
Entertainment	158 (69.3)	124 (35.3)
Using technological devices when eating (n (%))[3]		
Yes	55 (24.1)	62 (17.6)
No	172 (75.4)	290 (82.4)
Technological device usage (hours) (Mean (SD))[5]		
Television[4]	1.02 (0.94)	1.33 (0.95)
Tablet[3]	0.22 (0.52)	0.46 (1.04)
Computer[3]	0.06 (0.27)	0.12 (0.39)
Smart phone[3]	0.63 (0.80)	0.87 (0.95)
Total[4]	1.94 (1.32)	2.77 (1.58)
Screen time (n (%))[4]		
<2 h	144 (63)	141 (40)
≥2 h	84 (37)	211 (60)

BMI; Body Mass Index. Underweight (BMI-for-age z-score <-2), normal weight (-2≤ BMI-for-age z-score ≤1) and overweight/obese (BMI-for-age z-score > +1). [1]Multiple choices. [2]Two missing value for 4-6 years and three for 7-10 years. Medium means monthly income as equal to their monthly expenses. [3]p<0.05. [4]p<0.001. [5]Average of 3 days. Independent simple T-test, and Pearson Chi-square for categoric variables.

Daily energy, macronutrient, and micronutrient intakes in age groups according to screen time are given in Table 2. In children aged 4–6 years, total energy and macronutrient intakes did not differ significantly based on screen time. Only protein (E%) and monounsaturated fatty acids (E%) were significantly higher in <2 hours of screen time. Intakes of α-tocopherol and Niacin equiv. significantly higher in <2 hours of screen time, as medians of 7.0 (mg/day), 3.02 (mg/MJ), respectively. In children aged 7–10 years, those with ≥2 hours of screen time had significantly higher carbohydrate intake (median of 175.0g vs. 156.7g), higher protein intake per weight (medians of 1.61 g/kg vs. 1.86 g/kg), higher dietary fiber intake (medians of 15.0 g vs. 16.2 g, p<0.05), and polyunsaturated fatty acids intake (8.2 g vs 9.3 g). Similarly, vitamin intake, including α-tocopherol, thiamine, biotin, pantothenic acid, and vitamin C, and micronutrient intake, including potassium, phosphorus, iron, zinc, and copper, were higher in ≥2 hours of screen time.

Daily nutrient intakes expressed as a percentage of the DRVs were visualized in Figure 1. Children aged 4–6 years did not meet DRVs for energy and nutrients, including α-tocopherol, calcium, and magnesium, in both screen time groups (pantothenic acid and iron did not meet DRVs only in ≥2 hours of screen time, while dietary fiber met in <2 hours of screen time). Also, higher screen time showed energy, protein, retinol, α-tocopherol, vitamin K, niacin, folate, pantothenic acid, calcium, potassium, magnesium, phosphorus, iron, and zinc of the DRV percentage declined. Children aged 7–10 years did not meet DRVs for energy and nutrients, including α-tocopherol, calcium, magnesium, iron, and zinc, in both screen time groups (dietary fiber did not meet DRVs only in <2 hours of screen time). Moreover, higher screen time showed that retinol, vitamin K, and niacin of the DRV percentage declined.

Table 2. Energy, Macronutrient and Micronutrient Intakes in Child Age Groups according to Screen Time

	4-6 Years (n= 228)		p	7-10 Years (n= 352)		p
	<2 h	≥ 2h		<2 h	≥ 2h	
Energy (kcal)	1291 (1204-1339)	1227 (1111-1353)	0.842	1331 (1287-1402)	1470 (1407-1542)	0.001
Macronutrients						
Protein (g)	49.4 (46.6-52.0)	40.3 (37.1-47.7)	0.053	47.2 (44.4-52.2)	52.0 (47.8-55.0)	0.089
Protein (g/kg body weight)	2.17 (2.07-2.37)	1.98 (1.86-2.26)	0.374	1.61 (1.51-1.86)	1.86 (1.78-2.00)	<0.05
Protein (E %)	15.0 (14.7-15.9)	14.0 (14.0-14.9)	<0.05	14.2 (14.0-14.9)	14.1 (13.8-14.6)	0.252
Fat (g)	51.1 (48.0-55.6)	48.7 (42.6-55.1)	0.631	53.4 (47.7-57.8)	58.8 (53.4-64.1)	0.056
Fat (E %)	37.4 (35.2-39.6)	35.4 (33.4-37.0)	0.182	36.5 (34.3-38.7)	36.1 (34.9-37.4)	0.625
Monounsaturated fatty acids (g)	16.9 (15.8-18.5)	14.5 (13.2-16.9)	0.162	16.2 (14.9-18.1)	19 (16.9-20.0)	0.155
Monounsaturated fatty acids (E%)	12.3 (11.4-13.3)	10.6 (10.1-12.1)	<0.05	11.2 (10.7-11.9)	11.1 (10.6-11.6)	0.325
Polyunsaturated fatty acids (g)	7.5 (7.1-8.6)	7.5 (7.5-9.4)	0.892	8.2 (7.5-9.3)	9.3 (8.6-10.7)	<0.05
Polyunsaturated fatty acids (E%)	5.54 (5.25-5.89)	5.67 (4.62-6.17)	0.973	5.87 (5.26-6.34)	6.17 (5.99-6.64)	0.478
Cholesterol (mg)	168 (162-174)	161 (133-175)	0.234	163 (143-175)	167 (156-175)	0.702
Carbohydrate (g)	144.4 (131.1-152.9)	149.3 (149.3-170.8)	0.115	156.7 (147.3-171.2)	175.0 (167.9-187.7)	<0.001
Carbohydrate (E %)	47.6 (45.7-49.2)	50.0 (48.3-52.5)	0.074	49.0 (47.6-50.9)	49.8 (49.0-51.7)	0.382
Total dietary fiber (g)	13.3 (12.2-14.3)	12.5 (11.5-14.0)	0.748	15.0 (14.0-16.3)	16.2 (15.3-17.7)	<0.05
Vitamins						
Retinol equiv. (µg)	648.2 (576.4-745.4)	619.4 (517.6-698.7)	0.242	695.5 (570.8-732.5)	674.8 (628.9-701.6)	0.578
α-tocopherol (mg/day)	7.0 (6.6-7.8)	6.4 (5.4-6.6)	<0.05	7.5 (6.6-7.9)	8.1 (7.8-9.0)	<0.05
Vitamin K (mg)	67.2 (54.7-76.5)	59.8 (47.3-74.0)	0.493	69.2 (62.8-79.3)	74 (68-77.8)	0.718
Cobalamin (µg)	2.8 (2.4-3.3)	2.6 (2.3-3.2)	0.131	2.7 (2.4-3.2)	3.0 (2.7-3.3)	0.494
Thiamin (mg)	0.60 (0.60-0.70)	0.60 (0.60-0.70)	0.569	0.60 (0.60-0.70)	0.70 (0.70-0.80)	<0.05
Thiamin (mg/MJ)	0.11 (0.10-0.11)	0.12 (0.11-0.13)	0.294	0.12 (0.11-0.12)	0.12 (0.11-0.13)	0.692
Riboflavin (mg)	1.1 (1.1-1.3)	1.0 (0.9-1.2)	0.408	1.1 (1.1-1.2)	1.1 (1.1-1.2)	0.247
Niacin equiv. (mg)	15.9 (14.9-17.4)	13.0 (13.0-15.2)	0.071	16.1 (15.1-17.7)	17.3 (16.4-18.6)	0.284
Niacin equiv. (mg/MJ)	3.02 (2.74-3.17)	2.76 (2.49-2.84)	<0.05	2.87 (2.71-3.10)	2.80 (2.65-2.84)	0.121
Biotin (µg)	33.8 (31.6-35.7)	34.1 (31.8-36.2)	0.958	35.7 (31.6-38.0)	39.4 (36.2-41.8)	<0.05
Folate equiv. (mg)	163.9 (146.1-172.5)	145.0 (145.0-163.5)	0.285	167.9 (157.7-179.1)	178.2 (168.3-187.6)	0.102
Pantothenic acid (mg)	3.5 (3.4-3.8)	3.2 (3.1-3.5)	0.252	3.6 (3.4-3.8)	4.0 (3.8-4.3)	<0.05
Pyridoxine (mg)	0.9 (0.9-1.0)	0.8 (0.8-1.0)	0.449	1.0 (0.9-1.1)	1.1 (1.1-1.2)	0.061
Vitamin C (mg)	69.8 (59.2-83.44)	74.6 (66.9-94.2)	0.453	71.6 (60.4-82.1)	99.6 (86.5-111.6)	<0.001
Minerals						
Calcium (mg)	483.1 (429.2-532.5)	473.7 (417.5)	0.543	534.6 (475.1-544.4)	520.5 (478.3-569.9)	0.105
Potassium (mg)	1710 (1602-1834)	1656 (1599-1824)	0.999	1815 (1711-1973)	2110 (1907-2251)	<0.001
Magnesium (mg)	182.1 (171.2-192.1)	175.4 (157.0-193.2	0.838	205.1 (190.4-215.5)	224.5 (211.5-236.1)	<0.05
Phosphorus (mg)	775.1 (722.4-815.2)	754.6 (661.7-831.7)	0.999	792.1 (733.8-855.0)	867.7 (819.8-925.8)	<0.001
Iron (mg)	6.9 (6.4-7.4)	5.9 (5.8-6.6)	0.236	7.1 (6.7-7.4)	8.0 (7.7-8.5)	<0.05
Zinc (mg)	7.0 (6.4-7.9)	6.0 (5.2-6.8)	0.067	6.4 (6.1-7.1)	7.2 (7.1-7.7)	<0.05
Copper (mg)	0.90 (0.90-1.0)	0.90 (0.90-1.0)	0.311	1.1 (1.1-1.3)	1.2 (1.1-1.3)	<0.05

Data are shown as (Median (95.0% Lower - Upper for Median CI). CI; 95% confidence interval. Significant differences were obtained from non-overlapping 95% CIs of medians.

Consistent with previous studies, excessive screen time was associated with greater consumption of energy-dense, nutrient-poor foods such as snacks, sugar-sweetened beverages, and processed items.[17] In overweight Canadian children aged 8–10 years, Shang et al. (2015) also reported less desirable food choices, particularly among those with higher screen exposure.[18] Our Turkish sample similarly showed that prolonged screen time was related to higher intakes of energy-dense foods.[19,20] These patterns may be driven by food cues and marketing during screen use[21], including frequent exposure to advertisements for calorie-rich snacks and drinks.[22] Without intervention, the combination of sedentary behavior and poor diet quality could elevate long-term cardiometabolic risk. Children with higher screen exposure were also more likely to deviate from EFSA Dietary Reference Values (EFSA, 2017)[4], particularly in the school-age group, aligning with evidence from Brazil, Spain, and China showing higher intake of unhealthy foods and lower adherence to healthy dietary patterns such as the Mediterranean diet.[17]

From a public health perspective, nutrient-intake differences must be interpreted relative to requirements.[23] DRVs are designed to cover the needs of nearly all healthy individuals.[5] In line with Tsujiguchi et al. (2018), who reported longer TV viewing associated with lower protein, fiber, and multiple micronutrients in children aged 6–15 years, our analysis revealed notable age-specific patterns in nutrient intake related to screen time.[24]

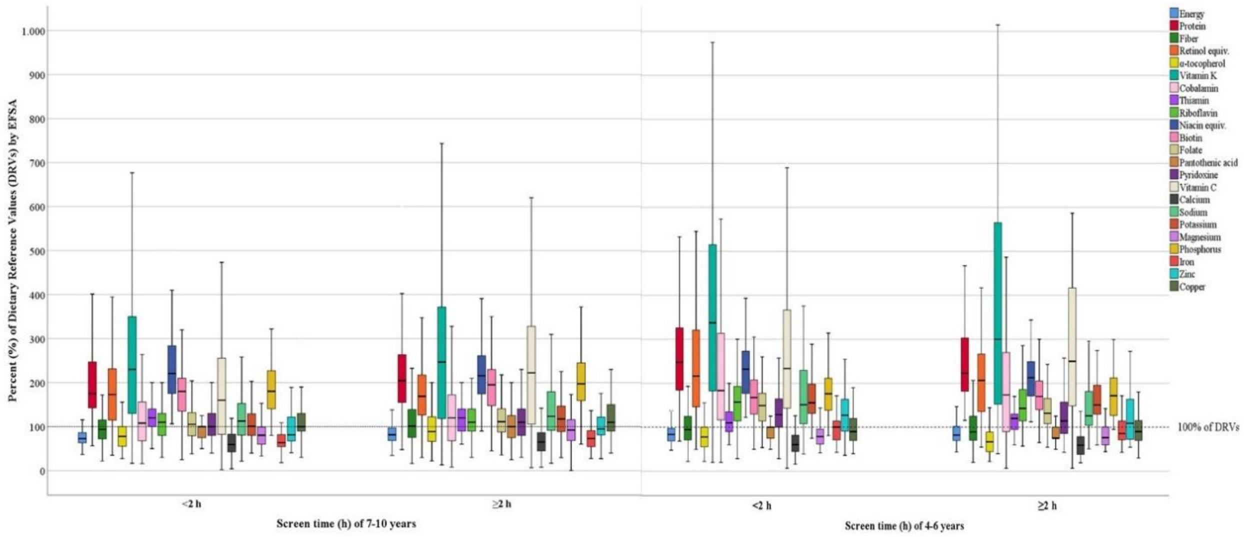

Figure 1. Daily Energy, Macronutrient, and Micronutrient Intake Stratified by Screen Time and Expressed as % of the Drvs (Whisker Length Limited To 1.5 Times The Interquartile Range)

Among children aged 4–6 years, <2 hours/day of screen time aligned with better adherence to DRVs for some nutrients (e.g., protein, monounsaturated fatty acids), potentially reflecting fewer mealtime distractions and less exposure to junk-food marketing.[25] Nonetheless, intakes frequently fell below 80% of DRVs for α-tocopherol, calcium, and magnesium, underscoring clinical relevance. For α-tocopherol, the AI is 9 mg/day at ages 4–9 and 13 mg/day (boys) / 11 mg/day (girls) at age 10; mean intake among 4–6-year-olds was 61.3% of AI, comparable to the German KiESEL study (61–77%).[12] Given vitamin E's role in immune protection and cellular integrity, prolonged insufficiency may increase oxidative stress.[26] Because oils and nuts are major sources, targeted dietary modification may be required.[27] Older children showed slightly higher α-tocopherol intake yet often failed to meet sex-specific AIs—clinically relevant given immune implications.[28]

Calcium—critical for bone development—also fell short. EFSA AI is 800 mg/day for ages 4–10; in our data, 4–6-year-olds averaged 72.1% of AI, and 7–10-year-olds remained below recommendations (notably 10-year-old girls 65.3% and boys 69.8%).[29] Suboptimal calcium during growth is linked to delayed skeletal development, fracture risk, and suboptimal peak bone mass.[30] Screen-based sedentary behavior may further harm bone status through lower activity and potential vitamin D insufficiency.[31] Although a systematic review found a negative association between screen time and bone status, only four studies included diet factors and reported no consistent differences in calcium intake by screen time.[32]

Magnesium, essential for neuromuscular function and bone health, was also inadequate.[33] EFSA AIs are 230 mg/day for ages 4–9, and at age 10: girls 250 mg/day, boys 300 mg/day. In our sample, 4–6-year-olds averaged 65.7% of AI; 7–10-year-olds were higher but still suboptimal (girls 72.8%, boys 74.2%), indicating a broader need for vegetables, nuts/seeds, and dairy.

In 7–10-year-olds, screen time showed a more complex profile: higher total intake of carbohydrates and some micronutrients (e.g., fiber, potassium, magnesium), likely reflecting greater overall consumption—including larger portions, snacks, and fortified products—rather than healthier choices.[21] Thus, screen time appears to increase quantity more than quality[34], a pattern echoed by Barros et al. (2023)[17] (~20% higher unhealthy food consumption), and meta-analyses.[35] Recent Greek data similarly link high screen exposure with more unhealthy foods and fewer healthy options.[36] Our finding of greater fiber/potassium among high-screen older children likely reflects intake from chips/cereals/juices alongside excess sugars and fats.

Results for CEBQ scores and eating behaviors by age group and screen time (h) may be found in Table 3. In the 4-6 years: The "Enjoyment of Food" subscale was significantly lower in children with ≥2 hours of screen time (2.68) compared to those with <2 hours (3.02). The “Satiety Responsiveness” was significantly higher, with 3.34 in ≥2 hours of screen time compared to 3.05 in <2 hours. The “Food Fussiness” was significantly higher, with 2.60 in <2 hours of screen time compared to 2.24 with ≥2 hours. In the 7–10 years, only "Desire to Drink" was significantly higher in those with ≥2 hours of screen time, with 2.95, compared to <2 hours, with 2.54. Moreover, snacking was significantly more frequent in children of both age groups with higher screen time. Snacking frequency was 4.39 in 4-6 years and 4.50 in7-10 years children at ≥2 hours of screen time. Whereas, it was 4.07 in 4-6 years and 3.78 in 7-10 years, children <2 hours of screen time.

Table 3. The CEBQ Scores and Food Group Intakes in Child Age Groups according to Screen Time

	4-6 Years		7-10 Years	
	<2 h	≥ 2h	<2 h	≥ 2h
The CEBQ subscale scores[1]				
Food responsiveness	1.72 (0.71)	1.70 (0.62)	1.86 (0.79)	1.96 (0.74)
Enjoyment of food	3.02 (0.95)[3]	2.68 (0.84)[3]	3.17 (0.95)	3.09 (0.88)
Emotional overeating	1.44 (0.58)	1.52 (0.65)	1.57 (0.59)	1.60 (0.63)
Desire to drink	2.79 (1.09)	2.89 (0.97)	2.54 (0.97)[4]	2.95 (1.07)[4]
Satiety responsiveness	3.05 (0.78)[3]	3.34 (0.75)[3]	2.92 (0.70)	3.04 (0.71)
Slowness in eating	2.83 (0.81)	2.89 (0.89)	2.78 (0.76)	2.87 (0.77)
Emotional undereating	2.83 (0.82)	2.89 (0.90)	2.79 (0.75)	2.88 (0.76)
Food fussiness	2.60 (1.05)[3]	2.24 (0.71)[3]	2.82 (0.90)	2.78 (1.01)
Food frequency[2]				
Dairy	3.62 (1.08)	3.85 (1.03)	3.50 (0.98)	3.57 (1.11)
Meat	3.58 (0.74)	3.59 (0.56)	3.56 (0.70)	3.59 (0.72)
Grains	3.17 (0.55)	3.27 (0.53)	3.24 (0.56)	3.20 (0.55)
Vegetable-Fruit	4.49 (2.14)	4.36 (1.94)	4.17 (1.77)	4.47 (2.04)
Snacks	4.07 (0.95)[3]	4.39 (0.94)[3]	3.78 (0.95)[4]	4.50 (1.00)[4]

Significant differences between screen time groups in different ages were performed with Independent samples T-test and data are shown as Mean (Standard Deviation). CEBQ; Children´s Eating Behaviour Questionnaire. [1]Rating scale (never to always; 1–5). [2]Likert scale (never to every day; 1–6). [2]p<0.05. [3]p<0.001.

Eating-behavior traits clarified these age effects. In preschoolers, higher screen time coincided with lower *Enjoyment of Food* and higher *Satiety Responsiveness*, suggesting disrupted appetite regulation via screen distractions.[37] In older children, higher *Desire to Drink* pointed to greater sugar-sweetened beverage consumption[38], and *Emotional Overeating* also increased with screen time.[39] Reviews emphasize that food-approach traits predict higher intake of sweets and high-fat foods.[6] Interventions should therefore combine screen limits with mindful, screen-free meals and parent-led routines.

Multivariable regression models for energy and macronutrient intakes according to screen time is presented in Table 4. After adjusting for potential confounders, including age, sex, BMI, maternal education, income level, and eating behavior traits (CEBQ subscales), multivariable regression analyses revealed that both environmental and behavioral factors were associated with children’s macronutrient intake.

Children who spent ≥2 h/day on screens had significantly higher total energy intake (B=109.33, p=0.001). This finding corroborates previous reports that prolonged exposure to digital media increases energy-dense food consumption through both distraction and targeted advertising.[2,40] Age was a strong positive predictor (B=46.27, p<0.001), reflecting the physiological rise in energy requirements with growth.[4] Conversely, maternal education was inversely associated with energy intake (B=−48.54, p=0.016), consistent with evidence that higher parental education levels contribute to healthier child dietary patterns.[41] *The Desire to Drink* subscale of the Children's Eating Behaviour Questionnaire (CEBQ) also predicted higher energy intake (B=17.96, p=0.001), suggesting that beverage-driven energy consumption—often from sugar-sweetened drinks—plays a key role.[25]

Table 4. Multivariable Regression Models for Energy and Macronutrient Intakes According to Screen Time

Dependent Variable	Significant Predictors	B	S. E	β	95% CI	p
Energy (kcal/day)	Screen time (≥ 2 h/day)	109.33	31.74	0.141	46.99 – 171.67	<0.05
	Age (Years)	46.27	9.49	0.207	27.62 – 64.91	<0.001
	Mother education	-48.54	20.16	-0.105	-88.14 – -8.95	<0.05
	CEBQ (Desire to Drink)	17.96	5.48	0.147	7.18 – 28.73	<0.05
Protein (g/day)	Age (Years)	1.65	0.44	0.163	0.78 – 2.53	<0.001
	BMI (kg/m2)	-0.66	0.28	-0.104	-1.20 – -0.11	<0.05
	Mother education	-2.26	0.94	-0.108	-4.12 – -0.41	<0.05
	CEBQ (Desire to Drink)	0.65	0.26	0.117	0.15 – 1.15	<0.05
	Screen time (≥2 h/day)	1.02	1.48	0.029	-1.89 – 3.94	0.491
Carbohydrate (g/day)	Screen time (≥ 2 h/day)	19.30	4.71	0.168	10.04 – 28.55	<0.001
	Age (Years)	5.76	1.41	0.174	2.99 – 8.52	<0.001
	Mother education	-6.82	2.99	-0.100	-12.70 – -0.94	<0.05
	CEBQ (Desire to Drink)	2.12	0.81	0.117	0.52 – 3.72	<0.05
Fat (g/day)	Age (Years)	1.79	0.52	0.152	0.77 – 2.82	<0.05
	CEBQ (Food responsiveness)	-0.68	0.34	-0.123	-1.35 – -0.00	<0.05
	CEBQ (Desire to Drink)	0.71	0.30	0.110	0.12 – 1.30	<0.05
	Screen time (≥2 h/day)	2.89	1.75	0.071	-0.54 – 6.32	0.098

B=coefficient of regression. S. E=Standard Error. β =Odds Ratio, CI=Confidence Interval. BMI; Body mass index. The analysis was perfomed by using binary logistic regression. p=level of significance <0.05.

Protein intake increased with age (B=1.65, p<0.001) but was inversely associated with BMI (B=−0.66, p=0.019) and maternal education (B=−2.26, p=0.017). These findings may indicate that children with higher BMI or more educated parents consume smaller or more selective protein portions.[23] *Desire to Drink* was positively associated (B=0.65, p=0.012), reflecting that protein sources such as milk or flavored dairy beverages may contribute notably to total intake.

Carbohydrate intake rose significantly with both age (B=5.76, p<0.001) and screen time ≥ 2 h/day (B=19.30, p<0.001). Children exposed to longer screen durations consumed more carbohydrate-rich foods, echoing international findings that screen exposure promotes intake of refined carbohydrates, snacks, and sweetened beverages.[17,42] *The Desire to Drink* subscale showed a significant positive association (B=2.12, p=0.009). Conversely, maternal education (B=−6.82, p=0.023) was inversely linked, supporting the protective influence of parental nutritional literacy.[43]

Age (B=1.79, p=0.001) and *Desire to Drink* (B=0.71, p=0.019) were positively associated with fat intake, indicating that overall energy expansion with growth also includes higher lipid consumption. Interestingly, *Food Responsiveness* was negatively associated with fat intake (B=−0.68, p=0.049), suggesting that although these children respond strongly to food cues, parental control or meal structure might limit fat-dense food availability.[5] The association between screen time and fat intake was positive but not statistically significant (B=2.89, p=0.098), yet its direction was consistent with prior evidence linking screen exposure with greater dietary fat intake.[18,19]

Overall, the consistent effect of the *Desire to Drink* subscale across all macronutrients highlights beverage-driven overconsumption as a behavioral mechanism underlying the screen–diet relationship. Similar findings have been reported in other European cohorts, where frequent beverage intake during screen activities increased total caloric load without improving nutrient density.[20,36] Furthermore, the protective role of maternal education suggests that family-level nutrition education could buffer children from unhealthy media-driven eating patterns.[43]

These results collectively reinforce that excessive screen exposure in children is not merely a sedentary behavior but a complex behavioral environment shaping food choices and nutrient intake. Interventions aiming to limit screen time, regulate beverage access, and promote mindful eating may thus be crucial for preventing early dietary imbalances and related metabolic risks.[1,2]

Limitations

Several limitations of this study should be acknowledged to interpret the findings appropriately. First, our sample was drawn from 10 schools in Erzurum, a single region of Türkiye. The relatively localized and voluntary nature of our sample may limit the generalizability of these findings to the broader population of Turkish children. Thus, the generalisability of the findings beyond the current sample is unknown. Future studies need to draw samples from other cities. Second, we did not account for several important potential confounding variables. Physical activity levels were not measured, so we could not adjust our analyses for how exercise might influence both screen time and diet. This is important because a child who is very sedentary (high screen time) might also expend fewer calories and have different appetite signals than an active child, affecting their energy balance and food choices. Similarly, we lacked data on sleep patterns – inadequate sleep has been linked to increased appetite and preference for high-sugar/high-fat foods in children, and screen time often interferes with sleep. Without controlling for these factors, there is a possibility that some of the associations we attribute to screen time might partially reflect these underlying lifestyle factors. We acknowledge that the observed relationships might be over- or under-estimated due to residual confounding. Future studies should include a more comprehensive set of behavioral and environmental covariates to clarify the independent effect of screen use on children's nutrition. Third, our assessment of screen time did not differentiate between types of screen use (e.g., television vs. tablet vs. smartphone, or content watched) beyond total duration.

Different screen activities may have distinct relationships with diet – for example, TV viewing might expose children to more food advertising, while tablet use might allow more uncontrolled snacking. Fourth, the cross-sectional design of our study limits to infer causality of relationships. While we discuss the results as associations (e.g., screen time linked to poor diet), we cannot conclude that high screen time causes unhealthy eating. It is equally plausible that children with poor dietary habits might be given screens more often, or that some third factor leads to increases in both screen use and poor diet. Longitudinal studies or randomized trials would be needed to establish cause-and-effect relationships – for example, to test if reducing screen time leads to improvements in diet and body weight. Lastly, the data on screen time and dietary intake were based on parent-reported questionnaires (including an FFQ), which are subject to recall bias. We did take steps to cross-check and ensure consistency in reported food intake, but some errors in estimating screen hours or food quantities are likely. Despite these limitations, this study has several strengths. Notably, we employed detailed dietary assessment and compared nutrient intakes to EFSA reference standards, offering insight into not just broad food group trends but also micronutrient adequacy in children's diets. We also examined eating behavior traits using a validated questionnaire (CEBQ), providing a novel perspective on how screen time might correlate with how children eat, not only what they eat. These contributions help enrich the understanding of screen time's multifaceted impact on child health.

CONCLUSION AND RECOMMENDATIONS

The current results revealed that significant micronutrient deficiencies (e.g., α-tocopherol, calcium, magnesium) are associated with increased screen time, emphasizing its impact on not just energy intake but also diet quality. These findings highlight the importance of promoting balanced screen time alongside healthy eating habits, particularly among children at risk of exceeding recommended screen time thresholds, especially among children aged 7-10 years.

Strategies should include educating parents—especially mothers—about the implications of screen time on eating behaviors and nutrient intake. Targeted interventions could involve setting consistent screen time limits, encouraging family meals free from screens, and fostering healthier snacking options during screen use. Future studies should explore the quality of foods consumed during screen time and longitudinal assessments. Additionally, age-specific intervention strategies to improve nutrient intake—particularly for α-tocopherol, calcium, and magnesium—are critical to addressing observed deficiencies. Our findings have practical implications for parents, healthcare providers, and policymakers. For parents and caregivers, the evidence suggests that limiting children's recreational screen time can be beneficial for their nutrition and eating habits. Current guidelines, such as those from the American Academy of Pediatrics, already recommend that children over 2 years old spend no more than 2 hours per day on recreational screens, and that children under 2 have no screen time at all. Pediatricians and nutritionists should consider routinely asking about screen habits during consultations; counselling families on the importance of moderating screen time could be integrated into advice on healthy eating and lifestyle. Simple steps such as establishing screen-free times (especially during meals and before bedtime) and offering healthy snacks (fruits, yogurt, nuts) instead of chips or sweets during permitted screen time can help mitigate some of the risks. In conclusion, this study highlights that excessive screen time is linked with poorer eating behaviors and nutrient imbalances in children, with notable differences between preschool and school-age groups. Reducing screen exposure and addressing associated eating habits should be a part of comprehensive strategies to improve childhood nutrition and prevent obesity.

Conflict of Interest

The authors declare that this study was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Author Contributions

IMA: Formal analysis, Investigation, Methodology, Supervision, Visualisation, Writing - original draft, Writing - review & editing. BMÖ: Data curation, Funding acquisition, Investigation, Methodology, Writing - original draft. HD: Data curation, Investigation, Methodology, Writing - original draft.

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