

# Prevalence of and Factors Influencing Oral Health Behaviours in 2-Year-Old Children: A Cross-Sectional Analysis of Data from the KUNO-Kids Health Study

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## Keywords

Paediatric dentistry · Preschool · Diet · Oral hygiene · Northeastern Bavaria

## Abstract

**Introduction:** This questionnaire-based investigation aimed to assess oral health behaviour (OHB) in 2-year-old children taking part in a birth cohort study and to identify relationships between general health, socioeconomic as well as psychosocial factors and OHB. **Methods:** Factors examined were single-parent status, migration background, child's sex, parity, maternal age, education and social support, paternal employment, parental mental and physical health, and child health, data for which were collected at birth, 4 weeks, or 1 year. Participants who answered all OHB questions at 2 years ( $n = 730$ ) were included. Nutritional score (NS), toothbrushing score (TS), and dental check-up score (CS) were used to calculate overall OHB score.

**Results:** Overall OHB in this cohort was good. 62% ate fruit or vegetables daily, 75% brushed 2–3 times daily, and 61% had already had a dental check-up. Children of single mothers had significantly lower OHB scores. NS was significantly higher for children with migration background, children of mothers with better physical health or higher educational level, but lower for children of mothers reporting poor social support. TS was significantly lower in children of single mothers and children of fathers reporting poorer mental health. CS was significantly higher in children of multiparous mothers. This study highlights the relevance of social support and parental health, in contributing to OHB patterns. **Conclusion:** Families with special healthcare needs or less robust social support may have difficulty maintaining good OHB.

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## Plain Language Summary

This study recorded the oral health habits (diet, toothbrushing, and check-up attendance) of 2-year-old children in southeastern Germany. The research also aimed to understand how different factors, such as family background, parents' health, and education levels can influence these habits. The study involved 730 children, and the information was collected through questionnaires answered by parents. We found that, in general, these children's oral hygiene and dental check-up habits were fairly good. Most children brushed their teeth regularly and had already visited a dentist by the age of two. However, there were some worrying behaviours, such as use of baby bottles at age 2 and frequent consumption of sweets, which can increase the risk of tooth decay. One significant finding was that children of single mothers tended to have poorer oral health habits. This may be due to the challenges single mothers face in finding time to maintain good OHBs for their children. Additionally, the study found that children from families with lower social support or where parents had health issues also had lower scores and may need extra support to maintain good oral health habits for their children.

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## Introduction

Early childhood caries (ECC) is a global public health concern, disproportionately affecting socially disadvantaged populations [1, 2]. ECC is a frequent indication for general anaesthesia in preschool children. It negatively impacts children's quality of life, resulting in pain, difficulty with eating, weight loss, sleeping and speech issues, behavioural changes, low self-esteem, and reduced school performance [3, 4].

ECC is a disease with a complex multifactorial aetiology, in which biological, environmental, psychosocial, sociodemographic, and behavioural factors play a leading role [5]. While certain factors may not be easily alterable, modifying behaviours remains an important aspect to address in the prevention of this disease. The main behavioural risk factors for ECC are diet, oral hygiene habits, and the uptake of dental care [6, 7]. These behaviours may in turn be influenced by other factors such as migration status, level of education, income, overall health, and levels of stress. Oral health behaviour (OHB) in families during the time leading up to and beyond the eruption of the first teeth is a central determining factor for the development or prevention of ECC. These habits are predominantly influenced by the parent or primary

caregiver during early childhood [8]. The time parents invest, in providing optimal OHB for each child, may also be limited by further factors such as number of children, employment, and their own physical and mental health [9].

Birth cohort studies offer valuable insights into the relationship between factors in early life and diseases which develop later. OHB in preschool children has been previously reported in birth cohorts, and an association with sociodemographic factors has been shown [10–12]. Data on toothbrushing and dental check-up attendance for very young children (0–2 years) also show differences between sociodemographic groups [13]. However, other factors such as health and social support may also influence a parent's ability to provide optimal oral health care for their child. Therefore, the aims of this prospective study were to describe the OHB of 2-year-old children participating in the KUNO-Kids birth cohort study and to investigate the impact of general health, socioeconomic, and psychosocial factors of participating families on the OHB of these children.

## Methods

Findings from this study are reported according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist, see online supplementary material 1 (for all online suppl. material, see <https://doi.org/10.1159/000542913>) [14].

### *Study Design and Patient Cohort*

The KUNO-Kids health study is a prospective birth cohort study designed to evaluate multiple aspects of child health and development [15]. In total, 3,100 participants were recruited from the maternity department of the St. Hedwig clinic in Regensburg, Germany, between 2015 and 2020. The catchment area was Regensburg and its mostly rural surrounding areas in northeastern Bavaria. Mothers who were at least 18 years of age with sufficient German language skills to complete the questionnaires were included in the birth cohort study. Only one child per family was invited to participate in the study. Additional siblings were excluded if a sibling had already been enrolled in the study. A baseline interview was conducted before the mother and child were discharged from maternity hospital. Follow-ups were conducted via questionnaires at 4 weeks and at each birthday. As a cross-sectional analysis within the birth cohort, our data were collected at single, not repeated timepoints. Data for OHB were collected at 2 years, and data for

potential influencing factors were collected from the earliest applicable questionnaire but also only once. Data for child's sex, maternal age at time of birth, single-mother status, maternal education, migration background, and parity were collected at the baseline interview. Data on fathers' migration background were collected at 4 weeks, fathers' employment status, child and parent health, and social support were collected at 1 year.

Brandstetter et al. [15] have described the characteristics and sociodemographics of this cohort in detail, allowing comparison with other populations; a response rate of 49% at 1 year was recorded. The present analysis is a cross-sectional analysis within a birth cohort using data that was collected until March 2020. Participants of the KUNO-Kids health study, who provided answers for all relevant oral health-related questions in the 2-year child questionnaire ( $n = 730$ ), were included for the present analysis. Participants ( $n = 110$ ) who did not provide complete responses to the questions necessary for calculating an oral health score were excluded due to missing data.

The study was approved by the Ethics Committee of the University of Regensburg (reference numbers: 14-101-0347 and 19-1646-101). Written informed consent to take part in the study was obtained from all participants aged 18 and over. Written informed consent to take part in the study was obtained from parents/legal guardians for all participants aged under 18.

#### *Oral Health Behaviour*

For the purposes of this study, OHBs were defined based on guidelines for 18-month-old children, as outlined in the child dental health passport. This passport, published by the Bavarian dental council, was provided to all participating families before discharge from the maternity hospital [16].

The advice given included that the child should eat a balanced diet including fruit and vegetables and avoid frequent consumption of sugary snacks. Children should not drink sugary drinks, particularly from a baby bottle and especially at night. Cup use should be introduced by 9 months and used exclusively for drinks from the first birthday. At 18 months, the child's teeth should be brushed twice daily with a fluoridated children's toothpaste. The parents should brush the child's teeth even if the child brushes them first. A first check-up appointment should be made. Based on this advice, five nutritional behaviours, three toothbrushing behaviours, and one check-up attendance behaviour were defined (see Table 1).

#### *Allocation of Points towards Scores*

Points were awarded based on whether each participant complied with these guidelines. Twenty points were available for full compliance with each OHB (see Table 1). Fewer points were awarded if the behaviour was only partially followed, for example brushing only once a day was awarded only 10 points. Zero points were awarded if the behaviour was not carried out at all. The information on whether each participant complied with a particular behaviour was derived from responses to nearly 300 variables covering aspects of diet, oral hygiene, and doctors' visits from the 2-year questionnaire.

Nutritional score (NS), toothbrushing score (TS), and check-up score (CS) were calculated as a sum from responses on dietary, oral hygiene and check-up attendance habits, collectively contributing to the overall OHB score for each child. A maximum possible OHB score of 180 points was possible, made up of NS (100 points), TS (60 points), and CS (20 points).

#### *Potential Influencing Factors*

The following data on potential influencing factors were collected from the baseline interview and follow-up questionnaires up to 1 year of age: child's sex, maternal age at time of birth, single-mother status, parity, parent-assessed child health status, migration background, maternal education, fathers' employment status, parents' physical and mental health-related quality of life (HRQOL), measured using the short-form health survey (SF-12) and maternal social support, measured using the short-form of the F-SozU K-14 questionnaire. The following interval scale data were converted into two or three categories for subsequent analysis of association between influencing factors and OHB scores: reasons for categorisation are addressed in the discussion. Maternal age at time of birth was categorised as up to and including 27 years, 28–37 years and over 37 years. Maternal education was classified as up to 10 years, 10 years, or more than 10 years school education. Short-form health survey (SF-12): maternal and paternal HRQOL was assessed using the SF-12, a validated instrument comprising both physical and mental components [17, 18]. This yielded mental component scores (MCS) and physical component scores (PCS) for both parents, which were categorised into low, moderate, and high scores. Data were split into three categories, approximately separating the highest 10%, the lowest 10%, and the middle 80%. However, the split was not always possible at exactly 10%, as adjustments were made to ensure each participant was fully assigned to a single category. Maternal-perceived social support was measured using the "F-SozU K-14," a standardised short-form social support questionnaire with 14

**Table 1.** Allocation of points towards NS, TS and CS

	Points
<i>Nutritional score (max. 100 points)</i>	
Child did not have sugary drinks	20
Child had both sugary and sugar-free drinks	10
Child had only sugary drinks	0
Child drinks from a cup and only daytime	20
Child drinks from cup at night also	10
Child drinks from bottle during daytime	3
Child drinks from a bottle at night	0
Child does not eat sweets	20
Child eats sweets once a month	18
Child eats sweets several times a month	15
Child eats sweets once a week	7
Child eats sweets several times a week	5
Child eats sweets almost daily	3
Child eats sweets daily	2
Child eats sweets several times a day	0
Child eats fruit or vegetables several times a day	20
Child eats fruit or vegetables daily	18
Child eats fruit or vegetables almost daily	15
Child eats fruit or vegetables several times a week	7
Child eats fruit or vegetables once a week	5
Child eats fruit or vegetables several times a month	3
Child eats fruit or vegetables once a month	2
Child does not eat fruit or vegetables	0
Child avoided eating honey	5
Child avoided eating sugar	5
Child avoided eating sweets	5
These foods were avoided for dental health reasons	5
<i>Toothbrushing score (max. 60 points)</i>	
Child's teeth brushed after every meal	20
Child's teeth brushed 2–3 times a day	20
Child's teeth brushed once a day	10
Child's teeth brushed once a week	0
Child's teeth brushed occasionally	0
Child's teeth not brushed	0
Parent brushes child's teeth	20
Other member of household brushes child's teeth	20
Child brushes own teeth under supervision	10
Child brushes own teeth	0

**Table 1** (continued)

	Points
Children's fluoridated toothpaste used	20
Adult fluoridated toothpaste used	15
Children's non-fluoridated toothpaste used	5
Adult non-fluoridated toothpaste used	5
No toothpaste used	0
<i>Dental check-up score (max. 20 points)</i>	
Child had dental visit since first birthday	20
Child has not had dental visit since first birthday	0

statements covering practical and emotional support, social integration, perceived social support, and social strain [19, 20]. We classified scores of 3.3 or less as low, representing the bottom 10% of scores for mothers who responded. Parent-assessed child health was subjectively ranked on a visual analogue scale of 0–100. These scores were classified as up to or over 80, separating those with very good or excellent health from those with less than excellent health.

#### Data Analyses

Frequency tables were generated for OHB, NS, TS, and CS. Association between all four scores: OHB, NS, TS, CS, and potential influencing factors (child's sex, maternal age at time of birth, single-mother status, parity, parent-assessed child health status, migration background, maternal education, fathers' employment status, mothers' MCS and PCS, fathers' MCS and PCS, and maternal perceived social support) was tested using the chi-squared test.

Statistical processing was carried out using SPSS for Windows, version 29, SPSS Inc., Chicago, USA. For pairwise comparisons, the level of significance was set at  $\alpha = 0.05$ . This level was adjusted according to the error rate method to  $\alpha^* (k) = 1 - (1 - \alpha)^{1/k}$ , where  $k$  represents the number of pairwise tests considered for multiple comparisons.

## Results

### *Dietary, Toothbrushing, and Dental Check-Up Attendance Behaviour within the Study Population*

Some aspects of OHB in this cohort were good: sixty-two percent ate fruit or vegetables at least once daily, 75% brushed 2–3 times daily or after each meal and 80% reported that the child's teeth were brushed not only by the child but also by a parent or another member of the household. Sixty-one percent had a dental check-up since their first birthday. But nutritional guidelines to avoid cariogenic foods and

prolonged baby bottle use were poorly followed. Seventy-nine percent were still using a baby bottle, 65% were still using it at night, and 40% reported eating sweets (sweets, chocolate, gummi bears, sugar, honey, jam, or hazelnut chocolate cream) several times a week. Eighty-one percent of children received beverages both with and without sugar and 17% reported using non-fluoride toothpaste. A detailed overview of dietary, toothbrushing and dental attendance habits and behaviour is given in Table 2.

#### Scores

The overall OHB scores achieved by participants exhibited a broad range, spanning from 33 to 135 of a possible 180 points, as illustrated in Figure 1. The most frequent score (80) was achieved by 44 participants. However, 52% of participants scored less than half (90) of the available points.

The frequency distribution for NS is illustrated in Figure 2, with scores ranging from 10 to 90 out of a possible 100 points. The distribution is skewed to the left, with 81% achieving less than half (50) of the available points.

On the other hand, the frequency distribution for tooth brushing score (TS) is strongly skewed to the right. The maximum 60 points was most frequently recorded and achieved by 48% of participants as shown in Figure 3.

Dental CS: more than half the population studied had already visited a dentist. Sixty-one percent of children ( $n = 444$ ) scored the maximum 20 points having visited a dentist in the previous year. Thirty-nine percent of children ( $n = 286$ ) had not had a dental check-up.

### *Demographic and Socioeconomic Characteristics within the Study Population*

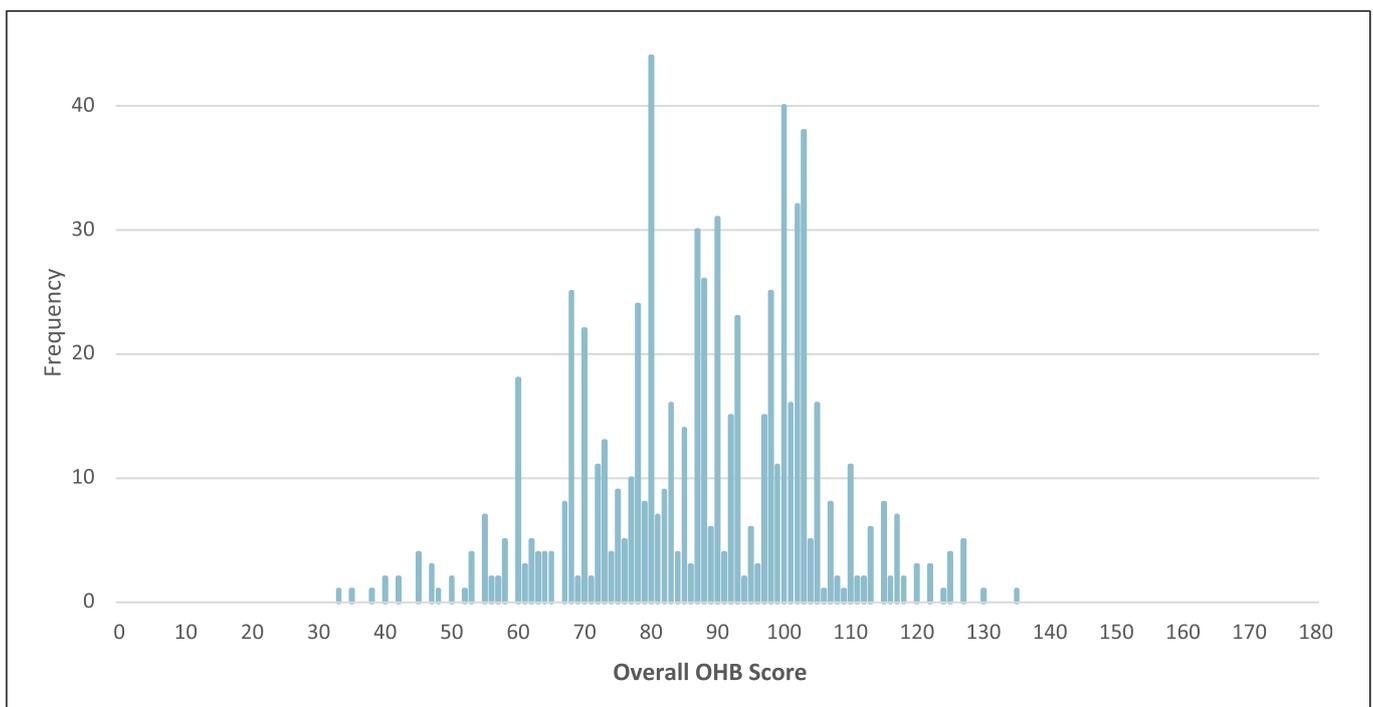
Family health and socioeconomic characteristics within the study population are given in Table 3. There was a very small proportion (1.5%) of single mothers. Both parents

**Table 2.** Dietary, toothbrushing, and dental attendance behaviour in the study population

	Frequency, %	<i>n</i>
<i>Dietary behaviour</i>		
Fruit or vegetables several times daily	40.1	293
Fruit or vegetables daily	21.6	158
Fruit or vegetables almost daily	17.9	131
Fruit or vegetables several times per week	10.5	77
Fruit or vegetables once per week	0.4	3
Fruit or vegetables several times per month	1.5	11
Fruit or vegetables once per month	0.4	3
Never eaten fruit or vegetables	0	0
Contradictory answers	7.4	54
Sweets several times daily	2.6	19
Sweets once daily	11.2	82
Sweets almost daily	16.2	118
Sweets several times per week	40.4	295
Sweets once per week	10.5	77
Sweets several times per month	8.5	62
Sweets once per month	2.3	17
Not eaten any sweets	7	51
Contradictory answers	1.2	9
Received only sugar-free beverages	18.8	137
Received beverages with and without sugar	80.8	590
Received only sugary beverages	0.4	3
Received beverages from the bottle	78.8	575
Received beverages from the bottle even at night	64.8	473
Received beverages only during the day and from the bottle	14	102
Received beverages only from the cup	21.2	155
Received beverages from the cup even at night	13	95
Received beverages only during the day and from the cup	8.2	60
Avoided honey, sugar, and sweets for dental health	5.9	43
Did not avoid honey, sugar, or sweets	78.5	573
<i>Toothbrushing behaviour</i>		
After every meal or 2–3 times daily	72.5	529
Once daily	26.8	196
Once weekly or occasionally/never	0.7	5
<i>Who brushes the child's teeth?</i>		
Parents or another person in the household	80.1	585
Child self and checked afterwards	18.8	137
Child self without checking	1.1	8

**Table 2** (continued)

	Frequency, %	<i>n</i>
<i>Toothpaste used</i>		
Children's toothpaste with fluoride	81.8	597
Adult toothpaste with fluoride	0.3	2
Adult or children's toothpaste without fluoride	16.6	121
Without toothpaste or other means	1.4	10
<i>Dental check-up attendance behaviour</i>		
Visited a dentist for examination	60.8	444
Did not visit a dentist since the first birthday	39.2	286



**Fig. 1.** Histogram showing overall OHB score frequency for study population ( $n = 730$ ), of a possible 180 points.

had German citizenship in the great majority (80%) of participating families. High educational levels and very low levels of unemployment were recorded.

#### *Association between Potential Influencing Factors and Scores*

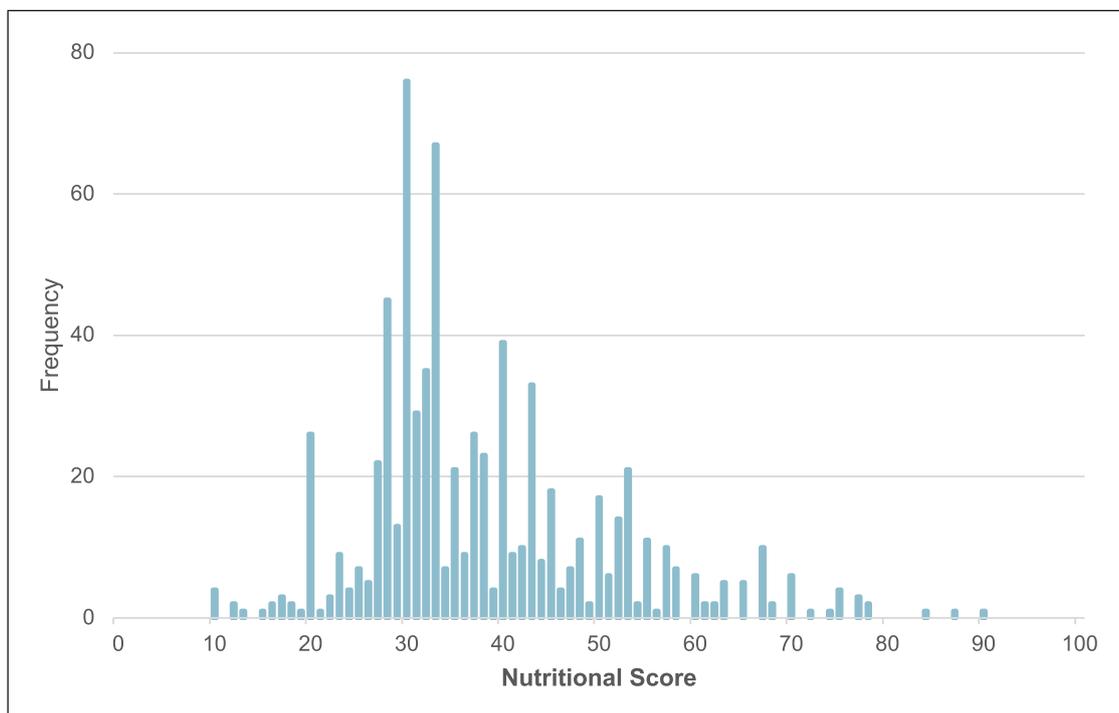
##### Overall OHB Score

Table 4 shows the associations between all factors tested and OHB score. The only factor found to have a statistically significant effect on the overall OHB score was single motherhood ( $p = 0.01$ ). Single motherhood

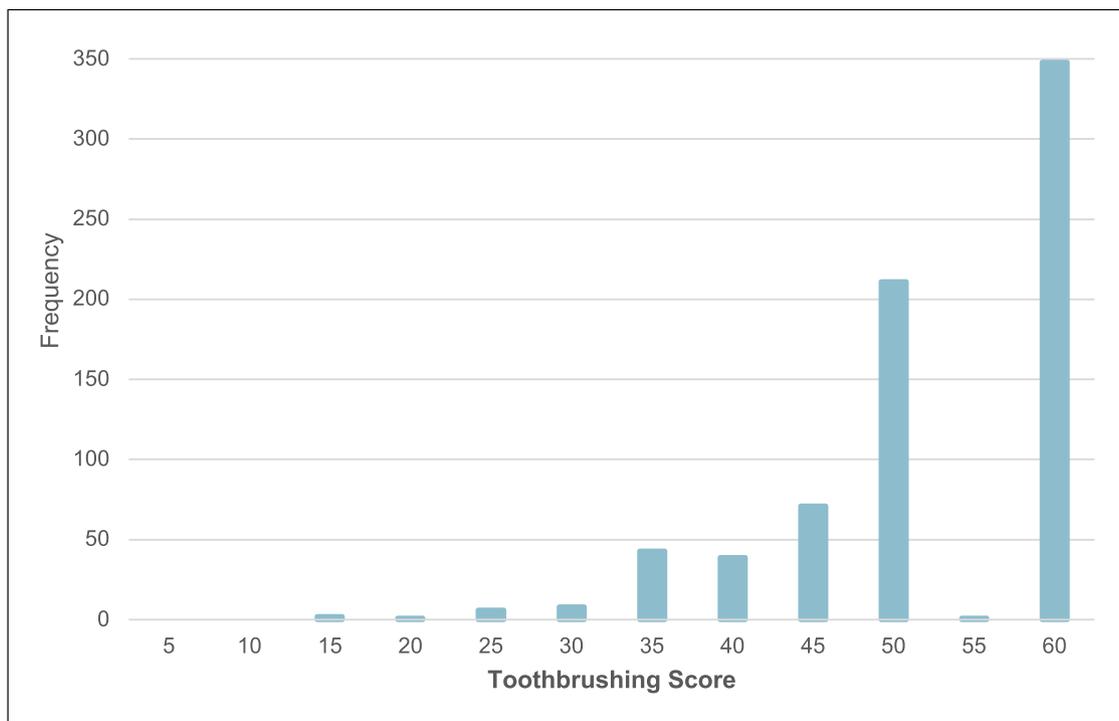
was associated with lower OHB score. None of the children from single-mother households achieved a high OHB score ( $>105$  points). No significant association could be shown for multiple variables.

##### Nutritional Score

Table 5 shows the associations between all factors tested and NS. We found that migration background was significantly associated with higher NS. Maternal education, perceived maternal social support, and maternal mental HRQOL scores were all significantly



**Fig. 2.** Histogram showing NS frequency for study population ( $n = 730$ ), of a possible 100 points.



**Fig. 3.** Histogram showing TS frequency for study population ( $n = 730$ ), of a possible 60 points.

**Table 3.** Overall distribution of family health and socioeconomic factors in the study population

Population health and sociodemographics	Total sample (N = 100%)	Proportion, N (%)
Single-mother status	713	
Yes		11 (1.5%)
No		702 (98.5%)
Migration background	726	
At least one parent without German citizenship		140 (19.3%)
No		586 (80.7%)
Child's sex	726	
Female		351 (48.3%)
Male		375 (51.7%)
Parity	724	
Primiparous		450 (62.2%)
Multiparous		274 (37.8%)
Maternal age	723	
<28		70 (9.7%)
28–37		579 (80.1%)
>37		74 (10.2%)
Maternal education	708	
<10 years		44 (6.2%)
=10 years		212 (29.9%)
>10 years		452 (63.8%)
F-SozU mother	660	
≤3.3 points		66 (10%)
>3.3 points		594 (90%)
Mental component score (MCS) mother	640	
<34 points		63 (9.8%)
34–57 points		525 (82%)
>57 points		52 (8.1%)
Physical component score (PCS) mother	640	
<46 points		67 (10.5%)
46–58.5 points		504 (78.8%)
>58.5 points		69 (10.8%)
Father's employment	626	
Employed		613 (97.9%)
Unemployed		13 (2.1%)
Mental component score (MCS) father	612	
≤35 points		64 (10.5%)
>35–53.5 points		487 (79.6%)
>53.5 points		61 (10%)
Physical component score (PCS) father	612	
≤48 points		58 (9.5%)
48–59 points		502 (82%)
>59 points		52 (8.5%)
Child health status	653	
>80		589 (90.2%)
≤80		64 (9.8%)

**Table 4.** Factors influencing OHB score (low OHB  $\leq 64$ ,  $64 <$  middle OHB  $\leq 105$ , high OHB  $> 105$ )

Influencing factor	Low OHB, %	Middle OHB, %	High OHB, %	<i>p</i> value
Single-mother status				<b>0.010</b>
Yes	36.4	63.6	0	
No	9.5	80.9	9.5	
Migration background				0.124
At least one parent without German citizenship	14.3	75.0	10.7	
No	8.9	81.7	9.4	
Child's sex				0.606
Female	8.8	82.1	9.1	
Male	10.9	79.5	9.6	
Parity				0.217
Primiparous	10.9	78.7	10.4	
Multiparous	8.4	83.9	7.7	
Maternal age				0.274
$\leq 27$	15.7	80.0	4.3	
28–37	9.5	80.1	10.4	
$> 37$	8.1	82.4	9.5	
Maternal education				0.575
$< 10$ years	13.6	81.8	4.5	
$= 10$ years	10.4	81.6	8.0	
$> 10$ years	9.3	80.3	10.4	
F-SozU mother				0.798
$\leq 3.3$ points	9.1	83.3	7.6	
$> 3.3$ points	9.4	80.5	10.1	
Mental component score mother				0.170
$\leq 33$ points	17.5	74.6	7.9	
$> 33$ –57 points	8.8	81.0	10.3	
$> 57$ points	5.8	86.5	7.7	
Physical component score mother				0.310
$\leq 45$ points	11.9	74.6	13.4	
$> 45$ –58.5 points	9.7	81.3	8.9	
$> 58.5$ points	4.3	82.6	13.0	
Father's employment				0.567
Employed	9.0	80.9	10.1	
Unemployed	15.4	69.2	15.4	
Mental component score father				0.651
$\leq 35$ points	14.1	75.0	10.9	
$> 35$ –53.5 points	8.6	81.7	9.7	
$> 53.5$ points	8.2	80.3	11.5	
Physical component score father				0.407
$\leq 48$ points	12.1	77.6	10.3	
$> 48$ –59 points	8.2	82.1	9.8	
$> 59$ points	15.4	73.1	11.5	
Child health status				0.434
$> 80$	9.5	80.8	9.7	
$\leq 80$	4.7	84.4	10.9	

**Table 5.** Factors influencing NS (low NS <26, middle NS = 26–55, high NS >55)

Influencing factor	Low NS, %	Middle NS, %	High NS, %	<i>p</i> value
Single-mother status				0.152
Yes	27.3	63.6	9.1	
No	9.7	81.1	9.3	
Migration background				<b>0.018</b>
At least one parent without German citizenship	7.9	76.4	15.7	
No	10.2	81.7	8.0	
Child's sex				0.946
Female	9.4	81.2	9.4	
Male	10.1	80.5	9.3	
Parity				0.072
Primiparous	9.6	79.1	11.3	
Multiparous	10.2	83.6	6.2	
Maternal age				0.332
<27	15.7	72.9	11.4	
28–37	9.2	81.2	9.7	
>37	8.1	85.1	6.8	
Maternal education				<b>0.045</b>
<10 years	20.5	75.0	4.5	
=10 years	11.3	81.6	7.1	
>10 years	8.2	81.4	10.4	
F-SozU mother				<b>0.036</b>
≤3.3 points	18.2	72.7	9.1	
>3.3 points	8.4	81.3	10.3	
Mental component score mother				<b>0.026</b>
≤33 points	19.0	74.6	6.3	
>33–57 points	8.4	80.6	11.0	
>57 points	7.7	88.5	3.8	
Physical component score mother				0.117
≤45 points	7.5	85.1	7.5	
>45–58.5 points	10.7	79.4	9.9	
>58.5 points	1.4	85.5	13.0	
Father's employment				0.570
Employed	9.1	80.9	10.0	
Unemployed	15.4	69.2	15.4	
Mental component score father				0.779
≤35 points	9.4	76.6	14.1	
>35–53.5 points	9.4	81.3	9.2	
>53.5 points	11.5	78.7	9.8	
Physical component score father				0.208
≤48 points	15.5	79.3	5.2	
>48–59 points	8.6	81.5	10.0	
>59 points	13.5	73.1	13.5	
Child health status				0.537
>80	9.3	80.8	9.8	
≤80	12.5	75.0	12.5	

**Table 6.** Factors influencing TS (low TS  $\leq 35$ , 35 < middle TS  $\leq 55$ , high TS  $> 55$ )

Influencing factor	Low TS (%)	Middle TS (%)	High TS (%)	<i>p</i> value
Single-mother status				<b>0.004</b>
Yes	9.1	90.9	0.0	
No	8.1	43.2	48.7	
Migration background				0.076
At least one parent without German citizenship	11.4	48.6	40.0	
No	7.5	42.8	49.7	
Child's sex				0.094
Female	6.0	44.7	49.3	
Male	10.4	43.5	46.1	
Parity				0.562
Primiparous	9.1	43.1	47.8	
Multiparous	6.9	45.3	47.8	
Maternal age				0.972
$\leq 27$	8.6	44.3	47.1	
28–37	8.5	43.5	48.0	
$> 37$	6.8	47.3	45.9	
Maternal education				0.959
$< 10$ years	11.4	43.2	45.5	
$= 10$ years	8.0	43.4	48.6	
$> 10$ years	8.2	44.2	47.6	
F-SozU mother				0.247
$\leq 3.3$ points	3.0	51.5	45.5	
$> 3.3$ points	8.1	44.1	47.8	
Mental component score mother				0.733
$\leq 33$ points	6.3	52.4	41.3	
$> 33$ –57 points	8.0	44.2	47.8	
$> 57$ points	7.7	40.4	51.9	
Physical component score mother				0.161
$\leq 45$ points	4.5	50.7	44.8	
$> 45$ –58.5 points	8.9	42.7	48.4	
$> 58.5$ points	2.9	53.6	43.5	
Father's employment				0.907
Employed	7.3	44.5	48.1	
Unemployed	7.7	38.5	53.8	
Mental component score father				<b>0.015</b>
$\leq 35$ points	15.6	48.4	35.9	
$> 35$ –53.5 points	6.0	43.9	50.1	
$> 53.5$ points	11.5	49.2	39.3	
Physical component score father				0.226
$\leq 48$ points	3.4	48.3	48.3	
$> 48$ –59 points	7.6	43.6	48.8	
$> 59$ points	11.5	53.8	34.6	
Child health status				0.538
$> 80$	7.8	44.8	47.4	
$\leq 80$	4.7	42.2	53.1	

**Table 7.** Check-up attendance score (low CS 0, high CS 20)

Influencing factor	Low CS, %	High CS, %	p value
Single-mother status			0.301
Yes	54.5	45.5	
No	39.2	60.8	
Migration background			0.121
At least one parent without German citizenship	45.0	55.0	
No	37.9	62.1	
Child's sex			0.967
Female	39.3	60.7	
Male	39.5	60.5	
Parity			< <b>0.001</b>
Primiparous	44.9	55.1	
Multiparous	30.3	69.7	
Maternal age			0.458
≤27	45.7	54.3	
28–37	38.2	61.8	
>37	40.5	59.5	
Maternal education			0.915
<10 years	36.4	63.6	
=10 years	39.2	60.8	
>10 years	39.6	60.4	
F-SozU mother			0.831
≤3.3 points	39.4	60.6	
>3.3 points	38.0	62.0	
Mental component score mother			0.148
≤33 points	44.4	55.6	
>33–57 points	38.1	61.9	
>57 points	26.9	73.1	
Physical component score mother			0.057
≤45 points	40.3	59.7	
>45–58.5 points	39.3	60.7	
>58.5 points	24.6	75.4	
Father's employment			0.571
Employed	38.5	61.5	
Unemployed	30.8	69.2	
Mental component score father			0.351
≤35 points	45.3	54.7	
>35–53.5 points	38.4	61.6	
>53.5 points	32.8	67.2	
Physical component score father			0.280
≤48 points	41.4	58.6	
>48–59 points	37.3	62.7	
>59 points	48.1	51.9	
Child health status			0.684
>80	38.5	61.5	
≤80	35.9	64.1	

and positively associated with NS. The effect of parity on the NS was just below the level of significance with higher scores achieved more frequently when the mother only had one child ( $p = 0.072$ ). No significant association could be shown for multiple variables.

#### Toothbrushing Score

Table 6 shows the associations between all factors tested and TS. The effect of single-mother status on TS was highly statistically significant ( $p = 0.004$ ). None of the children of single mothers achieved a high score ( $>55$  points). The fathers' mental health also had a significant effect. Children of fathers with a mental health score in the medium range had the best TSs. Lack of a migration background was associated with higher TS, but this was below the level of significance ( $p = 0.076$ ). TS was higher for girls compared to boys, but this association was not significant ( $p = 0.094$ ). The combination of single-mother status and fathers' mental health had a significant effect on TS according to the error rates method.

#### Check-Up Score

Table 7 shows the associations between all factors tested and CS. The association between parity and CS was highly significant. Children without siblings scored lower for check-up attendance compared to children who had at least one sibling ( $p \leq 0.001$ ). The association between mothers' physical health and CS was just below the level of statistical significance ( $p = 0.057$ ). Children of mothers with poorer physical health scored lower for check-up attendance. No significant association could be shown for multiple variables.

### Discussion

This study found significant differences in oral health behaviours in 2-year-old children within this cohort. Advice on toothbrushing frequency (twice daily) and dental check-up attendance (first check-up between the ages of 1 and 2 years) was followed by most participants. But dietary behaviours were concerning, with frequent sweet consumption and extended bottle use. Key maternal factors such as single motherhood, lower educational levels, and poor social support were strongly associated with poorer OHBs in children.

For the present study, only the baseline data were collected by interview before the family left maternity hospital, and subsequent data were collected via questionnaires. Although there is a risk of reporting bias, particularly for topics such as hygiene and dietary practices, questionnaire-based studies remain the most

feasible way to collect large-scale data, especially when studying behaviours that cannot easily be observed directly. Table 1 summarises responses to nearly 300 variables covering aspects of diet, oral hygiene, and doctor visits. These variables provide a detailed insight into the participants' habits, allowing us to comprehensively assess their behaviour based on the answers provided in the questionnaires.

The sociodemographic characteristics of this study population have already been described as being above average even for this relatively prosperous region in southern Germany, particularly when compared to census data [15]. This means that the socially disadvantaged group at high risk for ECC is likely underrepresented in this sample. Loss to follow-up is a well-known issue in birth cohort studies. The reasons for participant dropout were not investigated as part of this cross-sectional study. However, it is commonly understood that relocation and study fatigue are among the most frequent causes of attrition in cohort studies [21, 22]. An analysis of participants in this cohort up to 1 year showed that the overrepresentation of well-educated families increases over time [15]. Underage mothers and those with poor German language skills could not be included in the study due to the inability to provide informed consent. All of these factors should be taken into account when interpreting the results relative to the general population.

We used univariate analyses to identify pairwise associations and the error rates method to test for multivariate effects. The interpretation of multivariate results, particularly in identifying clinically relevant associations that could help identify families at higher risk for poor OHBs and ECC is complex. The only significant multivariate effect found was the combination of single-mother status and fathers' mental health which had a statistically significant association with the TS; however, this finding is not clinically relevant as these family dynamics do not typically coexist. The use of univariate models allowed us to identify key associations for individual risk factors. Data for maternal age, education, social support, parental HRQOL, and child health were categorised to facilitate analysis and identify patterns that might be obscured in an interval scale approach. This approach simplifies data interpretation, highlighting groups needing specific attention, minimises the effect of outliers, and facilitates generalisability. The categorisation of maternal age was based on the present study population, in which very young mothers are missing, and divided into three groups, younger, average age (80% of this population) and older, to reflect differences in life experience, rather than obstetric age, that may influence OHBs. HRQOL

and social support were divided into three similar categories, enabling focused analysis of at-risk extremes, such as the top and bottom 10%. Maternal education was split into three categories reflecting the 3-tier German school system. For parent-assessed child health, scores were separated into normal (average or high scores) and the bottom 10%, to identify children with serious health concerns, as these families may prioritise other health issues over oral health. While many birth cohort studies have looked at dental caries as an outcome [10, 11], few have examined factors affecting OHB as an outcome in very young children or on the factors influencing these behaviours.

Overall OHB score for this population showed a wide range of scores reflecting the diverse oral health practices within the cohort. But when split into separate scores for Nutrition, Toothbrushing and Check-up attendance, it became clear that while toothbrushing and check-up attendance behaviours were good, the results for nutritional behaviour were very worrying. In particular, sweet consumption was frequent, the majority of children received sugar-containing beverages, and were still using a baby bottle, even at night, at age two. These results agree with the findings for German children from the KiESEL study [23]. These nutritional habits are known risk factors for development of ECC [24–26]. Toothbrushing frequency was similar to that found for German children in the KiGGS study [27]. The KiGGS study did not record dental check-up attendance for children under 3.

We found that 61% of children had already had a dental visit, which was higher than expected for this age group [28, 29]. This may be due to the distribution of a child oral health booklet to all enrolled families, which advised a first dental check-up before the child's first birthday. It also recommended avoiding sweets, sweetened drinks, and the use of bottles beyond the first birthday. A substantial portion of the cohort ignored these recommendations, indicating that dietary habits are difficult to change. Seventeen percent of the children used a non-fluoridated toothpaste, revealing a significant minority actively avoiding or opposing fluoride use, putting them at increased risk for childhood caries. This avoidance rate is similar to the 10–20% observed in the American population [30].

Univariate analyses show a strong association between single motherhood and low TS. This is probably also the reason for the association between single motherhood and low overall OHB. Time and resource constraints are likely the reasons why children of single-parent households, particularly single mothers, have poorer dental hygiene and exhibit lower health behaviour scores [12, 31]. Children of one-parent families are known to have a

higher incidence of early childhood caries, but early prevention programmes have been shown to be effective in reducing this rate [32].

Generally, poorer oral health is reported for migrant compared to non-migrant populations [33, 34]. Interestingly, we found that migration background was significantly associated with higher NS. This result must be interpreted with care because families in this region with migration background may not be correctly represented as mentioned above. Selection bias is a problem in cohort studies in general, but its effects may be more concentrated for this subpopulation due to the language barrier. Because dietary behaviour for this cohort was far from ideal and other diet-related problems such as high child BMI are an issue in the Northern region of Bavaria [35], it can also not be ruled out that higher NS is indeed due to the migration context rather than increased selection bias. The fact that TS was lower for those with migration background (approaching significance  $p = 0.076$ ) supports this argument.

Our study shows that a number of maternal factors are significantly associated with lower NS. The link between mothers' oral health and OHB, including diet, and that of the child is well established [36–38]. Since dietary behaviour is most concerning for this group, it would make sense to focus dietary education on new mothers to promote awareness for risk factors concerning ECC.

Fathers' mental health component score was significantly associated with tooth brushing score. It has been shown that parental stress is associated with poor child oral health [39], and it is conceivable that in households, in which the father has mental health issues, finding time to carry out proper tooth brushing for children may be difficult.

Lower health literacy was found less frequently in this cohort than what would be expected in the general population [40]. An increase in health literacy over time has already been shown for this cohort particularly for first time mothers [40]. This may explain why children with older siblings scored higher for check-up score. Children of mothers with poorer physical health also had lower check-up score. This may be due to difficulty in physically attending appointments or again due to time constraints because of other medical appointments.

Outlook: future studies should include multilingual questionnaires, so that possibly high-risk groups are not missed. Efforts should also be made to include families with underage mothers, who may represent a particularly disadvantaged group, to provide more generalisable data on child OHB. Further research should investigate the effect of targeted interventions for at-risk groups on childhood oral health outcomes. The dietary habits in northeastern Bavaria, where this study was carried out,

leave room for improvement in terms of oral health. Prevention programs should focus on nutrition in general and also on vulnerable groups such as single-parent households and families with special healthcare needs or less robust social support.

## Conclusions

Within the limitations of this study, we can conclude that maternal factors including single motherhood, lower educational level, lower perceived social support, and poor mental health are all negatively associated with OHBs in 2-year-old children. Furthermore, families with a first child, parental mental or physical health issues, or a weaker social support network may need more support to achieve better child oral health practices from an early age.

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## Statement of Ethics

This study was conducted in accordance with the Declaration of Helsinki. It was reviewed and approved by the Ethics Committee of the University of Regensburg, protocol codes 14-101-0347 and 19-1646-101 on December 17, 2014 and January 15, 2020. Written informed consent to take part in the study was obtained from all participants aged 18 and over. Written informed consent to take part in the study was obtained from parents/legal guardians for all participants aged under 18.

## Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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## Author Contributions

Conceptualisation: Á.M.L.; formal analysis: K.-A.H., C.M., and Á.M.L.; investigation: C.M. and KUNO-Kids study group; resources: W.B., S.B., A.K., M.M., and M.K.; statistical analyses: K.-A.H.; data curation, K.-A.H., C.M., Á.M.L., and S.B.; writing – original draft preparation: Á.M.L.; writing – review and editing: Á.M.L., C.M., K.-A.H., N.G., W.B., S.B., M.K., A.K., M.M., and C.A.; visualisation: N.G. and Á.M.L.; funding acquisition: S.B., C.A., and M.K. All authors have read and agreed to the published version of the manuscript.

## Data Availability Statement

All data generated or analysed during this study are included in this article. Further enquiries can be directed to Karl-Anton Hiller (karl-anton.hiller@ukr.de).

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