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Caries experience among adults in core Sámi areas of Northern Norway

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Abstract

Objectives: Dental caries is a major oral health problem among indigenous people worldwide, but knowledge on this issue among the indigenous Sámi people in Norway is scarce. The aim of the study was to describe dental caries experience in an adult population in core Sámi areas of Northern Norway and to assess the corresponding associations with socio-demographic, socioeconomic and oral health-related behavioural factors.

Methods: This cross-sectional study is based on data from the Dental Health in the North study (2033 participants aged 18-75 years). A questionnaire was used to collect data on socio-demographic, socioeconomic and oral health-related behavioural factors. Clinical examinations were performed by dentists and dental hygienists at Public Dental Service (PDS) clinics in core Sámi areas of Northern Norway.

Results: About 68% (n = 1380) of participants reported Sámi ethnicity, and the mean number of decayed (D), missed (M) and filled (F) teeth (T) was 16.2 (standard deviation [SD] = 6.7). The mean DMFT was 15.7 (SD = 6.7) among Sámi and 17.0 (SD = 6.7) among non-Sámi. The mean DT among Sámi was 1.0 (SD = 1.6), with a significant, higher prevalence among coastal Sámi (DT = 1.3, SD = 1.8) than inland Sámi (DT = 0.8, SD = 1.5). Living in the coastal region, consumption of sugary soft drinks several times a week or daily, toothbrushing less than daily and irregular dental visits were associated with DT.

Conclusions: Caries experience among adults in core Sámi areas of Northern Norway was common. Dental caries were more common in the coastal than the inland region, with minor differences in caries experience between Sámi and non-Sámi people within these regions.

KEYWORDS

caries, epidemiology, indigenous, oral health, Sámi

1 | INTRODUCTION

Dental caries is a major oral health problem among indigenous people worldwide.[1] However, epidemiological information on indigenous oral health is mainly based on studies conducted in Australia, New Zealand, Canada, the United States or Brazil.[2,3] Population-based scientific knowledge about caries occurrence among the indigenous Sámi population is lacking. The indigenous Sámi is the only minority in the nation that the Norwegian parliament has acknowledged as an indigenous people. The Sámi people have traditionally lived in the

northern part of Norway, Sweden, Finland and in Kola Peninsula of the Russian Federation.

Epidemiological studies indicate that socioeconomic, behavioural and environmental factors are related to dental caries. Low income and low education level have been associated with a higher occurrence of dental caries,[4-6] and the development of caries is related to frequent sugar intake[7,8] and inadequate oral hygiene.[9] Lack of access to dental services and irregular dental visits are also associated with higher caries experience.[4,7]

In Norway, the Sámi people have the same access to Public Dental Service (PDS) clinics and private dental services as the general population. PDS clinics provide dental health care and treatment free of charge to people aged 0-18 years, to mentally disabled persons living in institutions and at home and to elderly and long-term care patients living in institutions or receiving care at home; youth aged 19 and 20 pay 25% of the public fees.[10] The private sector offers dental services to the general adult population. However, PDS clinics provide services to the whole population in rural areas of the northernmost part of Norway, as there are very few private clinics. The PDS reports the prevalence of decayed (D), missed (M) and filled (F) teeth (T) among children aged 5, 12 and 18 years to Statistics Norway every year.[11] According to this data, the DMFT among children in core Sámi areas (ie municipalities that are included in the 'Sami language administrative district') is higher than the mean DMFT in Norway. Due to legal restrictions in Norway, PDS data do not include information on ethnicity; thus, there is no way to know whether the caries prevalence is equally distributed across different ethnic groups in the same area. Epidemiological studies that used self-reported ethnicity have shown that general health among Sámi is similar to that of a nonindigenous reference population in multi-ethnic areas of Norway,[12] in contrast to most other indigenous populations worldwide.

At present, no peer-reviewed study has been published on caries experience in the adult Sámi population. A study by Holst et al,[13] published in Norwegian, found that the caries experience of populations in the northernmost county varied according to region, with 25-year-olds who lived in inland municipalities and spoke Sámi (n = 50) having lower mean DMF surfaces (S) (33.2) and untreated dental caries (DS = 2.9) than individuals who lived in the same area but spoke Norwegian (n = 16) (DMFS = 45.6, DS = 3.1). Among 55-year-olds, the opposite was found (DMFS = 91.8, DS = 4.8 vs DMFS = 94.5, DS = 1.8). Epidemiological studies from elsewhere in Norway have shown minor regional differences in caries experience among adults. A study from Oslo, the capital of Norway,[5] reported a mean DMFS and mean DS of 24.6 and 1.5 for adults aged 35 years, while in Troms County, Northern Norway,[7] the mean DMFS and DS were 17.9 and 1.5, respectively, among adults aged 20-34 years. A nationwide study of the oral health of elderly Norwegians found that the mean DMFT was lower, and mean DT was higher among elderly in the southern (24.3 and 0.59, respectively) than in the northern counties (26.8 and 0.37, respectively).[14] However, no information on ethnicity was reported in the above studies.

Regional differences in caries experience among children in Norway, and knowledge about inequalities in oral health among indigenous peoples worldwide,[2] raise the question of whether the high caries prevalence in the northernmost part of Norway (Finnmark County) differs by ethnicity. Equal access to dental services[15,16] is a likely explanation for the finding of no differences in the prevalence of periodontitis between Sámi and non-Sámi in this area.[17] Population-based studies[18-20] have shown that the dietary pattern in core Sámi areas differs to a certain degree, but the differences are small; Sámi women had a higher intake of added sugars compared to non-Sámi women, and populations from inland regions tended to have a higher intake of added sugars than those from coastal regions. Thus, we hypothesized that caries experience is equal among adults in core Sámi areas, independent of ethnicity. The aim of the study was to describe dental caries experience in an adult population in core Sámi areas in Northern Norway and to assess the corresponding associations with socio-demographic, socioeconomic and oral health-related behavioural factors.

2 | METHOD

2.1 | Study area and population

This study was based on data from the Dental Health in the North study, a cross-sectional study from rural areas in Northern Norway (municipalities of Kautokeino, Karasjok, Lakselv, Tana and Nesseby). The municipalities included in this study are core Sámi areas, where the Sámi and Norwegian language are equal.[15] Geographic region of residence was categorized as inland region (Kautokeino, Karasjok) and coastal region (Lakselv, Tana and Nesseby). The rationale behind this categorization was that, although both regions are multi-ethnic, with Sámi and Norwegian people, the ethnic and cultural structures of these regions are different. In the inland region, the Sámi are the majority; thus, the main language is Sámi, and the traditional Sámi culture is still strong. In the coastal areas, Norwegians are the majority, and the main language is Norwegian. Historical efforts to assimilate the Sámi people by forcing them to adopt the Norwegian language and change the basic value-structure of their Sámi culture and identity[21] caused many to lose their Sámi identity, language and culture. These assimilation efforts were historically most articulated in the coastal areas. Today, the Sami population has its own indigenous Parliament, The Sámi Parliament, which deals with all matters concerning the Sámi people.[22]

All patients aged 18-75 years who had an appointment scheduled or were on the re-call list at PDS clinics in the selected municipalities between February 2013 and May 2014 were invited to participate (n = 2520). In total, 2235 adults accepted (crude response rate: 88.7%). Immigrants (n = 44) and participants with missing data (n = 158) were then excluded, giving a final study sample of 2033 participants. Data were collected from questionnaires, and clinical and radiographic examinations. The Dental Health in the North study and methodology have been described previously in detail.[23]

The Regional Committee for Medical and Health Research Ethics of the University of Tromsø, Norway, approved the study (2012/1902/REK Nord). All participants provided written informed consent.

2.2 | Questionnaire

Ethnicity was determined by self-reported information from the questionnaire on (1) respondents' home language, (2) their/their parents'/their grandparents' ethnic background and (3) what ethnicity they considered themselves to be (ie subjective appraisal criteria). The response options to these questions were 'Norwegian', 'Sámi', 'Kven' (national minority in Norway that immigrated from Sweden and Finland) and 'other'. Participants who responded that they considered themselves to be Sámi, and that their, their parents' *and/or* their grandparents' home language *and/or* ethnic background is/was Sámi, were classified as Sámi. All others were classified as non-Sámi; this group consisted mainly of Norwegians, Kven (without Sámi affiliation, n = 99) and Sámi who did not report any subjective appraisal criteria (n = 165).

Information on the potential socio-demographic, socioeconomic and oral health-related confounders region of residence, sex, age, household income, duration of education, consumption of sugary soft drinks, frequency of toothbrushing and frequency of dental visits was also obtained from the questionnaire. Age was divided into four groups: 18-34, 35-49, 50-69 and 70-75 years. Duration of education was assessed with the question: 'How many years have you been studying?' with responses categorized into two groups: 1-13 years and ≥14 years. Consumptions of sugary soft drinks were divided into seldom or never (including answer options 'never' or 'once a week') and several times a week/daily. Frequency of toothbrushing was categorized as less than daily (including answer options from '6 times per week' to 'less than once a week'), daily, and twice daily or more. Frequency of dental visits was assessed with the question: 'When do you attend dental health services?' The response options were divided into two groups: regular ('regularly convened or booked dental appointments') or irregular ('irregular use of dental health services or attend only when having problems/pain').

2.3 | Clinical and radiographic examinations

Nine dentists and six dental hygienists (examiners) performed clinical and radiographic examinations at six PDS clinics in the five municipalities. Prior to the study, the examiners attended a workshop on diagnostic criteria and examination procedures, during which they were trained to diagnose caries using a five-grade scale by an experienced dentist (Nils Oscarson).[24] This scale was used to diagnose caries in both clinical and radiographic examinations (grade 1: white or brown caries lesion in enamel and/or radiolucency in outer half of enamel; grade 2: small cavitation in enamel and/or radiolucency in inner half of enamel; grade 3: moderate-sized cavity and/or radiolucency in outer third of dentin; grade 4: big cavitation and /or radiolucency in the middle third of dentin; Grade 5; very big cavity and/or radiolucency in the inner third of dentin). Caries grade 1-2 was classified as enamel caries and caries grade 3-5 as dentin caries. In the present study, the outcomes DT and DS include caries grade 3-5. Root caries and secondary caries were also included in these outcomes. FT and FS included all kinds of fillings (eg temporary fillings and dental crowns).

All examiners were also calibrated for radiographic examinations during the workshop, by diagnosing proximal and occlusal caries on premolars and molars in radiographs from two cases. However, as kappa values were not estimated following this calibration, post-clinical inter-examiner agreement was estimated in order to ensure the reliability of caries registration. For this, the first author (A-KSB) was calibrated with a specially designed software (DIL version 1.21; University of Bergen, Bergen, Norway). Two separate exercises were completed, each consisting of a judgement of 51 occlusal and proximal surfaces from radiographs. For each exercise, the agreement between the diagnoses of the first author and those contained in the software, which were assigned by an expert group, was expressed by weighted kappa (0.67 and 0.70, respectively). Then, the first author registered proximal and occlusal caries on premolars and molars from the radiographs of all participants using the five-grade diagnostic scale. These diagnoses were used as the gold standard for the inter-examiner agreement analysis. The diagnoses were then categorized as 'no caries' (grades 1-2) or 'caries' (grades 3-5). Finally, three participants from each examiner (45 participants in total) were randomly chosen and used to calculate a kappa value for each participant, as well as the mean kappa value for all examiners ($\kappa = 0.84$, range 0.55-1.00).

2.4 | Statistical analysis

Data were analysed using the IBM® SPSS® Statistics, version 26. Cross-tabulation and the Pearson chi-square test were used to test differences in categorical background characteristics between Sámi and non-Sámi participants. For continuous variables, the Mann-Whitney or Kruskal-Wallis test was used. Binary logistic regression was used to assess the odds of being exposed to selected socio-demographic, socioeconomic and oral health-related behavioural factors among participants with DT ≥ 1 versus those with DT = 0 (reference group). Two logistic regression models, adjusted for different confounders, were used (Amrhein, 2019). Model 1 was adjusted for region of residence, sex, age and duration of education. In model 2, we adjusted for the same confounders as in model 1, in addition to consumption of sugary soft drinks, frequency of toothbrushing and frequency of dental visits. All analyses were performed with a significance level at 0.05 and with 95% confidence intervals.

3 | RESULTS

Of the 2033 participants, 67.9% reported Sámi ethnicity. The mean age of Sámi and non-Sámi participants was 46.7 years (SD = 14.7) and 49.0 years (standard deviation [SD] = 13.4) years, respectively.

The majority of Sámi participants lived in the inland region, while the largest proportion of participants in the coastal region were non-Sámi. Frequency of toothbrushing and frequency of dental visits differed between the two ethnic groups, with a larger proportion of Sámi participants brushing their teeth only once daily or less and having irregular dental visits (Table 1).

Mean DMFT and mean DMFS in the study sample was 16.2 and 45.1, respectively. Dental caries experience did not vary substantially by sex. However, some differences in DMFT and DMFS were observed by ethnicity, region of residence and age (Table 2).

Seldom or never consuming sugary soft drinks, toothbrushing twice daily or more, and regular dental visits were all significantly related to a lower mean DT in both ethnic groups (Table 3). After adjustment for the socio-demographic and socioeconomic factors in model 1, having a DT ≥ 1 compared to a DT = 0 was associated with region of residence and age in Sámi participants, and with region of residence and sex in non-Sámi participants. Further adjustment for oral health-related behavioural factors in model 2 revealed an association between a DT ≥ 1 and living in the coastal region, consumption of sugary soft drinks several times a week or daily, toothbrushing less than daily and irregular dental visits in both ethnic groups. The factors used as independent variables in model 1 explained 5.8% and 5.4% of the variance in caries (Nagelkerke's R^2 of 0.058 and 0.054) in Sámi and non-Sámi participants, respectively. Model 2 explained 11.1% of the variance in caries (Nagelkerke's R^2 of 0.111) in both ethnic groups (Table 4).

TABLE 1 Characteristics of the study participants according to ethnicity and region of residence

Background characteristics	Sámi n (%)	Non-Sámi n (%)	Inland region n (%)	Coastal region n (%)
Participants	1380 (67.9)	653 (32.1)	985 (48.5)	1048 (51.5)
Region of residence				
Inland	869 (63.0)	116 (17.8)[a]		
Coastal	511 (37.0)[a]	537 (82.2)		
Sex				
Men	578 (41.9)	297 (45.5)	560 (56.9)	598 (57.1)
Women	802 (58.1)	356 (54.5)	425 (43.1)	450 (42.9)
Age (y)				
18-34	312 (22.6)	101 (15.5)[a]	252 (25.5)	161 (15.4)[a]
35-49	435 (31.5)	233 (35.7)	316 (32.1)	352 (33.6)
50-64	468 (33.9)	226 (34.6)	298 (30.3)[a]	396 (37.7)
65-75	165 (12.0)	93 (14.2)	119 (12.1)	139 (13.3)
Household income				
<300 000	184 (14.1)	83 (13.3)	141 (15.0)	126 (12.7)
300 001-600 000	546 (41.9)	231 (37.0)	405 (43.1)	372 (37.6)[a]
600 001-900 000	400 (30.7)	204 (32.6)	272 (28.9)[a]	332 (33.6)
>900 001	174 (13.3)	107 (17.1)	122 (13.0)	159 (16.1)
Duration of education (y)				
1-13	640 (48.4)[a]	367 (57.1)	446 (47.3)[a]	561 (54.8)
≥14	683 (51.6)	276 (42.9)[a]	497 (52.7)[a]	462 (45.2)
Consumption of sugary soft drinks				
Seldom/never	1110 (82.4)	514 (81.5)	767 (79.8)[a]	857 (84.3)
Several times a week/daily	237 (17.6)	117 (18.5)	194 (20.2)	160 (15.7)[a]
Frequency of toothbrushing				
Less than daily	142 (10.3)	32 (4.9)[a]	129 (13.1)	45 (4.3)[a]
Once daily	461 (33.5)	161 (24.7)[a]	353 (35.9)	269 (25.7)[a]
Twice daily or more	775 (56.2)[a]	459 (70.4)	502 (51.0)[a]	732 (70.0)
Frequency of dental visits				
Irregular	288 (21.1)	112 (17.3)[a]	207 (21.4)	193 (18.5)
Regular	1074 (78.9)[a]	536 (82.7)	732 (78.6)	848 (81.5)

[a]$P < .05$; chi-square test for differences between Sámi and Non-Sámi or between inland and coastal.

TABLE 2 Dental caries experience by ethnicity, sex and age group

		Number-T	Intact-T	DMFT	DFT	DT	DMFS	DFS	DS
Characteristics	**N**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**
Total	2033	25.2 (3.8)	10.0 (7.6)	16.2 (6.7)	13.3 (5.7)	1.0 (1.7)	45.1 (26.7)	31.4 (18.5)	1.5 (3.0)
Ethnicity									
Sámi	1380	25.1 (3.8)	10.4 (7.7)	15.7 (6.7)[a]	12.9 (5.7)[a]	1.0 (1.6)[a]	43.7 (26.5)[a]	29.8 (17.8)[a]	1.4 (2.8)[a]
Non-Sámi	653	25.2 (3.8)	9.2 (7.5)[a]	17.0 (6.7)	14.3 (5.8)	1.2 (1.8)	48.3 (27.0)	34.8 (19.4)	1.7 (3.3)
Region-Inland									
Sami	869	25.3 (3.9)	11.4 (7.7)	14.7 (6.6)[a]	12.0 (5.6)[a]	0.8 (1.5)	40.2 (25.8)[a]	27.0 (17.0)[a]	1.2 (2.6)
Non-Sami	116	25.5 (3.5)	10.3 (7.6)[a]	16.0 (6.6)	13.5 (5.8)	0.6 (1.0)	45.9 (27.2)	33.7 (20.7)	0.9 (1.7)
Region-Coastal									
Sámi	511	24.9 (3.8)	8.6 (7.3)	17.5 (6.5)	14.4 (5.5)	1.3 (1.8)	49.6 (26.7)	34.4 (18.0)	1.7 (3.1)
Non-Sámi	537	25.2 (3.8)	9.0 (7.4)	17.3 (6.7)	14.5 (5.8)	1.3 (2.0)	48.8 (26.9)	35.1 (19.2)	1.9 (3.6)
Sex									
Men	875	25.1 (3.9)	10.0 (7.7)	16.1 (6.8)	13.3 (5.8)	1.2 (1.8)	45.2 (27.0)	31.3 (18.6)	1.7 (3.3)
Women	1158	25.2 (3.8	10.0 (9.5)	16.2 (6.7)	13.4 (5.7)	0.9 (1.6)[a]	45.1 (26.6)	31.4 (18.4)	1.3 (2.7)[a]
Age (y)									
18-34	413	27.2 (1.4)[b]	17.4 (6.4)[b]	9.9 (6.1)[b]	9.1 (5.8)[b]	1.3 (2.0)[b]	19.2 (14.9)[b]	15.3 (12.0.)[b]	1.8 (3.3)[b]
35-49	668	26.4 (2.0)	12.7 (6.4)	13.9 (5.7)	12.4 (5.1)	1.0 (1.7)	34.3 (13.9)	26.7 (14.8)	1.5 (2.9)
50-64	694	24.6 (3.4)	5.8 (4.9)	19.8 (4.3)	16.4 (4.3)	0.9 (1.6)	59.1 (19.7)	42.4 (16.1)	1.4 (3.1)
65-75	258	20.3 (5.7)	2.7 (3.4)	22.2 (3.8)	14.5 (5.5)	0.9 (1.5)	77.1 (18.7)	39.6 (18.3)	1.3 (2.4)

Abbreviations: D, Decayed (Dentin caries grade 3-5); F, Filled; M, Missed; N, Number of participants; S, Surface; SD, Standard Deviation; T, Teeth.
[a]$P < .05$; Mann-Whitney *U* test.
[b]$P < .05$; Kruskal-Wallis test.

4 | DISCUSSION

Dental caries experience was common among adults in the investigated core Sámi areas of Northern Norway, with a variation in relation to region of residence. Findings from the present study showed that caries experience was lower among Sámi participants, who also had a lower mean DT than non-Sámi participants. On the other hand, dental caries was significantly higher among participants from the coastal region compared to those from the inland region. Having caries was associated with the oral health-related behavioural factors: consumption of sugary soft drinks, toothbrushing less than daily and irregular dental visits.

A strength of this study is the large sample size and the fact that a majority of the participants self-identified as Sámi. This is unlike other studies in indigenous populations, in which the number of indigenous participants was very low compared with nonindigenous.[2,3,25] There are several reasons for the high number of indigenous participants in the present study. The study was conducted in areas with a high density of individuals of Sámi ethnicity, and thus where the Sami culture is strong, reindeer herding is still common, and a majority of the population speaks the Sámi language. Local PDS clinics were used as an arena for clinical examinations. Those clinics were familiar to the inhabitants, and most of the participants reported regular dental visits, which could have contributed to the high number of participants. Furthermore, the cooperation between local dental healthcare workers and the research team reinforced a culturally safe indigenous methodology, involving examiners who were familiar with the Sámi culture and who speak the Sámi language. More than half of the employees (16 of 29) in the included PDS clinics were of Sámi ethnicity.[23] Even though the present study has a cross-sectional design, it contributes to knowledge about associations between ethnicity and dental caries, as this was the first epidemiological study conducted in core Sámi areas. The present study also has a methodological strength in the questionnaire, which included questions and established instruments used in other population-based surveys.[23,26]

Participants were not chosen randomly, since the majority of them used the PDS clinics regularly. This could affect the external validity of the study, as those in the population who do not attend regular dental visits might be underrepresented. In the present study, 20% of the participants did not attend dentist regularly, but to what extent this correspond to the number of the total population who do not attend dentist regularly, are unknown. The study sample is at large comparable to the general national population stratified by age,[27] however, a slightly larger group aged 50-66 and less proportion of those aged 67-79 (data not shown). More women than men participated in the present study. This comparison reflecting what is known from population-based studies that women and the

TABLE 3 Mean number of decayed teeth by selected characteristics, stratified by ethnicity

Background characteristics	Mean DT (SD)	
	Sámi N = 1380	Non-Sámi N = 653
Region		
Inland	0.8 (1.5)[b]	0.6 (1.0)[b]
Coastal	1.3 (1.8)	1.3 (2.0)
Sex		
Men	1.1 (1.8)[a]	1.4 (2.0)
Women	0.9 (1.5)	1.0 (1.7)[b]
Age (y)		
18-34	1.1 (1.8)[a]	1.9 (2.3)[c]
35-49	1.0 (1.6)[a]	1.2 (1.7)
50-64	0.9 (1.5)	1.0 (1.8)
65-75	0.9 (1.6)	0.9 (1.3)
Household income		
<300 000	1.0 (1.7)	0.9 (1.5)
300 001-600 000	0.9 (1.7)[a]	1.2 (1.9)
600 001-900 000	1.0 (1.5)	1.2 (2.1)
>900 000	1.0 (1.7)[a]	1.2 (1.6)
Duration of education (y)		
1-13	1.1 (1.8)[a]	1.4 (2.1)
≥14	0.9 (1.5)	0.9 (1.4)
Consumption of sugary soft drinks		
Seldom/never	0.9 (1.9)[a,b]	1.0 (1.7)[b]
Several times a week/daily	1.4 (1.5)[a]	1.9 (2.3)
Frequency of toothbrushing		
Less than daily	1.7 (2.3)[a]	3.1 (3.4)
Once daily	1.1 (1.8)[a]	1.3 (1.6)
Twice daily or more	0.8 (1.3)[a,c]	1.0 (1.7)[c]
Frequency of dental visits		
Irregular	1.7 (2.3)[a]	2.9 (3.0)
Regular	0.7 (1.3)[a,b]	0.8 (1.2)[b]

Abbreviations: DT, Decayed teeth (Dentin caries grade 3-5); SD, Standard Deviation.

[a]$P < .05$; Mann-Whitney *U* test for differences between ethnic groups.

[b]$P < .05$; Mann-Whitney *U* test for differences within ethnic groups.

[c]$P < .05$; Kruskal-Wallis test for differences within ethnic groups.

middle-aged are more willing to participate in such studies. Another limitation was that the municipalities chosen were all in rural areas, meaning that the results might not represent the caries prevalence among Sámi in urban areas in the north or elsewhere in Norway. Moreover, the data used in the present study are from 2013 to 2014. As Statistics Norway has reported that the number of 18-year-olds without caries (DMFT = 0) is increasing in Norway, and in the northernmost part of Norway the proportion of DMFT = 0 has increased from 11.4% in 2015 to 18.8% in 2019,[11] it is possible that the caries experience among young adults in core Sámi areas also decreased slightly between 2014 and 2019. To what degree this suggested time trend differs by ethnicity is unknown.

When comparing findings in the present study with those of other studies of indigenous populations, we found some differences. First, the mean DT was lower in the present indigenous Sámi population than that reported in indigenous Australians (2.4-4.4)[25,28-30] and indigenous Brazilians (2.6).[3] Second, we found only minor differences in caries experience between Sámi and non-Sámi when comparing ethnic groups within the inland and coastal regions. Furthermore, regardless of geography, there were differences in mean DT by ethnicity, but when comparing mean DT in the different ethnic groups within the inland and coastal regions, no differences were observed. These findings highlight that, when comparing oral health outcomes between or within ethnic groups, the reference group should come from the same region of residence, as societies and ways of life may differ between urban and rural areas. A review from Australia emphasized the importance of citing rural or urban location when reporting indigenous oral health, as this can influence oral health status in indigenous adults.[31] The high caries experience among indigenous people when compared to nonindigenous people in Australia, Brazil and New Zealand are related lower education levels, limited access to dental services, and scarcity of dentists and other dental healthcare workers of indigenous ethnicity in areas where indigenous people live.[32,33] These challenges are known to result in inequalities in oral health between indigenous and nonindigenous populations in these countries. Although Sámi people generally have the same access to dental health care as their nonindigenous counterparts in core Sámi areas,[16] there is a history of irregular access to dentists in our study area.[34] The situation has improved since the establishment on a program of dental education at the University of Tromsø in 2002, which helped increase the number of dentists in Northern Norway and contributed to an increase in the number of dentists who speak Sámi.[35] In the present study, duration of education was not associated with an increased risk of dental caries, although this duration was higher among Sámi and among participants from the inland region, compared with non-Sámi and participants from the coastal region. These findings are contradictory to those of other studies, in which socioeconomic factors were found to be associated with caries.[4,6] Minor differences in socioeconomic status between Sámi and non-Sámi, and the equal access to dental services may explain the minor differences in caries experience between ethnic groups in same region. These findings are in line with results from studies on general health among adults in core Sámi areas, where minor differences were found between Sámi and non-Sámi.[12,36]

Caries arises as a result of a complex interplay between environmental factors, such as fluoridation, location of primary residence, availability and accessibility of dental services, and individual factors (including diet and lifestyle habits). Within ethnic groups, inland Sámi had a significant, lower mean DT than coastal Sámi, and costal Sámi were more likely to have caries. In Norway, no fluoride is added to drinking water, and the maximum level of fluoride allowed in drinking water is 1.5 mg/L.[37] The majority of residents in

TABLE 4 Summary of binary logistic regression models for person with one or more decayed teeth (DT > 0) stratified by ethnicity

	Adjusted odds ratio (95% Confidence Interval)			
	Sámi		Non-Sámi	
Characteristics	Model 1 N = 1323	Model 2 N = 1277	Model 1 N = 643	Model 2 N = 616
Region				
Coastal	2.3 (1.9-2.9)	2.8 (2.2-3.5)	1.6 (1.1-2.5)	1.7 (1.1.-2.7)
Inland	Ref.	Ref.	Ref.	Ref.
Sex				
Men	1.0 (0.9-1.3)	0.9 (0.7-1.1)	1.4 (1.1-1.9)	1.2 (0.8-3.2)
Women	Ref.	Ref.	Ref.	Ref.
Age (y)				
18-34	1.8 (1.2-2.7)	1.4 (0.9-2.3)	1.5 (0.9-2.8)	1.0 (0.5-2.0)
35-49	1.5 (0.9-2.2)	1.3 (0.8-1.9)	0.9 (0.6-1.6)	0.9 (0.5-1.5)
56-64	1.4 (0.9-2.0)	1.4 (0.9-2.1)	0.8 (0.5-1.3)	0.8 (0.5-1.4)
65-75	Ref.	Ref.	Ref.	Ref.
Duration of education (y)				
1-13	1.2 (0.9-1.5)	1.1 (0.8-1.4)	1.5 (1.1-2.1)	1.2 (0.9-1.7)
≥14	Ref.	Ref.	Ref.	Ref.
Consumption of sugary soft drinks				
Several times a week/daily		1.6 (1.2-2.2)		1.7 (1.1-2.8)
Seldom/Never		Ref.		Ref.
Frequency of toothbrushing				
Less than daily		2.1 (1.4-3.2)		3.0 (1.1-8.0)
Once daily		1.3 (0.9-1.7)		1.4 (0.9-2.1)
Twice daily or more		Ref.		Ref.
Frequency of dental visits				
Irregular		2.0 (1.5-2.6)		2.2 (1.4-3.6)
Regular		Ref.		Ref.

Abbreviation: Ref., Reference group.

the municipalities (inland and coastal) in core Sámi areas under study receive drinking water from municipal waterworks, which is regulated and controlled by the authorities. It is stated that a diet with low intake of fermentable carbohydrates (ie food/drinks containing sucrose) prevents caries.[38] Studies from core Sámi areas of northern Norway have reported that Sámi women and inhabitants of the inland region, regardless of ethnicity, tended to have a higher intake of added sugar.[18-20] In the present study, there were no differences in the consumption of sugary soft drinks between Sámi and non-Sámi, but the inland population had a higher consumption of sugary soft drinks than the coastal population. The underlying causes of geographic differences in caries experience are unknown, and a different study design would be needed to and to gain knowledge of these contributing factors.

One effective self-care method for preventing caries is toothbrushing with fluoride toothpaste twice daily.[39] While frequency of toothbrushing was one of the strongest predictive factors for DT, about 30%-50% of the participants did not brush their teeth twice daily. Consequently, oral hygiene education to increase toothbrushing frequency and efficacy may be one of the most effective caries prevention measures in core Sámi areas. In order to provide the best prevention and treatment, dental professionals need to be familiar with the history and culture of the indigenous people and be able to give information about oral health in the patients' language. In general, the high caries prevalence in coastal Sámi areas and the high prevalence of periodontitis in core Sámi areas that were reported in a recent study[17] indicate the need for targeted preventive strategies, with more context-specific, culturally appropriate and community-based oral health promotion to improve oral health.

Compared to other adult populations in Norway, we observed a higher caries experience among adults in Finnmark County. However, caries prevalence in core Sámi areas differed to some degree in relation to region of residence, with participants from the inland region having a mean DS score that was comparable to that of the adult populations in Troms County in Northern Norway

(mean DS = 0.8).[7] Participants from the coastal region had a higher prevalence relative to that in Troms County, regardless of ethnicity. The mean DT and mean DS among the elderly in Troms County were reported to be 0.2 and 0.33, respectively,[40] which is in the same range as findings from a nationwide study (DS = 0.3) among elderly Norwegians (60-94 years old),[14] but lower than what we observed among the elderly in core Sámi areas. Caries experience among young adults in our study sample in Finnmark County was also higher than that among young adults in Troms County[7] and in Oslo, the capital of Norway.[5]

In conclusion, caries experience among adults in core Sámi areas remains common. DT was more common in the coastal region compared to the inland region, with minor differences in caries experience between Sámi and non-Sámi participants within regions. When studying indigenous people's oral health, region of residence must be taken into consideration. Our findings show that, in order to improve oral health, there is a need to focus on caries prevention measures in the population of Northern Norway.

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CONFLICT OF INTERESTS

The authors have stated explicitly that there are no conflicts of interest in connection with this article.

AUTHOR CONTRIBUTION

MB initiated, planned and led the data collection. AKSB participated in the data collection. All authors have made substantial contributions to the conception and design of the study. AKSB and BJ drafted the manuscript, carried out the statistical analysis and interpreted the results. All authors have revised the manuscript critically and have given final approval.

DATA AVAILABILITY STATEMENT

The datasets generated and/or analyzed during the current study are not publicly available due to EU GDPR regulation, we cannot make the data into so called “open access data”.

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