# Association between migration history and oral health: results of the 6th German Oral Health Study (DMS • 6)

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**Objectives:** Studies have demonstrated a significant association between migration history and oral health. Even after adjusting for confounders, migration history remains an independent risk factor for poorer oral health. As part of the 6th German Oral Health Study (DMS • 6), disease and care prevalence among individuals with migration history was surveyed at the population level. This article aims to assess the relationship between migration history, education status, and oral health. **Method and materials:** The analyses of the relationship between migration history and various oral health outcomes were conducted separately for younger adolescents (12-year-olds), adults (20-year-olds, 35- to 44-year-olds, 43- to 52-year-olds), and seniors (65- to 74-year-olds, 73- to 82-year-olds). **Results:** A significant association between migration history and poorer oral health outcomes, as well as less favorable oral health behaviors, was observed across all age groups. After adjusting for age, gender, and education, individuals with migration history exhibited higher levels of plaque, more bleeding sites, a higher prevalence of decayed teeth, insufficient tooth brushing frequency, and complaint-oriented dental service utilization. **Conclusion:** Previous studies have consistently identified education as a risk factor for poorer oral health. In the present study, even after adjusting for education status in multivariate models, the association between migration history and oral health outcomes remained significant. This finding underscores migration history as an independent risk factor for poorer oral health outcomes. This is the first large-scale cohort study in Germany to analyze the relationship between migration history and multiple oral health outcomes across different age groups. Future research should focus on uncovering migration-related factors, health literacy, and health behaviors to better explain the observed differences and improve oral health for migrant populations. *(Quintessence Int 2025;56 (Suppl):S126–S134; doi: 10.3290/j.qi.b5982024)*

**Keywords:** cross-sectional studies, dental care, dentists, DMS 6, education, epidemiology, health behavior, human migration, oral health

Previous international and national studies have demonstrated a significant association between migration history and oral health.[1-5] Even after adjusting for education and socioeconomic status, migration history was identified as an independent risk factor for poorer oral health outcomes.

In a previous article, cross-sectional data from the 6th German Oral Health Study (DMS • 6) on oral health, dental service utilization, and the prevalence of oral diseases among people with migration history (PwM) and people without migration history (PwoM) were analyzed and compared.[6] The data from the DMS • 6 cross-sectional arm were analyzed separately for younger adolescents (12-year-olds), younger adults (35- to 44-year-olds), and younger seniors (65- to 74-year-olds). The results revealed differences in disease and care prevalence between PwM and PwoM across all three age groups. PwM exhibited higher prevalence of oral diseases as well as a more complaint-oriented dental service utilization.

In the present paper, the relationship between migration history and various oral health outcomes is reported using current data from the DMS • 6, considering other relevant social determinants such as age, gender, and education. Cross-sectional data from all observed age groups—derived from both the cross-

sectional component and the cohort component of the DMS • 6 —were utilized. The results are stratified for younger adolescents (12-year-olds), adults (20-year-olds, 35- to 44-year-olds, 43- to 52-year-olds), and seniors (65- to 74-year-olds, 73- to 82-year-olds).

## Method and materials

The general methodology of the study has been described previously.[7,8] The 6th German Oral Health Study (DMS • 6) has been approved by the Institutional Review Board (IRB) of Witten/ Herdecke University, Witten, Germany (registration number S-249/2021). This study is registered at the German Clinical Trials Register (registration number DRKS00028701).

### Sample

Study participants were included in the statistical analyses if they met the inclusion criteria of the DMS • 6 analysis set and provided complete data on migration history (PwM/PwoM), age (years), gender (male/female), and education status (low/medium/high). In total, 62 of 958 younger adolescents, 115 of 1,640 adults and 76 of 1,170 seniors were excluded due to missing data. Consequently, 879 younger adolescents, 1,525 adults, and 1,094 seniors were included in the analyses.

### Variables

#### Definition of the variable "migration history"
For migration-sensitive health monitoring, the basic set of indicators was used to record migration-related determinants.[9] For the identification of PwM and PwoM, the items related to their own place of birth ("Which country were you born in?") and that of their parents ("Which country were your parents born in?") were evaluated. PwM are defined as study participants:
- who were not born in Germany (immigrants) or
- whose parents were not born in Germany (direct descendants of immigrants).

The analysis collective consisted of all study participants who fulfilled the inclusion criteria and for whom valid information on the characteristic migration history was available.

#### Oral health outcomes
For the analysis of the research question, clinical and behavioral oral health indicators from the clinical examination and the interviews were selected, specific to each age group:

- number of teeth (adults: < 28 teeth / 28 teeth; seniors: < 20 teeth / ≥ 20 teeth)
- number of sound teeth (ST), younger adolescents
- number of decayed teeth (DT; DT = 0 / DT ≥ 1), all age groups
- modified Marginal Plaque Index (mMPI, % segments with plaque), younger adolescents
- mean probing depth (PD, mm), partial recording protocol: index teeth with three sites, adults and seniors
- mean clinical attachment level (CAL, mm), partial recording protocol, adults and seniors
- bleeding on probing (BOP, % sites), partial recording protocol, adults and seniors
- root caries (yes / no), seniors
- self-assessment of oral health status ([very good/good] / [moderate/poor/very poor]), all age groups
- tooth brushing frequency (< 2 times daily / ≥ 2 times daily), all age groups
- interdental cleaning frequency (< once daily / ≥ once daily), all age groups
- dental service utilization (complaint-oriented/control-oriented), all age groups.

The definition of the variables is described in detail elsewhere.[10-13]

### Statistical analysis

Descriptive analyses of sociodemographic variables and oral health outcomes were conducted separately for younger adolescents, adults, and seniors, stratified by migration history (PwM/PwoM).

Multiple association analyses were performed across the different age groups to evaluate the relationship between migration history (exposure of interest) and the aforementioned oral health outcomes (specific to each age group). Appropriate statistical models were selected based on the distribution of the outcome variable, including generalized linear models with Gaussian or gamma distribution, Poisson regressions with robust standard errors, and fractional probit regressions. Mixed-effects regression models were employed to estimate the associations between migration history and the oral health outcomes. These models accounted for covariates such as age, gender, and education (fixed effects) and incorporated a composite region variable as a random effect. The analyses followed a stepwise approach:
- Step 1: Basic models assessing the association between migration history (exposure) and the oral health outcome without any adjustments.

**Table 1** Baseline characteristics of study participants and oral health outcomes in adults by migration history

| Variable | | PwM | PwoM |
|---|---|---|---|
| No. of participants (n) | | 280 | 1,245 |
| Age, years | | 38.0 ± 8.6 | 37.3 ± 10.5 |
| Gender | Male | 139 (49.6%) | 621 (49.9%) |
| | Female | 141 (50.4%) | 624 (50.1%) |
| Education group | Low | 39 (13.9%) | 80 (6.4%) |
| | Medium | 142 (50.7%) | 796 (63.9%) |
| | High | 99 (35.4%) | 369 (29.6%) |
| Monthly net equivalent income, Euro | | 2,021 ± 1,344 | 2,348 ± 1,378 |
| Migration history | Without migration history | 0 (0.0%) | 1,245 (100.0%) |
| | 1st generation (immigrated to Germany themselves) | 217 (77.5%) | 0 (0.0%) |
| | 2nd generation (both parents born outside Germany) | 63 (22.5%) | 0 (0.0%) |
| Smoking status | Never smoked | 159 (57.0 %) | 751 (60.3%) |
| | Former smoker | 44 (15.8%) | 217 (17.4%) |
| | Current smoker | 76 (27.2%) | 277 (22.2%) |
| Self-assessment of oral health status | Very good/good | 187 (67.3%) | 979 (78.8%) |
| | Moderate/poor/very poor | 91 (32.7%) | 264 (21.2%) |
| Dental service utilization | Complaint-oriented | 67 (24.0 %) | 99 (8.0 %) |
| | Control-oriented | 212 (76.0 %) | 1,146 (92.0 %) |
| Professional tooth cleaning (utilization) | Yes | 200 (73.0 %) | 931 (74.8 %) |
| | No | 72 (26.3%) | 305 (24.5%) |
| | Don't know | 2 (0.7%) | 8 (0.6%) |
| Tooth brushing (frequency)* | ≥ 2 times daily | 213 (76.3%) | 1,072 (86.1%) |
| | < 2 times daily | 66 (23.7%) | 173 (13.9%) |
| Interdental cleaning (frequency)* | ≥ once daily | 78 (28.0 %) | 273 (21.9%) |
| | < once daily | 201 (72.0 %) | 972 (78.1%) |
| No. of teeth | | 26.4 ± 2.7 | 26.9 ± 2.2 |
| | < 28 teeth | 136 (48.6%) | 428 (34.4%) |
| | 28 teeth | 144 (51.4%) | 817 (65.6%) |
| DT | | 0.6 ± 1.4 | 0.4 ± 1.1 |
| | DT = 0 | 214 (76.4%) | 1,031 (82.8%) |
| | DT > 0 | 66 (23.6%) | 214 (17.2%) |
| Mean PD, mm | | 2.4 ± 0.6 | 2.2 ± 0.5 |
| Mean CAL, mm | | 1.4 ± 1.0 | 1.2 ± 0.8 |
| BOP (% sites) | | 14.9 ± 16.8 | 11.3 ± 14.0 |

Data are presented as numbers (percentages) or mean ± standard deviation based on unweighted data for participants with valid information on migration history, age, gender, and education.
BOP, bleeding on probing; CAL, clinical attachment level; DT, decayed teeth; PD, probing depth; PwM, people with migration history; PwoM, people without migration history.
*Dentate study participants.

- Step 2: The models were adjusted for age (adults and seniors only) and gender.
- Step 3: Further adjustment was made by including education status in the model to account for socioeconomic differences.

The results were presented as unstandardized coefficients (b) or prevalence ratios (PR) along with their 95% confidence intervals (CIs) and *P* values. Additional methodologic details are provided in Appendix 1.

All analyses were based on unweighted data. Detailed information on data handling and statistical methods is described previously.[14]

# Results

## Descriptive characteristics

Descriptive characteristics of the 12-year-olds stratified by migration history were detailed in a previous article.[6] Table 1 provides the characteristics of the adults (20-year-olds, 35- to 44-year-olds, 43- to 52-year-olds) and Table 2 outlines those of the seniors (65- to 74-year-olds, 73- to 82-year-olds).

## Sociodemographic and migration-related indicators

Among the 12-year-olds (n = 879), 220 younger adolescents (24.6%) had a history of migration, of whom 57.7% were immigrants themselves (first generation) and 42.3% were direct descendants of immigrants (second generation). Among the adults (n = 1,525), 280 participants (18.4%) had a history of migration, with 77.5% being first-generation and 22.5% second-generation immigrants. For the seniors (n = 1,094), the proportion of PwM was 12.8% (72.1% first generation; 27.9% second generation).

The age and gender distributions between PwM and PwoM were consistent across all age groups. However, disparities in education status were evident. Among the 12-year-olds, the proportion with a low education status was four times higher among PwM compared to PwoM (22.2% vs 5.2%). For adults, this proportion was twice as high (13.9% vs 6.4%), yet adult PwM also had a higher proportion of participants with a high education status compared to PwoM (35.4% vs 29.6%). For the seniors, the proportion with a low education status was lower among PwM than PwoM (20.0% vs 25.1%). Additionally, the monthly net equivalent income was lower for PwM compared to PwoM across both adults (€2,021 vs €2,348) and seniors (€1,779 vs €2,004).

## Oral hygiene and dental service utilization

The proportion of participants with complaint-oriented dental service utilization was three times as high for adult PwM (24.0% vs 8.0%) and twice as high for senior PwM (22.1% vs 11.1%) compared to PwoM. Within the senior group, PwM stated more frequently that they had never had their teeth professionally cleaned compared to PwoM (28.3% vs 20.4%). This difference was not observed in the adult sample (26.3% vs 24.5%). Regarding tooth brushing frequency, the proportion of adults brushing

less than twice daily was almost twice as high among PwM compared to PwoM (23.7% vs 13.9%). However, for the seniors, tooth brushing frequency distributions were similar between the groups.

## Epidemiologic description of oral diseases

For the younger adolescents, the epidemiologic description of oral diseases has been published elsewhere.[1] The data for the adults and seniors are presented in Tables 1 and 2. Among the adults, PwM exhibited more decayed teeth than PwoM (DT: 0.6 vs 0.4), whereas the seniors showed the opposite trend (0.4 vs 0.5 for PwM vs PwoM). PwM seniors also had less root caries (55.0% vs 62.9%). BOP was higher among PwM in both adults (14.9% vs 11.3%) and seniors (23.4% vs 18.9%). The average CAL was higher for adults with PwM (1.4 mm vs 1.2 mm), but showed no differences for the seniors (2.8 mm vs 2.8 mm).

## Regression analyses

### Younger adolescents

After adjusting for gender and education, the younger adolescents with migration history had a significantly higher prevalence of decayed teeth (DT > 0) (PR = 5.1 [95% CI 2.6; 10.0]), $P < .001$) and a higher mMPI (B = 9.2 [4.9; 13.4], $P < .001$) compared to younger adolescents without migration history. Moreover, the Poisson regression analyses confirmed that migration history was significantly associated with a higher prevalence of a tooth brushing frequency of less than twice daily (PR = 2.36, $P < .001$) and a complaint-oriented dental service utilization (PR = 9.30, $P < .001$), even after adjusting for gender and education status (Table 3).

### Adults

Among the adults, PwM had a significantly higher prevalence of decayed teeth (DT ≥ 1) (PR = 1.36, $P = .005$), a tooth brushing frequency of less than twice daily (PR = 1.58, $P < .001$), and a complaint-oriented utilization behavior (PR = 2.69, $P < .001$), after adjusting for age, gender, and education. Furthermore, regression analyses revealed a significant association between migration history and higher mean CAL (b = 0.15, $P = .008$) and BOP (b = 0.15, $P = .002$; Table 3).

### Seniors

For seniors, regression analyses revealed a significant association between migration history and higher BOP (b = 0.18, $P = .017$), after adjusting for age, gender, and education. No significant asso-

**Table 2** Baseline characteristics of study participants and oral health outcomes in seniors by migration history

| Variable | | PwM | PwoM |
|---|---|---|---|
| No. of participants (n) | | 140 | 954 |
| Age, years | | 71.9 ± 4.7 | 72.5 ± 4.8 |
| Gender | Male | 67 (47.9%) | 449 (47.1%) |
| | Female | 73 (52.1%) | 505 (52.9%) |
| Education group | Low | 28 (20.0 %) | 239 (25.1%) |
| | Medium | 73 (52.1%) | 441 (46.2%) |
| | High | 39 (27.9%) | 274 (28.7%) |
| Monthly net equivalent income, Euro | | 1,779 ± 932 | 2,004 ± 1,030 |
| Migration history | Without migration history | 0 (0.0%) | 954 (100.0%) |
| | 1st generation (immigrated to Germany themselves) | 101 (72.1%) | 0 (0.0%) |
| | 2nd generation (both parents born outside Germany) | 39 (27.9%) | 0 (0.0%) |
| Smoking status* | Never smoked | 44 (42.3%) | 312 (48.4%) |
| | Former smoker | 46 (44.2%) | 239 (37.1%) |
| | Current smoker | 14 (13.5%) | 94 (14.6%) |
| Self-assessment of oral health status | Very good/good | 83 (59.3%) | 628 (65.9%) |
| | Moderate/poor/very poor | 57 (40.7%) | 325 (34.1%) |
| Dental service utilization | Complaint-oriented | 31 (22.1%) | 106 (11.1%) |
| | Control-oriented | 109 (77.9%) | 847 (88.9%) |
| Professional tooth cleaning (utilization) | Yes | 97 (70.3%) | 753 (79.4%) |
| | No | 39 (28.3%) | 193 (20.4%) |
| | Don't know | 2 (1.4%) | 2 (0.2%) |
| Tooth brushing (frequency)[†] | ≥ 2 times daily | 102 (82.9%) | 743 (83.7%) |
| | < 2 times daily | 21 (17.1%) | 145 (16.3%) |
| Interdental cleaning (frequency)[†] | ≥ once daily | 38 (30.9%) | 349 (39.3%) |
| | < once daily | 85 (69.1%) | 539 (60.7%) |
| Number of teeth | | 18.0 ± 9.0 | 19.1 ± 8.0 |
| | < 20 teeth | 58 (41.4%) | 364 (38.2%) |
| | ≥ 20 teeth | 82 (58.6%) | 590 (61.8%) |
| Edentulism | Yes | 14 (10.0%) | 44 (4.6%) |
| | No | 126 (90.0%) | 910 (95.4%) |
| DT | | 0.4 ± 1.1 | 0.5 ± 1.4 |
| | DT = 0 | 115 (82.1%) | 746 (78.2%) |
| | DT > 0 | 25 (17.9%) | 208 (21.8%) |
| Root caries | Yes | 77 (55.0%) | 600 (62.9%) |
| | No | 49 (35.0%) | 310 (32.5%) |
| Mean PD, mm | | 2.9 ± 0.9 | 2.7 ± 0.8 |
| Mean CAL, mm | | 2.8 ± 1.4 | 2.8 ± 1.5 |
| BOP (% sites) | | 23.4 ± 21.8 | 18.9 ± 19.7 |

Data are presented as numbers (percentages) or mean ± standard deviation based on unweighted data for participants with valid information on migration history, age, gender, and education.
BOP, bleeding on probing; CAL, clinical attachment level; DT, decayed teeth; PD, probing depth; PwM, people with migration history; PwoM, people without migration history.
*Not assessed for older seniors (73- to 82-year-olds).
[†]Dentate study participants.

ciation was found for mean CAL (b = 0.01, P = .825). In addition, the Poisson regression to assess the association between migration history and the prevalence of decayed teeth showed no significant association (PR = 1.05, P = .145). This also applies to the prevalence of root caries (PR = 1.14, P = .363) and tooth brushing frequency (PR = 1.07, P = .777). Yet, just like the other

age groups, migration history was significantly associated with a higher prevalence of complaint-oriented dental service utilization (PR = 2.01, *P* < .001), even after adjusting for age, gender, and education (Table 3).

## Discussion

The present study identified a significant association between migration history and poorer oral health outcomes and behaviors across all age groups. After adjusting for age (for adults and seniors), gender, and education, PwM exhibited more plaque (in younger adolescents), more bleeding sites (in adults and seniors), and a higher prevalence of decayed teeth, insufficient tooth brushing frequency, and complaint-oriented dental service utilization.

Comparable data on the relationship between migration history and various oral health outcomes for younger adolescents are rare. The KiGGS Wave 2 study found that children and adolescents (aged 0 to 17 years) with migration history had a significantly higher chance of insufficient tooth brushing frequency (odds ratio [OR] = 1.94) and low utilization of regular dental check-ups (OR = 1.56) compared to their peers without migration history.[15] Similarly, the DMS • 6 study showed that younger adolescents with migration history had a significantly higher prevalence of insufficient tooth brushing frequency (less than two times daily) (PR = 2.36) and complaint-oriented dental service utilization (PR = 9.30). These findings thus indicate a higher likelihood of insufficient oral hygiene within the group of younger adolescents with a history of migration. However, the KiGGS study included a broader age range (0 to 17 years) and employed different parameters to measure oral health behavior, which limits direct comparability with the findings presented here.

Available data on the association between migration history and oral health outcomes in adults and seniors are also scarce. In a cross-sectional survey of a large German-speaking cohort (ages 18 to over 80), migration history was associated with a reduced chance of attending regular dental check-ups after adjusting for demographic and socioeconomic factors (OR = 0.71; multiple logistic regression).[16,17] Importantly, this study adjusted for narrower age ranges compared to the DMS • 6 data. However, the results in adults and seniors presented here also showed that migration history was associated with a reduced chance of control-oriented dental service utilization, reflecting similar trends. These patterns are consistent with international studies, although a lot of the research focuses on ethnicity rather than migration history, a distinction that should not be overlooked.[4,18,19]

In the Hamburg-based MuMi intervention study, adults without migration history had a significantly higher chance of having good to optimal approximal plaque indices (APIs) compared to those with migration history (OR = 1.75; mean age 44.0 years for PwoM and mean age 38.7 years for PwM).[1] Among the adults in the DMS • 6 cohort, PwoM had a significantly higher prevalence of brushing their teeth at least twice daily compared to PwM. Research suggests that tooth brushing frequency is closely associated with plaque removal efficacy.[20]

In a cross-sectional explorative study among migrants in Hamburg (mean age 69.7 years), migrants had, on average, three more decayed teeth than nonmigrants, even after adjusting for age, gender, income, education, and number of teeth.[3] However, the PwM seniors in the DMS • 6 cohort had fewer decayed teeth and did not show a higher prevalence of decayed teeth compared to PwoM of the same age group. These differing results may be explained by differences in education status: In the Hamburg study, a higher proportion of migrants had a lower education status (10 years or less) compared to nonmigrants. In contrast, in the DMS • 6 cohort, a larger proportion of PwoM had a low education status (25.1% for PwoM vs 20.0% for PwM). Moreover, the proportion of first generation immigrants in the DMS • 6 cohort was lower compared to those of the Hamburg-based study (72% vs 100%).

Education status is a well-established risk factor for poorer oral health.[21-23] Studies have shown that migrant populations tend to have a lower education status than those without migration history.[24] The statistical models presented here were thus adjusted for education status, yet the association between migration history and oral health outcomes remained significant. This reinforces the notion of migration history as an independent risk factor for poorer oral health, consistent with previous research.[3,25]

In addition to whether a person or their parents were born in Germany or not, further migration-related factors (eg, origin, length of stay, circumstances of migration, level of acculturation, language proficiency) should also be considered in future studies. For instance, in a study examining the interrelationship between ethnicity, migration history, and dental caries, Delgado-Angulo et al[19] found that, among foreign-born participants, age at arrival and length of residence were positively associated with DMFT (decayed, missing, filled teeth). ▦

## Conclusion

To the best of the present authors' knowledge, this is the first large cohort study to analyze the association between migra-

**Table 3** Association analyses between migration history and different oral health outcomes by age groups

| Age group | Dependent variable | | Step 1: crude estimate | | Step 2: adjusted for gender | | Step 3: adjusted for gender and education | |
|---|---|---|---|---|---|---|---|---|
| | | | Estimate (95% CI) | P value | Estimate (95% CI) | P value | Estimate (95% CI) | P value |
| Younger adolescents (12-year-olds) | Sound teeth (n)* | | b = 0.00 (−0.02; 0.03) | .731 | b = 0.01 (−0.02; 0.03) | .701 | b = 0.01 (−0.02; 0.03) | .661 |
| | Decayed teeth (ref. DT = 0)† | DT ≥ 1 | PR = 5.58 (3.34; 9.32) | <.001 | PR = 5.57 (3.32; 9.35) | <.001 | PR = 5.06 (2.57; 9.98) | <.001 |
| | mMPI (% segments with plaque)‡ | | b= 11.1 (7.0; 15.2) | <.001 | b = 11.0 (6.9; 15.2) | <.001 | b= 9.2 (4.9; 13.4) | <.001 |
| | Self-assessment of oral health status (ref. very good/good)† | Moderate/poor/ very poor | PR = 1.77 (1.53; 2.04) | <.001 | PR = 1.75 (1.54; 2.00) | <.001 | PR = 1.71 (1.45; 2.01) | <.001 |
| | Tooth brushing frequency (ref. ≥ 2 times daily)† | < 2 times daily | PR = 2.45 (1.68; 3.57) | <.001 | PR = 2.44 (1.68; 3.55) | <.001 | PR = 2.36 (1.61; 3.45) | <.001 |
| | Interdental cleaning frequency (ref. ≥ once daily)† | < once daily | PR = 1.00 (0.94; 1.06) | .985 | PR = 1.00 (0.94; 1.06) | .994 | PR = 1.01 (0.95; 1.06) | .816 |
| | Dental service utilization (ref. control-oriented)† | Complaint-oriented | PR = 11.73 (5.67; 24.29) | <.001 | PR = 11.73 (5.67; 24.28) | <.001 | PR = 9.30 (4.06; 21.30) | <.001 |
| Adults (20-year-olds, 35- to 44-year-olds, 43- to 52-year-olds) | Number of teeth (ref. 28 teeth)† | < 28 teeth | PR = 1.42 (1.21; 1.66) | <.001 | PR = 1.39 (1.20; 1.60) | <.001 | PR = 1.35 (1.16; 1.56) | <.001 |
| | Decayed teeth (ref. DT = 0)† | DT ≥ 1 | PR = 1.48 (1.16; 1.88) | .002 | PR = 1.43 (1.11; 1.86) | .006 | PR = 1.36 (1.10; 1.69) | .005 |
| | Mean CAL, mm*¶ | | b = 0.16 (0.04; 0.28) | .006 | b = 0.16 (0.05; 0.27) | .005 | b = 0.15 (0.04; 0.26) | .008 |
| | Mean PD, mm‡¶ | | b = 0.22 (0.16; 0.29) | <.001 | b = 0.21 (0.14; 0.27) | <.001 | b = 0.19 (0.13; 0.25) | <.001 |
| | BOP (% sites)§¶ | | b= 0.17 (0.08; 0.27) | <.001 | b = 0.16 (0.06; 0.25) | .001 | b = 0.15 (0.05; 0.24) | .002 |
| | Self-assessment of oral health status (ref. very good/good)† | Moderate/poor/ very poor | PR = 1.55 (1.27; 1.88) | <.001 | PR = 1.51 (1.26; 1.79) | <.001 | PR = 1.41 (1.21; 1.66) | <.001 |
| | Tooth brushing frequency (ref. ≥ 2 times daily)†‖ | < 2 times daily | PR = 1.71 (1.35; 2.17) | <.001 | PR = 1.66 (1.33; 2.08) | <.001 | PR = 1.58 (1.28; 1.96) | <.001 |
| | Interdental cleaning frequency (ref. ≥ once daily)†‖ | < once daily | PR = 1.27 (1.01; 1.61) | .043 | PR = 1.24 (1.00; 1.55) | .052 | PR = 1.28 (1.04; 1.57) | .022 |
| | Dental service utilization (ref. control-oriented)† | Complaint-oriented | PR = 3.02 (2.27; 4.01) | <.001 | PR = 2.91 (2.22; 3.81) | <.001 | PR = 2.69 (2.04; 3.54) | <.001 |
| Seniors (65- to 74-year-olds, 73- to 82-year-olds) | Number of teeth (ref. ≥ 20 teeth)† | < 20 teeth | PR = 1.09 (0.87; 1.36) | .468 | PR = 1.10 (0.88; 1.38) | .384 | PR = 1.11 (0.89; 1.40) | .346 |
| | Decayed teeth (ref. DT = 0)† | DT ≥ 1 | PR = 1.05 (0.98; 1.13) | .180 | PR = 1.05 (0.98; 1.13) | .167 | PR = 1.05 (0.98; 1.13) | .145 |
| | Mean CAL, mm*¶ | | b = 0.00 (−0.11; 0.11) | .959 | b = 0.01 (−0.10; 0.12) | .856 | b = 0.01 (−0.10; 0.12) | .825 |
| | Mean PD, mm‡¶ | | b = 0.11 (−0.05; 0.26) | .184 | b = 0.11 (−0.05; 0.26) | .179 | b = 0.12 (−0.03; 0.28) | .121 |
| | BOP (% sites)§¶ | | b= 0.18 (0.03; 0.33) | .022 | b = 0.17 (0.02; 0.32) | .025 | b = 0.18 (0.03; 0.33) | .017 |
| | Root caries (ref. no)†# | Yes | PR = 1.16 (0.88; 1.52) | .304 | PR = 1.13 (0.85; 1.51) | .406 | PR = 1.14 (0.86; 1.52) | .363 |
| | Self-assessment of oral health status (ref. very good/good)† | Moderate/poor/ very poor | PR = 1.19 (0.93; 1.53) | .163 | PR = 1.19 (0.93; 1.52) | .160 | PR = 1.19 (0.94; 1.51) | .146 |
| | Tooth brushing frequency (ref. ≥ 2 times daily)†‖ | < 2 times daily | PR = 1.06 (0.64; 1.73) | .828 | PR = 1.05 (0.65; 1.68) | .855 | PR = 1.07 (0.67; 1.71) | .777 |
| | Interdental cleaning frequency (ref. ≥ once daily)†‖ | < once daily | PR = 1.13 (1.06; 1.21) | <.001 | PR = 1.14 (1.05; 1.23) | .001 | PR = 1.15 (1.07; 1.24) | <.001 |
| | Dental service utilization (ref. control-oriented)† | Complaint-oriented | PR = 1.96 (1.51; 2.55) | <.001 | PR = 1.95 (1.52; 2.50) | <.001 | PR = 2.01 (1.60; 2.53) | <.001 |

Three separate models were calculated for each exposure/oral health outcome combination. Estimates are given for exposure = migration history (people with migration history vs people without migration history [reference]). Unweighted data set including study participants with valid information on migration history, age, gender, and education.
b, unstandardized regression coefficient; BOP, bleeding on probing; CAL, clinical attachment level; CI, confidence interval; DT, decayed teeth; mMPI, modified Marginal Plaque Index; PD, probing depth; PR, prevalence ratio.
*Model specifications: mixed-effects generalized linear model, family (gamma) link (log).
†Model specifications: mixed-effects generalized linear model, family (Poisson) link (log), robust standard errors.
‡Model specifications: mixed-effects generalized linear model, family (Gaussian), covariance = identity.
§Model specifications: fractional probit regression; excluding random effect.
‖Dentulous study participants.
¶ Partial recording protocol: index teeth with 3 sites.
#Excluding study participants without gingival recession.

tion history and multiple oral health outcomes across different age groups. A significant association between migration history and poorer oral health outcomes, as well as poorer oral health behaviors, has been shown after adjusting for age, gender, and education. These findings suggest that migration history is a crucial factor contributing to disparities in oral health out-

comes, highlighting the need for targeted oral health interventions. Future research should focus on uncovering migration-related factors, health literacy, and health behaviors to better explain the observed differences and improve oral health for migrant populations.

## Disclosure

KK and ARJ are employed by the National Association of Statutory Health Insurance Dentists (KZBV). The authors declare that there are no conflicts of interest according to the Uniform Requirements for Manuscripts Submitted to Biomedical Journals. The interpretation of data and presentation of information was not influenced by any personal or financial relationship with any individual or organization.

## Author contributions

All authors listed in the paper have contributed sufficiently to fulfill the criteria for authorship according to the Recommendations for the Conduct, Reporting, Editing and Publication of Scholarly Work in Medical Journals (ICMJE Recommendations). All authors have read and approved the final manuscript. BL is the author of the manuscript. LS is a member of the scientific advisory board of the DMS • 6 and a co-author of the manuscript. KK is the deputy principal investigator of the DMS • 6, responsible for the data analysis, and a co-author of the manuscript. VP is responsible for the data-analysis and a co-author of the manuscript. KB is a co-author of the manuscript. ARJ is the principal investigator of the DMS • 6, responsible for developing the clinical examinations, and a co-author of the manuscript. GA is a member of the scientific advisory board of DMS • 6, responsible for developing the clinical examinations, and a co-author of the manuscript.

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**Appendix 1**

Additional data available at: https://www.idz.institute/publikationen/online-journal-zahnmedizin-forschung-und-versorgung/association-between-migration-history-and-oral-health-results-of-the-6th-german-oral-health-study-dms-6-online-appendix/.