Oral health and dietary habits: results of the 6th German Oral Health Study (DMS • 6)

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Objectives: Dietary habits have significant implications for oral health, with the consumption of sugar-rich foods being strongly associated with caries. However, additional factors must be considered to fully establish their harmful effects. These relationships are examined in three age groups of the 6th German Oral Health Study (DMS • 6). **Method and materials:** Dietary habits were assessed using the short form of the Marburg Sugar Index (MSI-S), which comprises six questions regarding food consumption frequencies in various contexts. Responses provide insight into the degree of cariogenic eating behavior. In addition to demographic factors (gender, education status, migration history), clinical variables such as caries experience (decayed, missing, filled teeth [DMFT] index), plaque accumulation (modified Marginal Plaque Index [mMPI]), and the number of remaining teeth were included. **Results:** No direct relationship between the extent of cariogenic dietary habits (MSI-S total score) and clinical variables was observed in any of the examined age groups (n = 870 younger adolescents [12-year-olds], n = 853 younger adults [35- to 44-year-olds], and n = 730 younger seniors [65- to 74-year-olds]). Gender and education status also showed no significant differences. However, 12-year-olds with a migration history exhibited higher MSI-S scores compared to those without. Analyzing extreme groups (the top and bottom 10% of MSI-S scores), systematic differences in caries experience were observed among 12-year-olds and younger seniors, and in plaque levels among younger seniors. Younger adults showed no significant differences in clinical variables, even within extreme groups. **Conclusion:** The MSI-S scores demonstrated that particularly cariogenic dietary habits, as opposed to more favorable ones (extreme groups), are associated with increased caries experience. This was especially evident among 12-year-olds but also observed in younger seniors. The lack of differences among adults as well as the absence of significant associations between dietary habits and clinical variables in the overall groups suggest that the impact of cariogenic diets on oral health is moderated by additional variables, such as oral hygiene practices and dental service utilization. Migration history was identified as a relevant factor among 12-year-olds. The detrimental effects of cariogenic dietary habits on oral health are most evident when analyzed in the context of additional influencing factors and stratified by target groups. Promoting oral health awareness regarding nutrition is particularly important for adolescents and seniors. *(Quintessence Int 2025;56(Suppl):S88–S94; doi: 10.3290/j.qi.b5982015)*

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Dietary habits are crucial not only for general physical health but also specifically for oral health. The consumption of certain foods, particularly dietary sugars, remains a significant risk factor for the development of caries. In 2015, the World Health Organization (WHO) lowered its recommendation for daily sugar intake from less than 10% to less than 5% of total energy intake, citing additional positive health outcomes.[1]

Against this background, the German Oral Health Studies (DMS I to V) also assessed aspects of dietary behavior and their relationships with oral health.[2-6] In DMS IV and V, the focus was placed on the consumption of snacks and sugar- and acid-rich beverages. A consistent association with caries experience was observed among younger adolescents (12-year-olds); however, in DMS V, this association was limited to beverages. Evidently,

Table 1 MSI-S total score in younger adolescents (12-year-olds), younger adults (35- to 44-year-olds), and younger seniors (65- to 74-year-olds) by gender, education group, and migration history

Variable		12-year-olds		35- to 44-year-olds		65- to 74-year-olds	
		No. of participants (n)	MSI-S	No. of participants (n)	MSI-S	No. of participants (n)	MSI-S
Total		871	2.4 ± 0.5	854	2.1 ± 0.5	730	1.8 ± 0.5
Gender*	Male	433	2.4 ± 0.5	428	2.1 ± 0.5	345	1.8 ± 0.5
	Female	437	2.4 ± 0.5	425	2.1 ± 0.5	385	1.8 ± 0.4
Education group	Low	77	2.6 ± 0.6	78	2.3 ± 0.6	150	1.9 ± 0.5
	Medium	408	2.4 ± 0.5	397	2.1 ± 0.5	351	1.7 ± 0.4
	High	371	2.3 ± 0.5	372	2.1 ± 0.5	225	1.8 ± 0.5
Migration history	People with migration history	208	2.5 ± 0.6	187	2.1 ± 0.6	100	1.7 ± 0.4
	People without migration history	662	2.3 ± 0.5	652	2.1 ± 0.5	624	1.8 ± 0.5

Data are presented as number (n) or mean ± standard deviation based on unweighted data for participants with valid information on MSI-S.
*Data of two gender-diverse individuals are not presented.
MSI-S, Marburg Sugar Index short scale.

harmful dietary habits—particularly frequent sugar consumption and its effects on the oral microbiome—must be analyzed alongside other oral health-related behaviors (eg, oral hygiene practices, routine dental check-ups) to explain caries experience comprehensively. This multifactorial interplay has also been highlighted by other epidemiologic findings.[7,8]

One of the aims of the 6th German Oral Health Study (DMS • 6) was therefore to assess dietary behavior in a new way, together with other factors, and to analyze systematic relationships with oral health indicators across different age groups.

Method and materials

The methodologic approach for the social science survey and clinical examinations is presented in separate articles.[9,10] DMS • 6 has been approved by the Institutional Review Board (IRB) of the Witten/Herdecke University, Witten, Germany (registration number S-249/2021). The study is registered in the German Clinical Trials Register (registration number DRKS00028701).

Measurement and variables

Dietary habits were assessed using the short form of the Marburg Sugar Index (MSI-S) as part of the written survey. The short form, specifically designed for epidemiologic studies and consisting of six questions, has been shown to be equivalent in terms of item characteristics and reliability to the long form comprising 25 items.[11]

Clinical parameters used to examine associations with the MSI-S included caries experience (decayed, missing, filled teeth [DMFT] index), plaque accumulation (modified Marginal Plaque Index [mMPI]), and dentition/tooth loss (among the 65- to 74-year-olds). Demographic factors such as gender, education status, and migration history were also considered. The definitions of these variables are described in detail elsewhere.[12-15]

Sample

For the data analysis, participants with complete MSI-S data were selected from those who met the inclusion criteria for the DMS • 6 analysis set. Data from 871 younger adolescents (12-year-olds), 854 younger adults (35- to 44-year-olds), and 730 younger seniors (65- to 74-year-olds) were included in the analysis. Participants with missing MSI-S data (n = 158) and those with incomplete responses (fewer than six questions answered: n = 69) were excluded. Overall, 91.5% of participants in the target age groups completed the MSI-S in full.

Statistical analysis

To assess the reliability of the MSI-S, Cronbach alpha was calculated. This measure evaluates the internal consistency of the scale by assessing the homogeneity of its individual components. Descriptive statistics of the MSI-S total score, including mean and standard deviation (SD), were reported for each age

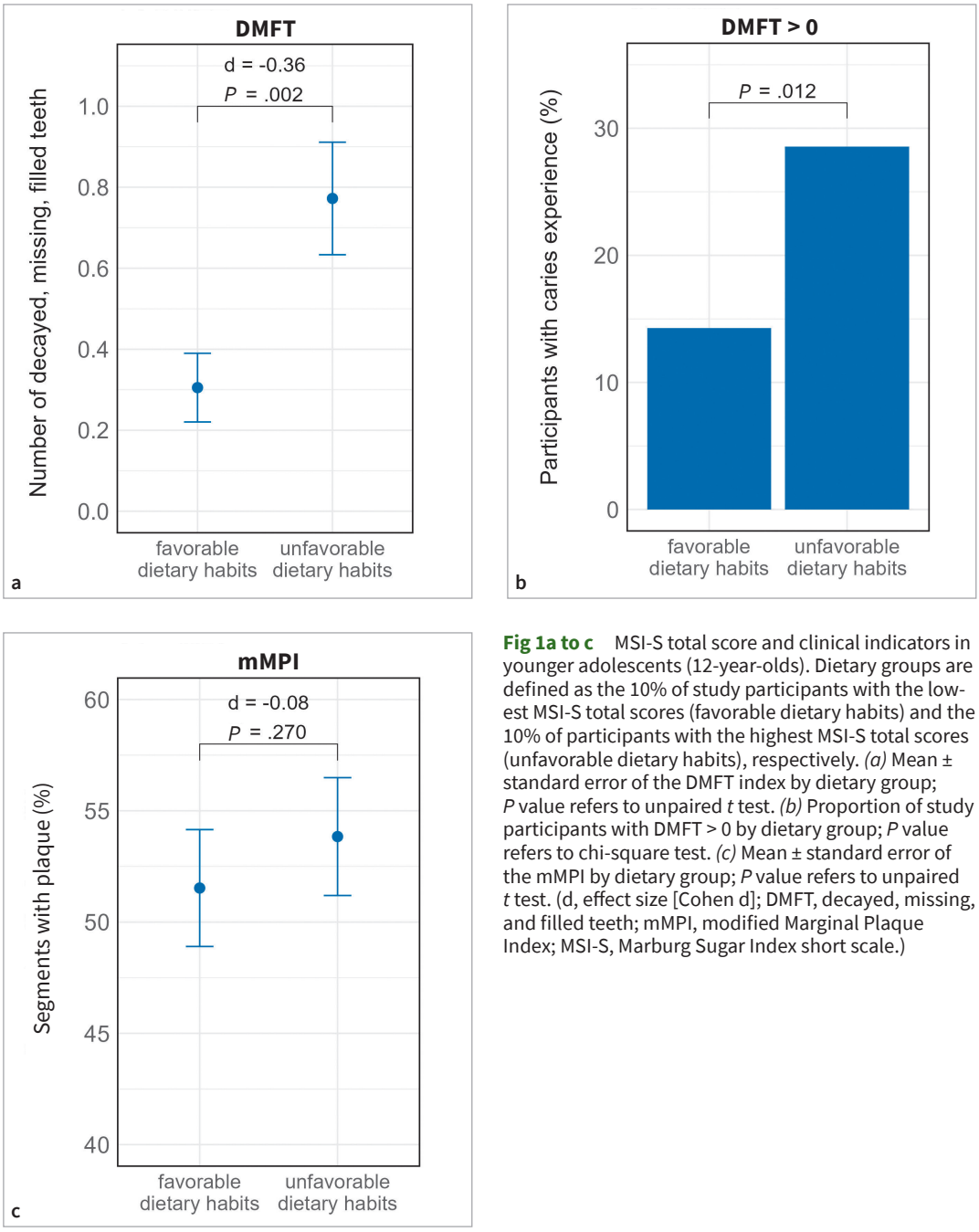

Fig 1a to c MSI-S total score and clinical indicators in younger adolescents (12-year-olds). Dietary groups are defined as the 10% of study participants with the lowest MSI-S total scores (favorable dietary habits) and the 10% of participants with the highest MSI-S total scores (unfavorable dietary habits), respectively. *(a)* Mean ± standard error of the DMFT index by dietary group; *P* value refers to unpaired *t* test. *(b)* Proportion of study participants with DMFT > 0 by dietary group; *P* value refers to chi-square test. *(c)* Mean ± standard error of the mMPI by dietary group; *P* value refers to unpaired *t* test. (d, effect size [Cohen d]; DMFT, decayed, missing, and filled teeth; mMPI, modified Marginal Plaque Index; MSI-S, Marburg Sugar Index short scale.)

group and stratified by gender, education group, and migration history within each group. Potential associations between the MSI-S total score and clinical parameters were analyzed using Spearman rho correlation coefficients. Additionally, comparisons between extreme groups (the top and bottom 10% of MSI-S scores within each age group) were conducted. Differences between extreme groups were tested using *t* tests for continuous variables and chi-square tests for categorical variables. Cohen d was reported as a measure of effect size. The reported *P* values are exploratory and provided for descriptive purposes; *P* values < .05 were considered statistically meaningful.

Sensitivity analysis

Only participants who answered all six MSI-S items were included in the analysis dataset. A sensitivity analysis was performed to determine whether including participants who answered only one to five items would alter the distribution

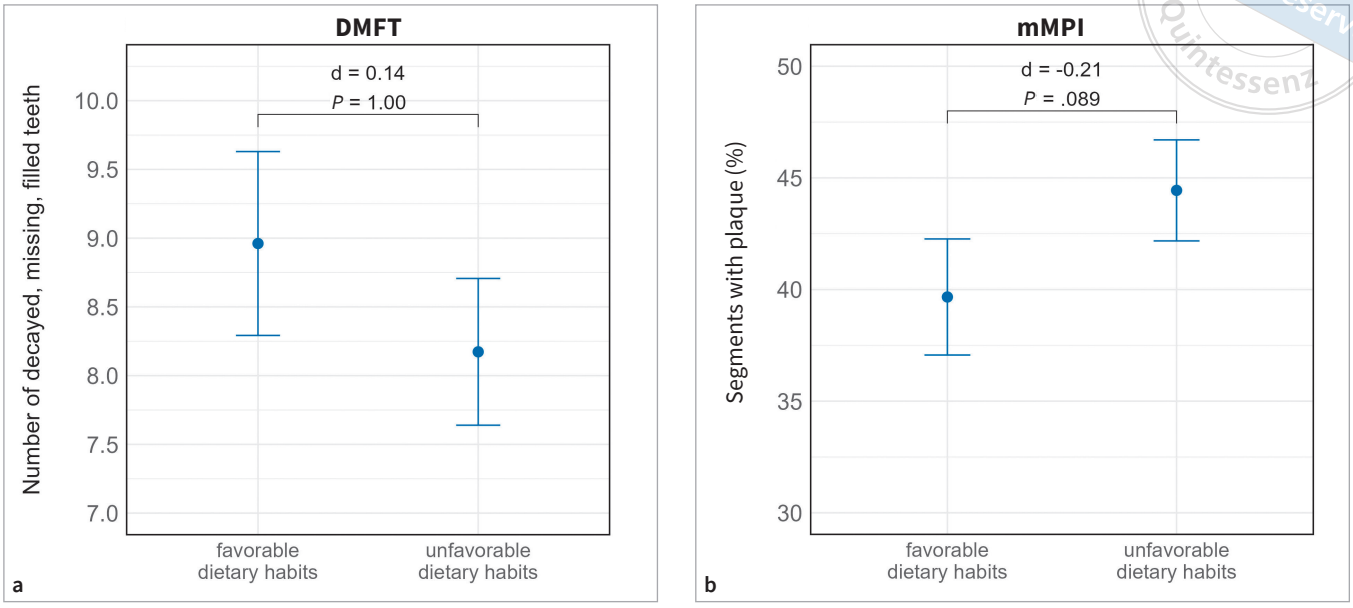

Fig 2a and b MSI-S total score and clinical indicators in younger adults (35- to 44-year-olds). Dietary groups are defined as the 10% of study participants with the lowest MSI-S total scores (favorable dietary habits) and the 10% of participants with the highest MSI-S total scores (unfavorable dietary habits), respectively. *(a)* Mean ± standard error of the DMFT index by dietary group; *P* value refers to unpaired *t* test. *(b)* Mean ± standard error of the mMPI by dietary group; *P* value refers to unpaired *t* test. (d, effect size [Cohen d]; DMFT, decayed, missing, filled teeth; mMPI, modified Marginal Plaque Index; MSI-S, Marburg Sugar Index short scale.)

parameters of the MSI-S total score. No indication of bias in the overall results was observed.

Analyses were conducted separately for each age group and based on unweighted data. Detailed information regarding data processing and statistical methods is provided in a separate methods article.[12]

Results

Reliability of the MSI-S across age groups

The reliability of the MSI-S scale (internal consistency, Cronbach alpha) was 0.41 for younger adolescents, 0.55 for younger adults, and 0.45 for younger seniors. They thus achieved a satisfactory reliability for the short form, which corresponds statistically to what would be expected with an item reduction from 25 to 6 items, and which is still sufficient for epidemiologic purposes.

Associations between the MSI-S and demographic factors

Table 1 provides an overview of the mean MSI-S total scores across the three age groups, as well as within these groups by gender (female/male), education groups (high/medium/low), and migration history (with migration history/without migration history). Differences in the total scores across age groups indicate varying frequencies of snack food consumption. Nevertheless, "sweet rolls" and "chocolate while watching TV" were the most frequently consumed items in all groups (data not shown).

Mean MSI-S scores were similar for female and male participants in all age groups. Differences between education and migration groups were small. Participants with the lowest education status consistently showed the highest MSI-S total scores, although the number of participants in this group was also the smallest. Systematic differences between participants with and without migration history were observed only among younger adolescents. In this group, migration history was associated with higher MSI-S total scores.

Associations between the MSI-S and clinical parameters in the overall cohorts

No significant correlations between MSI-S total scores and caries experience, plaque, or tooth loss were observed among younger adolescents and younger adults (Spearman rho ranging from 0.014 to 0.099). Among younger seniors, there was a very small but statistically meaningful correlation with the DMFT index (Spearman rho = 0.14).

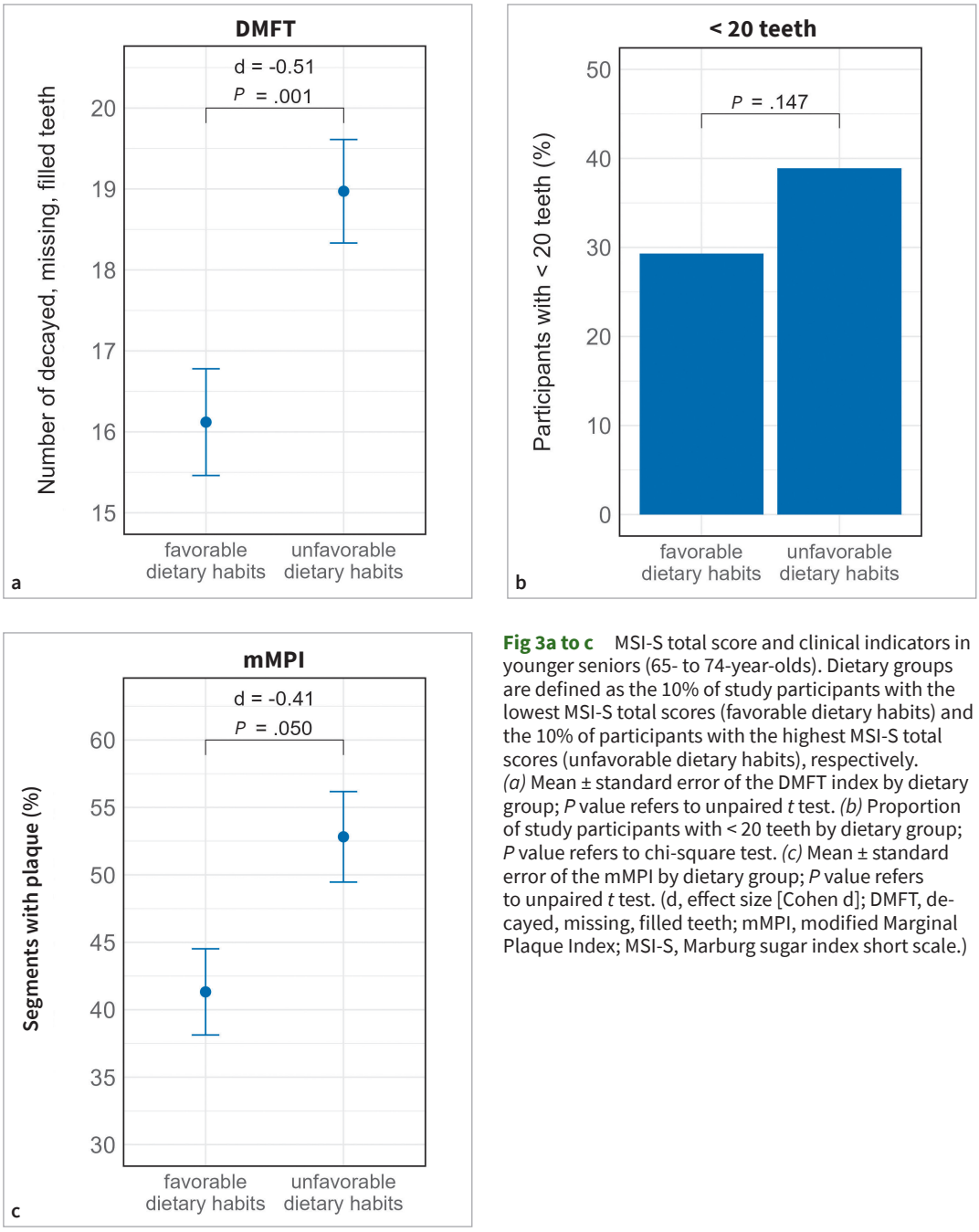

Fig 3a to c MSI-S total score and clinical indicators in younger seniors (65- to 74-year-olds). Dietary groups are defined as the 10% of study participants with the lowest MSI-S total scores (favorable dietary habits) and the 10% of participants with the highest MSI-S total scores (unfavorable dietary habits), respectively. *(a)* Mean ± standard error of the DMFT index by dietary group; *P* value refers to unpaired *t* test. *(b)* Proportion of study participants with < 20 teeth by dietary group; *P* value refers to chi-square test. *(c)* Mean ± standard error of the mMPI by dietary group; *P* value refers to unpaired *t* test. (d, effect size [Cohen d]; DMFT, decayed, missing, filled teeth; mMPI, modified Marginal Plaque Index; MSI-S, Marburg sugar index short scale.)

Associations between the MSI-S and clinical parameters in extreme groups

Figures 1 to 3 illustrate the results of the extreme group comparisons for younger adolescents, younger adults, and younger seniors.

Among younger adolescents, systematic differences in caries experience were found between groups with low and high MSI-S total scores. The mean DMFT index was higher for younger adolescents with more cariogenic eating behaviors, though the effect size was small (d = −0.36, Fig 1a). Similar patterns were observed when comparing caries-free adolescents to those with caries experience (Fig 1b). However, no differences in plaque levels were found between the extreme groups (Fig 1c).

For younger adults, clinical indicators did not differ systematically between the extreme groups of MSI-S total scores (Fig 2).

In the younger senior group, systematic differences were identified between the extreme groups for both the DMFT index

and mMPI, with small to moderate effect sizes (d = −0.51 and d = −0.41, respectively; Fig 3).

The observed differences in extreme groups were not attributable to differing distributions of education status within the groups for any age cohort. However, among younger adolescents, the association with migration history was a confounding factor. Differences in DMFT scores and caries experience related to cariogenic dietary habits were only observed in younger adolescents with migration history. Among younger adolescents without migration history, the differences between dietary groups disappeared.

Discussion

The use of a short form of the dietary behavior questionnaire (Marburg Sugar Index, MSI-S) within the DMS • 6 study yielded a solid data foundation for analysis, with 91.5% of participants in the younger adolescent, younger adult, and younger senior age groups providing complete responses. The overall score proved sufficiently reliable and sensitive in all three age groups to reveal associations with demographic and clinical variables, even if these were sometimes apparent only in extreme groups.

Among younger adolescents, a systematic difference in caries experience was observed between the two dietary groups. The link between sugar consumption and oral health in children and adolescents is well documented in the literature[16-18] and can be considered established. The current findings confirm that unhealthy dietary habits remain a risk indicator for the development of caries in this age group. However, it is crucial to recognize that additional factors moderate this relationship. This is particularly evident in the case of migration history. In the absence of migration history, there was no significant association between MSI-S total scores and caries experience in the DMS • 6 cohort, as these younger adolescents exhibited minimal caries.

Younger seniors with more frequent consumption of cariogenic foods also showed higher caries and plaque levels. Unbalanced and monotonous dietary habits are generally recognized as health risks for seniors and are associated with chewing and eating difficulties.[19] However, there is little prior evidence of a specific relationship between cariogenic dietary habits and caries or plaque in this age group. DMS • 6 was the first to reveal these correlations. These findings support the promotion of the common risk factor approach, according to which preventive messages should be formulated jointly by general and dental medicine, from a nutritional perspective.[20]

While associations between more and less harmful dietary habits and clinical indicators were found in younger adolescents and younger seniors, no such relationship could be statistically demonstrated among younger adults. Although the absolute amount of plaque was higher in individuals with unfavorable dietary habits, the caries burden was inversely related. In this age group—which is likely to have the greatest autonomy in managing its oral health—the multitude of other factors involved (both demographic and behavioral) may mask or compensate for the consequences of consuming cariogenic foods.

Conclusion

The DMS • 6 confirms an increased prevalence of caries among younger adolescents in the (extreme) group of individuals with frequent consumption of cariogenic foods. This finding also applies to younger seniors but not to younger adults. Educational efforts on oral health-promoting nutrition should play a central role in prevention programs, not only for adolescents but also for seniors.

Disclosure

ARJ and KK 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 is 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 Recommendations for the Conduct, Reporting, Editing and Publication of Scholarly Work in Medical Journals (ICMJE Recommendations). All authors read and approved the final manuscript. JMS and RD are members of the scientific advisory board of the DMS • 6, responsible for the development of the questionnaire used, and authors of the manuscript. ARJ is the principal investigator of the DMS • 6, responsible for the development of the clinical examinations, 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.

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