Received: 15 September 2021 | Revised: 20 January 2022 | Accepted: 14 February 2022

DOI: 10.1111/sms.14143

ORIGINAL ARTICLE

WILEY

Orofacial conditions and oral health behavior of young athletes: A comparison of amateur and competitive sports

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Funding information
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Purpose: This retrospective cross-sectional study aimed to evaluate oral health status (dental, periodontal, and functional) and oral health behavior in young German athletes including the comparison of competitive (CA) and amateur sports (AA).

Methods: Data of CA (German national teams, perspective, and youth squads) and AA aged between 18 and 30 years with an available oral examination in 2019 were included. Clinical examination: caries experience (DMF-T), non-carious wear (erosion, BEWE), partially erupted wisdom teeth, gingival inflammation (PBI), plaque index, periodontal screening (PSI), and temporomandibular dysfunction (TMD) screening. Questionnaires: oral health behavior and periodontal symptoms.

Results: 88 CA (w = 51%, 20.6 ± 3.5 years) of endurance sports and 57 AA (w = 51%, 22.2 ± 2.1 years) were included. DMF-T was comparable (CA: 2.7 ± 2.2, AA: 2.3 ± 2.2; $p = 0.275$) with more D-T in CA (0.6 ± 1.0) than AA (0.3 ± 0.7; $p = 0.046$; caries prevalence: CA: 34%, AA: 19%; $p = 0.06$). Both groups had low severity of erosion (BEWE about 3.5). CA had more positive TMD screenings (43% vs. 25%; $p = 0.014$). In both groups, all athletes showed signs of gingival inflammation, but on average of low severity (PBI <1). More CA needed complex periodontal treatment than AA (maximum PSI = 3 in 40% vs. 12%; $p < 0.001$). Oral health behavior was comparable (daily tooth brushing; regular dental check-ups in >70%).

Conclusions: Young German athletes (CA and AA) generally showed signs of gingival inflammation and needed to improve their oral health behavior. CA showed slightly increased oral findings (more D-T, periodontal and TMD screening findings) than AA, but similar oral health behavior. This may imply an increased dental care need in competitive sports.

Cordula Leonie Merle and Lisa Richter should be considered joint first author.

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KEYWORDS
athletes, biathlon, oral health, oral hygiene, prevention, sports dentistry

1 | INTRODUCTION

In competitive sport, protecting athletes' health is of primary importance to support wellbeing and performance.[1] Illness and pain can lead to interruption of training or even to missing important sports events. Furthermore, each small impact could affect the performance. Such possible influence factor is the oral health status: Between 17%[2] and 30%[3] of athletes in various sports report pain in the oral region with 4%[4] to 8%[3] declaring actual discomfort. Three percent of all athletes in the 2004 Olympic Games visited the dental clinic in Olympic Village.[5] First studies even revealed a possible link between oral health status and increased risk for muscle injuries.[2,6] Thus, orofacial health should be of sports medical and athletes' particular interest as by now several international associations have stated, for example, the International Olympic Committee,[7] the Fédération Dentaire Internationale[8] and the Union of European Football Associations.[9]

It is well known that more than one-quarter of contact and combat athletes experience dental injuries[10,11] and that mouthguards can be effective for their prevention.[12] However, as previous studies have reported, athletes commonly have oral health problems:[13] About 46% have dental caries[14] with a higher prevalence than controls.[15,16] Gingival inflammation is very common with 58% to 85%[2–4,15,17,18] and even periodontitis is reported in 5% to 41%.[3,4,17–19] Erosion affects nearly every second athlete.[20] Moreover, between 3% and 18% of athletes declared that oral health affected their training or performance.[3,4,17,18]

Numerous potential risk factors for oral diseases in competitive sports have been discussed, for example, special nutrition habits (usually high carbonate, partially as a gel),[21] mental stress,[15] changes in saliva,[16,22] and oral microbiome changes.[15] Overall, oral health behaviors of athletes might also compromise oral health with irregular or even no dental check-up visits,[2,4,15,18] deficits in daily toothbrushing and missing interdental cleaning.[21]

While there have been recommendations to implement oral health screening in athletes,[23,24] this is not yet standard and the number of epidemiological studies is low. The available studies were conducted in different healthcare systems with different organization types of competitive sports. The few existing studies with comparison to control groups[15,16] as well as the comparison to population-based data[3,17] indicate an increased prevalence of oral diseases for athletes.

The current study aimed to investigate the orofacial health status in German sports within a retrospective evaluation. It was hypothesized that young elite athletes would show worse oral health findings and behavior than young recreational athletes.

2 | METHODS

2.1 | Study design

This retrospective monocentric cross-sectional study was reviewed and approved by the Ethics Committee of the medical faculty of Leipzig University, Germany (No. 091/20-ek). All athletes were informed verbally and in writing about the scientific use of their clinical data and gave their general written informed consent (independent of this study). The recommendations for strengthening the reporting of cross-sectional studies (STROBE) were considered.[25]

2.2 | Participants

Competitive athletes (CA) were compared to amateur athletes (AA). Inclusion criteria were male and female athletes (AA and CA) aged between 18 and 30 years that provided agreement to scientific use of data, with performed standardized sport dental examination in the Institute for Applied Scientific Training (IAT) (CA) or dental clinic (AA) in 2019. CA were defined as members of the German national teams and perspective and youth squads. AA were defined as being sporting active each week, typically organized in sport clubs, but without regularly participating in competitions. Athletes with missing signed agreement to data use for scientific evaluation or incomplete clinical examination were excluded.

Data of CA were collected in a collaboration between the Dept. of Cariology, Endodontology and Periodontology, University of Leipzig and the Institute for Applied Scientific Training (IAT), Leipzig. The dental examinations were performed as a supplement to the annual sports-medical performance diagnostics between May and December 2019. AA presented themselves for the specialized sports dentistry consultation at the Dept. of Cariology, Endodontology and Periodontology, University of Leipzig. This service for dental check-up had been initiated in September 2019 and had been promoted at the

faculty of sports science, University of Leipzig, and to several local sport clubs.

2.3 | Data collection

Data were extracted from participants' dental records. General characteristics of the CA group were obtained from the sport medicine records. Both groups had been examined by one single skilled dentist who was trained in the performed dental parameters and screening instruments. For CA, all examinations were conducted using a headlight on an examination couch in the IAT. AA were examined in a dentist's chair in the dental clinic.

For CA and AA, the same examination protocol had been completed: It included dental findings, oral hygiene indices, periodontal and functional screening. Questionnaires about oral health behavior and periodontal symptoms were administered to all participants.

2.3.1 | Orofacial examination

Dental findings: Dental status was assessed with mirror and probe. Decayed, missing and filled teeth were quantified by the DMF-T.[26] All teeth with a clearly visible or suspected cavitation reaching the dentine layer were rated as decayed (D-T), teeth extracted due to caries (no agenesis or orthodontic indication upon request) were rated as missing (M-T) and teeth with restorations as filled (F-T). Non-carious wear due to erosion, abrasion, attrition or combination was evaluated using the basic erosive wear examination (BEWE).[27] The highest dental wear observed in each sextant was scored either with 0 (no tooth wear), 1 (initial loss of surface texture), 2 (distinct defect, hard tissue loss <50% of the surface area, dentin often is involved), or 3 (hard tissue loss ≥50% of the surface area, dentin often is involved). The cumulative BEWE score of all sextants was analyzed. Risk level and severity of wear were estimated as follows: none (0 – 2), low (3 – 8), medium (9 – 13), and high (14 and more).

Oral hygiene: Plaque accumulation was assessed by the plaque index (PI) by Silness and Loe.[28] All teeth were rated from vestibular by visual inspection and probe. Plaque was quantified with the scores 0 (no plaque), 1 (plaque only detectable with the probe), 2 (moderate visible plaque at gingival margin), and 3 (extensive plaque filling interdental triangles). Gingival inflammation was assessed by the papillary bleeding index (PBI), whereby the marginal gingival sulcus was spread out with a periodontal probe (PCP/UNC 15, Hu-Friedy, Chicago, IL, USA) and bleeding was recorded after 15 seconds (0: no bleeding; 1: one bleeding point; 2: fine line of blood; 3: blood fills interdental triangle; 4: profuse bleeding).[29] Plaque and PBI index were calculated per patient by dividing their total sum by the number of teeth/papillae.

Periodontal screening: Periodontal situation was examined using the Periodontal Screening Index (periodontal probe: PCP/UNC 15, Hu-Friedy, Chicago, IL, USA):[30,31] Score 0 to 2 has probing depths less than 3.5 mm. Score 0 shows no bleeding, no calculus, score 1 bleeding on probing and score 2 calculus. A score of 3 or 4 indicates increased probing depths (3: pocket depth 3.5 – 5.5 mm; 4: pocket depth >5.5 mm). Participants with at least one sextant scored 3 or 4 were stated as having more complex periodontal treatment need (including detailed periodontal assessment and professional debridement of periodontal pockets ≥4 mm).[32]

Wisdom teeth: Third molars were not included in indices or screenings unless they were present more anterior. However, the status of wisdom teeth was recorded per participant (presence, absence, or partially erupted).

TMD screening: Functional screening was performed from pain due to muscle palpation (M. masseter, M. temporalis, Venter anterior M. digastricus), mouth opening capability and movement, signs of traumatic occlusion, joint, and occlusal sounds.[33] Patients with two or more positive findings were classified as positive TMD screening and should be examined in more detail by functional analysis.

2.3.2 | Questionnaires

Standardized questionnaires about oral health behavior and periodontal symptoms were used as established in various previous studies by this working group.[34–36] All athletes were asked to complete them self-administered on-site. Questions were asked about dentist visits (control or complaint-oriented check-ups, regular professional teeth cleaning), the importance of oral health, oral hygiene behavior (frequency of toothbrushing, interdental hygiene, use of fluoride gels), and received instructions about oral hygiene. Questioned periodontal symptoms concerned the gums (swelling, pain, sensitivity, and bleeding), sensitive or mobile teeth, changes in tooth position or bite, bad breath or taste, toothache, and periodontal therapy in the past.

2.4 | Statistical analysis

Data were collected in a Microsoft Excel spreadsheet (Microsoft, Redmond, WA, USA). Statistical analysis was performed with SPSS Statistics for Windows (version 23.0, IBM Corp. Armonk, NY, USA). As no normal-distribution was given (tested with Kolmogorov–Smirnov

test), Mann–Whitney U test and Fisher's exact test were used. The significance level was defined with $p < 0.05$. Subgroup analyses were carried out with Pearson's chi-squared statistics for all disciplines with more than ten participants. Per group, potential associations between oral findings (D-T, maximum PSI ≥3) and oral health behavior (interdental cleaning, control-oriented dental check-ups, professional dental cleaning) were analyzed.

3 | RESULTS

3.1 | Patients

Patient records of 88 CA (w = 51%, 20.6 ± 3.5 years) and 57 AA (w = 51%, 22.2 ± 2.1) were included for retrospective evaluation. Table 1 shows the characteristics of the athletes in both groups with subdivision to disciplines (CA), respectively, discipline group (AA). In total, 100 CA had been invited to present themselves for a dental check-up in 2019; 88% attended.

3.2 | Orofacial findings

The mean DMF-T of the groups showed no significant difference (CA: 2.7 ± 2.2 vs. AA: 2.3 ± 2.2; $p = 0.275$). 34% of CA and 19% of AA had untreated caries ($p = 0.06$). Nevertheless, CA had in average statistically significantly more untreated decayed teeth (0.6 ± 1.0) than AA (0.3 ± 0.7; $p = 0.046$). Both groups showed erosive tooth wear of low severity (BEWE about 3.5) and mean plaque levels below 1. All athletes showed signs of gingival inflammation, but on average of low severity (PBI <1). In CA, a higher prevalence of increased probing depths indicating signs of periodontitis (maximum PSI score 3 in 40% vs 12%; $p < 0.001$) was revealed. A higher prevalence of signs of TMD was stated for CA (43%) than AA (25%; $p = 0.014$). More detailed further data are shown in Table 2.

The disciplines running and biathlon were analyzed in more detail by subgroup analysis (Table 3): Runners (R) showed compared to biathletes (B) an increased mean of filled teeth (R: 2.4 ± 1.9, B: 1.3 ± 1.5; $p = 0.017$) as well as a higher mean of a cumulative score of non-carious wear (R: 4.3 ± 2.8, B: 3.1 ± 2.2; $p = 0.036$). PI was statistically significantly higher in biathletes than in runners (B: 1.0 ± 0.4, R: 0.7 ± 0.4; $p = 0.003$). For all disciplines of CA separately, oral health findings are presented in Table S1.

TABLE 1 Characteristics of the study participants

	n	Age in years [mv ± SD]	Gender female [*n* (%)]
Competitive athletes			
Total	88	20.6 ± 3.5	45 (51.1)
Running	39	22.7 ± 3.4	13 (33.3)
Biathlon	27	18.0 ± 1.5	15 (55.6)
Cross-country skiing	10	18.4 ± 0.7	5 (50.0)
Rowing	8	23.8 ± 1.2	8 (100.0)
Triathlon	4	17.0 ± 2.0	4 (100.0)
Amateur athletes			
Total	57	22.2 ± 2.1	29 (50.9)
Sport students[a]	23	21.8 ± 2.1	10 (43.5)
Endurance	15	23.3 ± 1.4	8 (53.3)
Team sports	9	21.8 ± 2.6	3 (33.3)
Power	7	22.4 ± 2.1	5 (71.4)
Other	3	21.0 ± 1.7	3 (66.6)
p-Value		<0.001	1.000

Abbreviations: mv, mean value; n, number of participants; SD: standard deviation

[a]Sport students at the university with several disciplines.

3.3 | Oral health behavior and periodontal symptoms

74 CA and 57 AA completed the questionnaires about oral health behavior and periodontal symptoms. The results are presented in Figure 1. For all participants, tooth brushing was reported to be a daily routine, and nearly all participants rated a clean/healthy dentition as important or very important. However, less than 80% of the athletes (CA: 75.7%, AA: 71.9%; $p = 0.69$) reported regular dental check-ups. Only about a half of CA and a third of AA ($p = 0.076$) stated to go regularly for professional teeth cleaning. Less CA than AA (CA: 79.5%, AA: 93.0%; $p = 0.044$) reported having received oral hygiene instructions. Oral health behavior of biathletes and runners did not differ significantly. No group differences in reported periodontal symptoms could be found. More than a quarter of the athletes stated bleeding or sensitive gums, or sensitive teeth.

3.4 | Associations of clinical findings and oral health behavior

For both groups, no associations between decayed teeth and oral health behavior were found (Table S2). Less CA with signs of periodontitis stated regular professional teeth cleaning than those without having increased probing depths (25% vs 57%; $p = 0.009$). In AA, none associations

TABLE 2 Oral health of competitive and amateur athletes

	Competitive athletes ($n = 88$)	Amateur athletes ($n = 57$)	p-value
Dental findings [mv ± SD]			
DMF-T	2.7 ± 2.2	2.3 ± 2.2	0.275
D-T	0.6 ± 1.0	0.3 ± 0.7	**0.046**
M-T	0.1 ± 0.5	0.0 ± 0.1	0.818
F-T	2.0 ± 1.9	2.0 ± 2.1	0.933
BEWE	3.6 ± 2.5	3.4 ± 1.9	0.859
Oral hygiene [mv ± SD]			
Plaque Index (PI)	0.8 ± 0.4	0.6 ± 0.3	**<0.001**
Gingival Inflammation (PBI)	0.5 ± 0.3	0.5 ± 0.2	0.589
Periodontal screening [mv ± SD]			
max. PSI = 1	3 (3.4)	6 (10.5)	0.155
max. PSI = 2	50 (56.8)	44 (77.2)	**0.013**
max. PSI = 3	35 (39.8)	7 (12.3)	**<0.001**
Partially erupted wisdom teeth [n (%)]	13 (14.8)	14 (24.6)	0.190
Positive TMD screening [n (%)]	40 (45.5)	14 (24.6)	**0.014**

Abbreviations: BEWE, basic erosive wear examination; DMF-T, decayed-, missing- and filled-teeth index; D-T, decayed teeth; F-T, filled teeth; M-T, missing teeth; mv, mean value; PBI, papillary bleeding index; PSI, periodontal screening index; SD, standard deviation; TMD, temporomandibular disorder.

Bold marks significant differences ($p < 0.05$).

between clinical findings and self-reported oral health behavior were found.

4 | DISCUSSION

4.1 | Summary of the main results

In general, young athletes (AA and CA) showed a high prevalence of signs of periodontal disease, primarily gingival inflammation. Comparing CA and AA, CA showed statistically significantly more decayed teeth, a higher prevalence of positive TMD screening findings, elevated periodontal treatment need (increased probing depths). Both groups reported similar oral health behavior with potential for improvement.

4.2 | Interpretation compared to the available literature

For CA, the present study revealed less caries[14] and erosion[16] and similar oral health behavior,[2,15,18,21] but more periodontal treatment need than previous studies.[13] About one-third of CA had untreated carious lesions, and therefore, less than world-wide estimated (prevalence of caries in athletes: 46%).[14] Both groups showed lower DMF-T values than other studies on elite athletes in industrialized countries (4.8 to 5.7; mean age between 21 and 27 years).[2,15,18] Higher values observed in German triathletes (DMF-T = 9.7; medium age: 37 years)[16] could be explained by the high age-dependence of this parameter.

Erosion has been researched as one key point in athletes' oral health, and its general prevalence in these individuals is estimated as 47%.[20] The present study determined non-carious wear (tooth surface loss) of low severity in both groups (BEWE about 3.5), comparable to another study with competitive athletes (mean: 3.02, medium age: 26 years).[18] Potentially, with increasing age, higher values and group differences could become apparent as erosion is a long-term effect, for example, by intake of acid sport drinks. So, another German study described a medium level of erosive wear for triathletes (mean age: 37 years; mean BEWE: 9.6, control group: low level, 7.3).[16]

In both groups, mean PI and PBI were generally low (<1; Table 2), also in comparison to other studies which employed different indices.[2,15] However, in CA, the prevalence of significant signs of periodontal diseases (40%) was higher than the values from previously reported studies of 5% to 21%[3,4,17,18] and higher compared with AA at 12%. In this young age, moderately elevated periodontal pockets (none above 5.5 mm) could be a sign of gingivitis or initial periodontitis. Nevertheless, the data report a significant treatment need to manage periodontal health. A detailed periodontal examination in footballers (mean age: 28 years) reported a similar prevalence of periodontitis (41%), with the diagnosis of a moderate or severe stage in only two individuals (9%).[19]

TABLE 3 Subgroup analysis of oral health in competitive athletes for the disciplines running and biathlon

	Running ($n = 39$)	Biathlon ($n = 27$)	p-value
Dental findings [mv ± SD]			
DMF-T	2.8 ± 2.2	2.0 ± 2.0	0.162
D-T	0.5 ± 0.9	0.7 ± 1.2	0.418
M-T	0.0 ± 0.0	0.0 ± 0.0	n. a.
F-T	2.4 ± 1.9	1.3 ± 1.5	**0.017**
BEWE	4.3 ± 2.8	3.1 ± 2.2	**0.036**
Oral hygiene [mv ± SD]			
Plaque Index (PI)	0.7 ± 0.4	1.0 ± 0.4	**0.003**
Gingival Inflammation (PBI)	0.5 ± 0.3	0.6 ± 0.3	0.193
Periodontal screening [mv ± SD]			
max. PSI = 3	11 (28.2)	15 (55.6)	0.214
Partially erupted wisdom teeth [n (%)]	2 (5.1)	7 (25.9)	0.151
Positive TMD screening [n (%)]	20 (51.3)	12 (44.4)	0.312

Abbreviations: BEWE, basic erosive wear examination; DMF-T, decayed-, missing- and filled-teeth index; D-T, decayed teeth; F-T, filled teeth; M-T, missing teeth; mv, mean value; n. a., not applicable; PBI, papillary bleeding index; PSI, periodontal screening index; SD, standard deviation; TMD, temporomandibular disorder.

Bold marks significant differences ($p < 0.05$).

Almost 15% of the CA had partially erupted wisdom teeth. The status of wisdom teeth has sports-medical relevance as they present a risk of developing symptomatic pericoronitis leading to severe pain and difficulties in both oral function and lifestyle,[37] and therefore, potential treatment need during competitions.[4,38] A study on Dutch elite athletes described higher recommendation rates of wisdom tooth removal (22%).[18] Furthermore, the proportion of AA with partially erupted wisdom teeth was higher (about 25%) than in CA. Consequently, this point seems already to be considered in athletes' care in Germany.

More than 40% of the CA were suspected of having TMD by screening and suggesting a need for more detailed clinical functional analysis. The literature reports a wide range of TMD in athletes (between 12% and 100%) and is difficult to compare due to different methodological approaches.[39] The current study showed a statistically significantly higher prevalence in CA than AA (Table 1). This is in line with a study on karate athletes (54% in competitive vs. 18% in recreational athletes).[40] Whereas available data were based on contact-sports,[39] the present study verified the elevated prevalence also for non-contact sports.

The determined personal oral hygiene (Figure 1A), as well as self-reported oral symptoms (Figure 1B), were similar to the results of other studies. Daily toothbrushing was frequent,[18,41] but less than one-half of the participants reported performing interdental cleaning,[21] which is important to maintain periodontal health.[32] Regarding the use of professional dental services, more than 20% did not regularly attend a dentist for examinations. Other studies reported comparable or lower rates of dental visits in the last 12 months.[2,4,15,18] The association between regular professional teeth cleaning and no signs of periodontitis in CA underlines the importance of professional support for prevention. The prevalence of oral symptoms in CA (Figure 1B) was similar to reported data in literature: 8% to 10% for pain related to teeth,[3,17] 39% to 60% for bleeding gums,[2,3] and 23% to 27% for sensitive teeth.[3,17,41] As the oral health status was slightly worse in CA, this could suggest a different perception of oral health in CA.

All in all, it is remarkable that neither the oral hygiene (PI, PBI) nor the self-reported oral health behavior can explain the higher prevalence of periodontal treatment need in CA. Consequently, another factor seems to affect elite athletes' periodontal tissues. Therefore, a systemic impact of the physical stress of elite sports on oral inflammation should be investigated.

Regarding the comparison between runners and biathletes, some minor differences in oral health status (F-T, BEWE) but not in oral health behavior have been observed. On the one hand, besides the disciplines, the higher mean age of the runners (on average four years older) could influence these highly age-dependent parameters. On the other hand, runners are expected to be high consumers of sport nutrition as sport drinks and carbohydrate gels leading to a high risk for both caries and non-caries wear. Further studies on risk factors specific for the different sports disciplines are necessary.

4.3 | Strengths and limitations

An apparent strength of the study is the comprehensive orofacial examination. To the authors' knowledge, this is the first study on athletes evaluating dental (caries and erosion), periodontal, and functional aspects in the same cohort. In combination with the detailed information about oral health behaviors and periodontal symptoms, an overall appraisal of the athlete's oral health is possible. The same skilled dentist performed all examinations. CA were clearly serious elite athletes as they were all current members of the German national teams and national perspective and youth squads. They were active in competitive sport for already seven years and trained about 17 h per week. The AA group can be regarded as control group because of similar age and same gender ratio, same origin and examination with the same protocol by the same

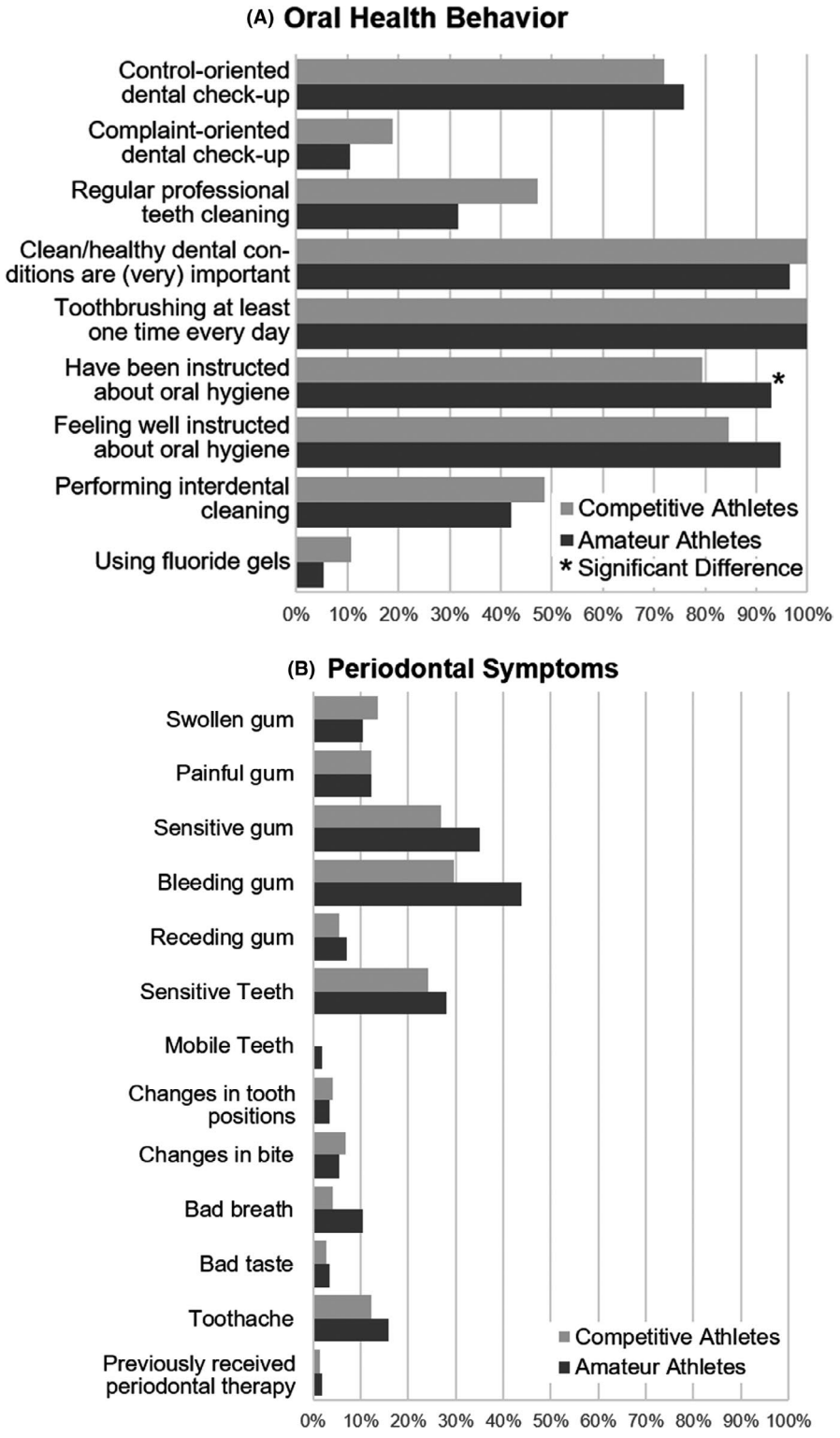

FIGURE 1 Results of Questionnaires about Oral Health Behavior (A) and Self-reported Periodontal Symptoms (B)

skilled dentist. This is important as the majority of studies on athletes do not include controls. Furthermore, AA as a control group helps to generate possible hypotheses on competitive sports as a risk factor.

Limitations of the study include the lack of a radiographic examination. As a result, the prevalence of caries could be underestimated,[42] and no statement about totally retained or impacted wisdom teeth is possible. Neither signs nor symptoms of pericoronitis were recorded. As no periodontal chart was determined, no information about attachment loss is available, and thus, the prevalence of periodontitis cannot be clearly stated. Furthermore, a separate evaluation for some disciplines is not meaningful regarding the very small number of athletes. Moreover, despite multiple testing no Bonferroni correction was used in this first retrospective pilot study. Consequently,

the interpretation of the statistics needs caution considering the potential risk of type 1 error. For some outcomes, differences between the different disciplines were seen (Table S1). Nevertheless, subgroup sizes were too small for drawing conclusions and also the comparison of biathletes and runners has to be interpreted with caution.

There are some potential risks for bias: Both groups have selection bias as attending dental check-ups was voluntary. Neither examination nor data extraction was blinded. Examination settings differed as AA were examined at a dentist's chair and CA at an examination couch with a headlight. In general, the comparison to AA could be criticized as they are physically active, too, and does not allow comparison to the general population. Furthermore, for interpreting the data, differences in performed sport disciplines between the groups have to be considered: While CA were all endurance athletes of five disciplines, AA included various disciplines, also power and team sports. About 40% of AA did several sports as they studied sports at university. This could lead to a less specific risk profile of AA, and therefore, could be another source of potential group difference.

Despite these limitations, these first data for elite athletes in Germany suggest differences in oral health may exist compared with recreational athletes. Further prospective and longitudinal research is needed to obtain results from a larger sample of athletes. Factors related to health status including health behaviors, knowledge, and beliefs among the athletes and their support network (parents/carers, coaches, sports scientists, etc.) should be considered. Especially, a possible systemic influence of the intensive sport should be investigated. Dental care programs for this population group could improve the oral health status.

5 | PERSPECTIVE

In general, young German athletes (CA and AA) showed signs of gingival inflammation and needed to improve their oral health behavior. CA showed more D-T and a higher prevalence of significant signs of periodontitis and positive TMD screening findings than AA, but comparable oral health behavior and oral hygiene. This may imply an additional systemic influence factor of elite sports on oral inflammation, and therefore, an increased need for dental care. Prospective studies on physical stress and oral inflammation should investigate this hypothesized interaction. Furthermore, prospective longitudinal studies with more participants of different disciplines and age groups will be important to determine risk levels and determinants of disease in competitive sports. Subsequently, special oral health promotion strategies should be discussed.

ACKNOWLEDGMENTS

The authors acknowledge support from Leipzig University for Open Access Publishing. Open access funding enabled and organized by ProjektDEAL.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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How to cite this article: Merle CL, Richter L, Challakh N, et al. Orofacial conditions and oral health behavior of young athletes: A comparison of amateur and competitive sports. *Scand J Med Sci Sports*. 2022;32:903–912. doi:10.1111/sms.14143