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CLINICAL FEATURE
ORIGINAL RESEARCH

Oral health among Dutch elite athletes prior to Rio 2016

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ABSTRACT

Objectives: Elite athletes are at high risk for poor oral health. A screening program to assess oral health and create dental awareness can improve oral health among elite athletes but has not been performed in the Netherlands before. We summarize the first results from such a screening conducted in Dutch elite athletes of the Nederlands Olympisch Committee*Nederlandse Sport Federatie (NOC*NSF, Dutch Olympic Committee).

Methods: In this cross-sectional study, 800 Dutch athletes eligible for the Olympic and Paralympic Games in Rio de Janeiro 2016 were invited to a costless and voluntary oral examination. The decayed, missing, and filled teeth-index (DMFT), the basic erosive wear examination (BEWE) and the Dutch Periodontal Screening-index (DPSI) were used to evaluate athlete's oral health. Information on socio-demographic variables and sport performance were collected in questionnaires.

Results: In total, 116 Dutch elite athletes were included in the study. The median (90%-range) DMFT-score was 3.0 (0.0–16.0), the median BEWE-score was 2.0 (0.0–10.0), and the mean± SD DPSI-score was 2.0 ± 0.73. Oral health-related quality of life was generally high, although only 28.2% of the athletes reported never having problems with their dentition or mouth. In 43% of the athlete's clinical findings were reported which needed a direct referral to the general dentist.

Conclusion: Oral health in this subsample of Dutch elite athletes was surprisingly affected as almost half of them needed dental treatment. Further research is needed to allow conclusions about oral health in Dutch elite athletes more broadly. However, regular screening of oral health incorporated into the general preventive health care of elite athletes is necessary to ensure athletes are fully healthy during competitions like the Olympic and Paralympic Games.

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Introduction

Oral health is, according to The World Health Organization (WHO), defined as, a state of being free from mouth and facial pain, oral and throat cancer, oral infection and sores, periodontitis, tooth decay, tooth loss, and other diseases and disorders that limit an individual's capacity in biting, chewing, smiling, speaking, and psychosocial wellbeing. [1]

Oral health is nowadays recognized as being an important part of general health [2]. Poor oral health has a big impact on well-being, functioning, and quality of life. Although poor oral health is preventable, the prevalence of oral diseases remains high among various population groups. Of note, elite athletes appear to be at high risk for poor oral health [3].

Traditionally, oral health research among athletes focused mostly on orofacial traumatology [4]. However, several recent studies targeted at the poor oral health of athletes provide a contrast to the otherwise healthy athlete. These studies have been conducted in various sports, but most commonly among Olympic athletes and footballers. In the UK, Spain and Brazil it was shown that professional footballers have worse oral health compared to the general population [4–6]. Similarly, athletes from Olympic sports present a high prevalence of dental caries in different studies [7–11]. Less is written about the actual impact of oral health on athletes' quality of life and performance. Only two studies reported that poor oral health is associated with negative self-reported impacts on training, performance, and well-being [7,12].

There are different reasons behind the high risk to poor oral health among elite athletes. First, sport nutrition might conflict with oral health due to frequent consumption moments and high sugar content [13]. Second, endurance sports might compromise dental health due to changes in saliva composition [14]. Third, athletes are supposed to have an irregular lifestyle with limited priority to oral health, while oral health behavior is an important determinant of oral health [15]. Lastly, oral health has in most countries not been integrated into the standard preventive care for athletes [16]. The fact that elite athletes are at high risk for poor oral health which in turn affects their performance, points to the need for action. A screening program for athletes is one measure to possible improve oral health among professional athletes. Therefore, we offered an extensive oral health screening program to all Dutch elite athletes in the preselection for the Olympic and Paralympics Games 2016 in Rio de Janeiro. The

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Supplementary data for this article can be accessed here.

purpose of this program was to assess oral health and to create dental awareness prior to the Olympic Games. In this study, we summarize the findings from this screening about the prevalence of oral disease, oral health behaviour, and the acceptance of a free and voluntary oral health screening among Dutch elite athletes.

Materials and methods

Study design and population

We performed a cross-sectional study at five different oral health-care centers in the Netherlands: Heerenveen, Arnhem, Amsterdam, Eindhoven, and Rotterdam. An invitation to a free dental screening was sent by email to all Dutch elite athletes eligible for participation in Rio 2016. The athletes were asked to make an appointment at the oral health-care center that was most easily accessible to them. The athletes had a period of 10 months to schedule the screening. After having made an appointment, a questionnaire was sent by email to the athlete, which was completed before the oral examination started. During the oral health screening by experienced dentists different oral health measures were assessed and finally the athlete received a referral letter for the follow-up of his/her oral health including reported clinical findings. This letter was sent to the dental practitioners of the participants and the office of the medical staff of the NOC*NSF. After making the referral letters anonymous the different findings were categorized into dental decay, gingivitis, periodontitis, wisdom teeth removal, erosion, endodontic treatment, and other.

The study is conducted in compliance with the STROBE-guidelines, which can be found in the supplemental material [17]. The study protocol followed the ethical principles of the Declaration of Helsinki. Informed consent was obtained from all participants before the data of the oral examination and the questionnaires were used for this study. The study protocol was reviewed and approved by the ethical committee of the Erasmus Medical Centre, Rotterdam, The Netherlands (MEC-2014-555).

Dental examination

The oral health assessments were carried out by five experienced dentists currently working in a dental practice. Before the program started, a meeting with the involved dentists was initiated to train them on the clinical scoring methods. During the study, the main researcher (LK) was contacted by the dentists or has visited them to assist when problems during the oral examination were experienced. All dentist were familiar with the clinical indices. The oral examination was conducted using standard methods in dentistry. The following validated oral health parameters were assessed:

First, the diseased, missing, and filled teeth index (DMFT) was used for the assessment of caries experience. The DMFT index expresses the total number of teeth that are either decayed, missing, or filled in an individual and has maximum range from 0 to 20. Second, dental erosion was assessed with the basic erosive wear examination index (BEWE). The BEWE records the by erosion most severely affected teeth in each sextant on a four-level scale. The scores of each sextant are summed for the final BEWE-score, which has a maximum range from 0 to 18 [18]. Periodontal health was assessed with the Dutch Periodontal Screening Index (DPSI). The DPSI Index is based on the health of the periodontium and depth of eventual pockets and the worst periodontium of one of the sextants gives the final DPSI-score having a maximum range from 0 to 4 [19].

In addition, the dentist noted the general impression of the oral cavity, the dentition, and the mucosa. In case of an indication, the dentist made a panoramic radiograph to identify odontogenic foci like alveolar bone loss related to periodontitis, cyst formation, periapical granulomas, or impacted teeth.

Questionnaire assessment

Questionnaire data included demographics (age, gender, education, ethnicity, height, and length), sport performance (duration of sports per week), oral health behavior (smoking, tooth brushing, frequency, and reasons for dental visits), nutritional information (consumption of sugary drinks and snacks), and impacts of oral health on well-being, training, and performance. For the latter, we used the Oral Health Impact Profile-14 (OHIP-14), which is a validated Dutch oral health-related quality of life (OHRQOL) questionnaire. The OHIP-14 consists of 14 items that assess the dysfunction, discomfort, and disability attributed to oral conditions [20,21]. The questions have a time reference of 3 month and the answers are given on a five-level Likert scale from never (0) to always (4). A higher OHIP-14 score indicates lower OHRQOL on a range from 0 to 56. Furthermore, the athletes were asked whether their oral health impaired their quality of life in the past 3 months, their sports performance or their training, whether they missed a training session or a competition and how often they missed a training session or competition due to their oral health.

Statistical analysis

Descriptive statistics were used to characterize the study population. The distribution of numerical variables was examined visually by histograms. Differences in demographics according to the sport variables were evaluated with the chi-square test and Fishers exact test. The sport variable was categorized into two groups, both based on the responses of the athletes and considering comparable group sizes. Subsequently, athletes were divided in doing more than 20-h sports a week or doing less than 20-h sports a week. For the main analysis, oral health variables according to the sport variable were assessed using chi-square tests for categorical variables and Mann–Whitney-*U*-tests or *t*-tests for continuous data. Finally, the athletes were grouped based on their socioeconomic status (SES) (educational level), and the oral health was compared between those strata using one-way ANOVAs and Kruskall Wallis tests. For all statistical tests, a p-value < 0.05 was used as significance level. The statistical analyses were performed in SPSS Statistics 21.0 (IBM Corp., Chicago, IL, USA).

Results

In total, 116 Dutch elite athletes participated in the study. Of these, five answered the questionnaire only but did not show up for the oral examination and one came to the oral examination only but did not complete the questionnaire.

In Table 1, the characteristics of the study population are presented. The mean age of the athletes was 25.84 (±5.82), the majority was female (76%), more than half were higher educated (52.6%), and almost all were native Dutch (98.3%). Of all athletes, 82.8% brushed their teeth twice or more a day and 81.0% visited the dentist in the past year. The demographic variables did not significantly differ between athletes with poorer and better oral health.

The prevalence of the oral health variables in the study population are given in Figure 1. All oral health variables, except the DPSI-score, were non-normally distributed. The median (90%-range) DMFT-score was 3.0 (0.0–16.0), the median BEWE-score was 2.0 (0.0–10.0), and the mean± SD DPSI-score was 1.71 ± 0.73. Also, OHRQOL was generally high with a median (90%-range) score of 2.0 (0.0–10.0). Nevertheless, 15% of all athletes had a DMFT-score > 10, which indicates poor oral health. There was no evidence of a statistically significant difference in DMFT-scores and DPSI-scores between SES strata based on educational level of the athletes. However, there was evidence of a statistically significant difference in BEWE scores between SES strata (Table 2).

The majority of the athletes (69.0%) trained more than 20 h a week. Athletes that were performing more than 20 h of sports a week had significantly lower OHRQOL (p-value = 0.03)

Table 1. Characteristics of the study population.

	n (%)	
n	116	Missing information
Gender		
Men	40 (34.5)	
Women	76 (65.5)	0.0%
Age		
Mean ± SD	25.84 ± 5.82	0.0%
Education[a]		
Low	8 (0.6)	
Middle	47 (40.5)	
High	61 (52.6)	0.0%
Ethnicity		
Dutch	114 (98.3)	
Other	2 (1.7)	0.0%
Smoking		
Never	112 (96.6)	
Less than five times a week	4 (3.4)	0.0%
Duration sport per week		
≤ 20 h	36 (31.0)	
> 20 h	80 (69.0)	0.0%
Number of sports		
1 sport	86 (74.1)	
2 sports	16 (13.8)	
More than 2 sports	14 (12.1)	0.0%
Tooth brushing		
Once a day	19 (16.4)	
Twice or more a day	96 (82.8)	0.9%
Dental visits in the last year		
Yes	94 (81.0)	
No	21 (18.1)	0.9%
DMFT-score		
Median (90% range)	3.0 (0.0–16.0)	4.3%
BEWE-score		
Median (90% range)	2.0 (0.0–10.0)	4.3%
DPSI-score		
Mean ± SD	1.71 ± 0.73	4.3%
OHRQOL		
Median (90% range)	2.0 (0.0–10.0)	0.9%
Missed training due to oral health		
Yes	4 (3.0)	0.9%
Oral health impacted their life		
Yes	31 (27.3)	0.9%
Oral health affected their training		
Yes	12 (10.0)	0.9%
Have had problems with their mouth		
Yes	81 (71.8)	0.9%

Numbers are frequencies (percentages) for categorical variables and means with standard deviation (age) or medians with 90 % range for continuous variables.
[a]Education: low = <4 years of high school, middle = college, high = Bachelor's/Master's degree.
OHRQOL: oral health-related quality of life; DMFT: decayed, missing, and filled teeth; BEWE: basic erosive wear examination; DPSI: Dutch periodontal screening index.

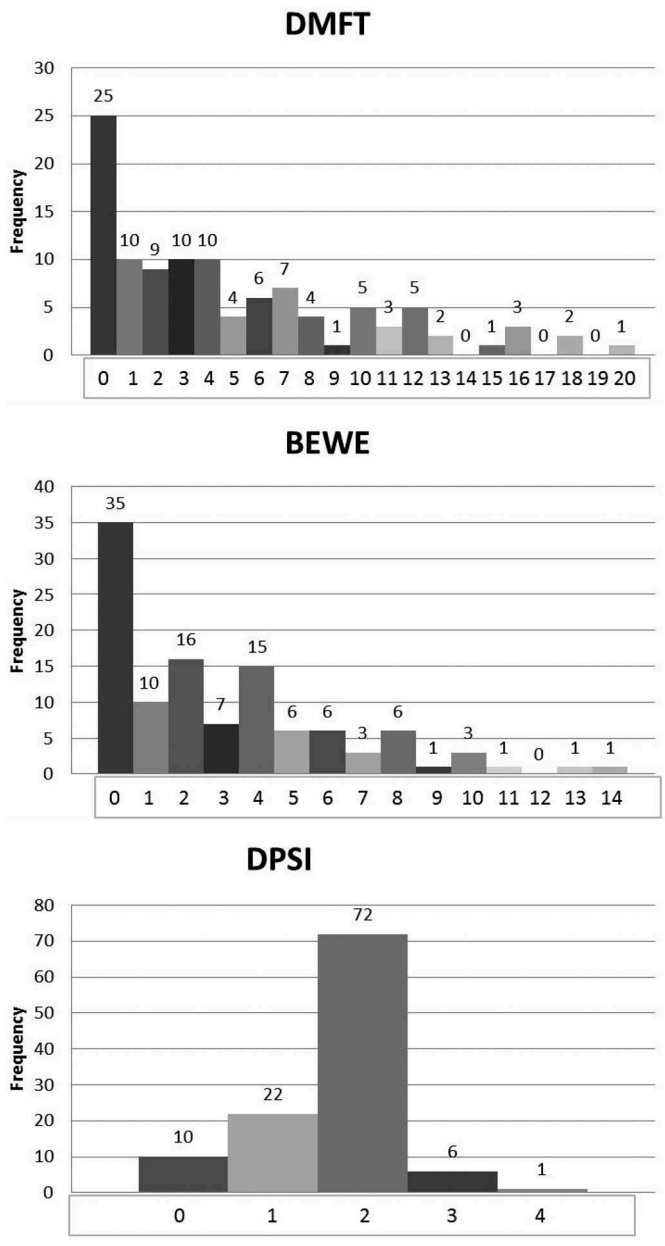

Figure 1. Prevalence of the oral health variables in the subsample of Dutch elite athletes (n = 111). DMFT: decayed, missing, and filled teeth; BEWE: basic erosive wear examination; DPSI: Dutch periodontal screening index.

Table 2. Oral health variables by SES strata based on educational level (n = 111).

	Low	Middle	High	p-Value
	n = 8	n = 43	n = 60	
DMFT-score				
Mean ± SD	5.25 ± 6.38	4.23 ± 4.58	5.28 ± 4.95	0.553
Median (90% range)	3.5(–)	3.0(0–12)	4.0(0–16)	0.500
BEWE-score				
Mean ± SD	5.0 ± 3.85	2.18 ± 3.04	3.35 ± 3.11	**0.035**
Median (90% range)	5.0(–)	1.0(0–9)	3.0(0–10)	**0.014**
DPSI-score				
Mean ± SD	1.62 ± 0.52	1.72 ± 0.77	1.68 ± 0.77	0.935
Median (90% range)	–	–	–	–

Numbers are percentages for categorical variables and medians with 90% range for continuous variables.

OHRQOL: oral health-related quality of life; DMFT: decayed, missing, and filled teeth; BEWE: basic erosive wear examination; DPSI: Dutch periodontal screening index; p-values are based on one-way ANOVAs and Kruskall Wallis tests.

Table 3. Dental characteristics by duration of sports per week (n = 110).

	≤20 h	>20 h	p-Value
	n = 35	n = 75	
General oral cavity			
Abnormal	2.9%	2.7%	1.00
General dentition			
Abnormal	2.9%	14.7%	0.09
General mucosa			
Abnormal	11.4%	8.0%	0.72
OHRQOL			
Median (90% range)	1.0 (0.0–6.2)	2.0 (0.0–10.0)	**0.03**
DMFT-score			
Median (90% range)	3.0 (0.0–15.2)	4.0 (0.0–16.4)	0.70
BEWE-score			
Median (90% range)	2.0 (0.0–10.6)	2.0 (0.0–10.0)	0.46
DPSI-score			
Mean± SD	1.71 ± 0.67	1.71 ± 0.77	0.96
Dental visit			
In the past year	17.1%	17.3 %	1.00
Tooth brushing			
≥2 times a day	97.1%	77.3%	**0.01**

Numbers are percentages for categorical variables and medians with 90 % range for continuous variables.

OHRQOL: oral health-related quality of life; DMFT: decayed, missing, and filled teeth; BEWE: basic erosive wear examination; DPSI: Dutch periodontal screening index; p-values are based on Fishers Exact tests, Mann Whitney U tests or t-test; significant results are bold.

and tended to have a higher DMFT-score (ns) than athletes that did less than 20-h sports a week (Table 3). However, there was no evidence of a statistically significant difference in oral health between athletes that trained more or less.

Only 3% of the athletes missed one training or competition due to their oral health, but 27.3% reported that their oral health has impacted their quality of life. Although, 90% reported that their oral health has never affected their training, only 28.2% of the athletes reported to have never problems with their mouth.

In 43.0% of the athletes, clinical findings were reported, and these athletes were requested to contact their dentist for additional consultation and treatment. Of these, 22 (19.8%) were diagnosed with dental decay, 24 (21.6%) were advised to have one or more wisdom teeth removed, 24 (21.6%) were diagnosed with gingivitis (red, swollen gingiva that bleeded after probing), and one case (0.9%) was diagnosed with periodontitis with alveolar bone loss. Furthermore, two athletes (1.8%) needed an endodontic treatment, in eight cases (7.2%) erosion was noticed, and five athletes (4.5%) demonstrated decay as well gingivitis and need for removal of one or more wisdom teeth.

Discussion

Summary main result

We invited 800 Dutch athletes prequalified for the Olympic Games in Rio 2016 to a costless and voluntary dental screening. Unfortunately, the response rate was relatively low (14.5%). The dentition of this sub-sample of Dutch athletes was quite affected in terms of erosion, periodontal health and caries experience and almost half of them had an indication for direct referral to a dentist. This is remarkable considering 81% of the respondents reported having visited their dentist in the previous year.

Comparison with other studies

We did not include a control group of non-athletes in this study. However, we compared athletes based on the training hours per week. This comparison has not been done previously in the literature, thus the results are difficult to compare. Still, we found lower OHRQOL and a higher DMFT-score among athletes doing more sports. This might be an indication for the hypothesis that conducting sports increases the risk to poor oral health. Still, we cannot determine the underlying mechanism behind it, whether it is due to frequent sugar intake, a change in saliva composition or because of an irregular lifestyle.

A recently conducted review of oral health of elite athletes showed that caries occurred in up to 75% of athletes [4]. In the present study, the prevalence of caries experience was the same, however, only a small group had severe caries experience (15% with DMFT > 10). This prevalence of caries is definitely in contrast with the expected good health of an athlete, but appears similar to the oral health in the general Dutch population [22]. Looking at the Dutch population with a similar age (21 years), the mean DMFT± SD value was estimated to be 3.1 (± 3.6) among the high SES groups and 4.4 ± 4.5 among the low SES groups in 2011 [22]. Still, possibly because only a small subsample of Dutch elite athletes participated in the present study, we could not replicate a high mean DMFT of above six as was shown in studies conducted among cyclists, footballers, swimmers, and wrestlers [5,23,24]. Not many other studies evaluated periodontal health among athletes and comparison with previous studies is difficult because various periodontal measures have been used. Generally, when information on periodontitis was provided, prevalence seemed rather low [25,26]. Gingivitis, however, is very common among elite athletes with prevalence ranging between 60% and 75% [26,27]. Comparable, our sample had a gingivitis prevalence of 64% and a mean± SD DPSI-score of 1.71 ± 0.73, which is equivalent to the presence of some hardened dental plaque or overlapping dental restorations and bleeding after probing. In only one athlete, deep pockets were noted. Tooth wear is also rarely reported in other studies, but seems to have a relatively high prevalence of 40–85% among cyclists, Olympic athletes and swimmers [23,26]. The median BEWE-score in our sample was 2.0, which requires only routine maintenance and observation in a 3-year interval [28]. The prevalence of tooth erosion, however, in our sample was (59%), which is double as high than in a comparable group of Dutch non- athletes of similar age (20–25%) [22].

Although OHRQOL was relatively high in our sample, and the impact of oral health on quality of life, training, and sport performance was low, around 70% of the athletes reported having problems with their teeth and mouth. The substantial negative impact of oral health on well-being and sport performances shown by the study of Needleman et al. was not apparent among the Dutch athletes participating in the current study [26]. Yet, the comparison with this study remains difficult since Needleman studied athletes of the London Olympic Games 2012 who visited the dental clinic within the athletes' village. These athletes had a particular reason to visit the dental clinic and originated from various countries including developing countries and therefore their oral health is likely to be worse compared to the oral health of Dutch elite athletes that voluntarily participated in an oral health screening [26].

Striking is that Dutch athletes did not prioritize oral health in the preparation for their performance and competitions. Although different attempts were repeatedly applied to invite the athletes for the costless oral examination, like direct invitation letters or advertisements in newsletters, the response rate remained low. Only after having involved the team doctors, participant inclusion of the present study raised. This indicates that dental care and oral health has an image of minor importance among elite athletes. Therefore, it seems necessary to make oral health an integral part within general care of athletes, as general health has commonly a high status among elite athletes.

Discussion unexpected results

Based on the recent literature on oral health in elite athletes, we expected worse oral health in our sample. Also, it has been reported that dental consultations during the Olympic Games have increased, which speaks for poor oral health among athletes [16]. Maybe, because the oral health screening was not obligatory, the more oral health conscious athletes replied to the present study, which might have led to the better oral health than expected in the current sample. Literature indicates that although the number of consultations during competition phases increase, the severity of these dental consultations decrease [25]. This could mean that athletes do not have poorer health than the general population or that their quality of life and performance is not more affected by oral health than that of the general population, but just that the elite athlete generally cannot afford the basic need for regular oral health care. This in turn would also be in line with the results from the present study, in which 43% of the athletes were in need for dental treatment. As oral health is an integral part of general health, it is even more suspicious that preventive oral health care is not a common part of the health programs offered to the athletes by the Nederlands Olympisch Committees [16]. Preventive oral health care has the potential to eliminate (non-)urgent dental care during Olympic Games and other competitions and might keep the athletes focused on their performance and recovery during competition phases.

Strength & limitations

A definite strength of our study is the comprehensiveness of the oral health assessment in an athletes' sample that visited the dentist without a particular complaint.

Still, some limitations of this study have to be addressed. Unfortunately, this study has a low sample size ($n = 116$). Many athletes spend considerable time abroad practicing their sport outside the Netherlands. For those it might have been problematic to schedule a dental visit, although the oral health screenings were offered within a time span of 10 months, which was reasonable time to plan a screening ahead. The relatively low response showed the low priority given to oral health by Dutch elite athletes. Because of this small sample, which also might be rather oral health conscious, the prevalence of oral disease among elite athletes is likely to be underestimated by the present study. Also, no control group was included in the current study; however, we were able to compare the results of our study sample with the results of a recently conducted oral health survey among 21- and 23-year-old Dutch non-athletes [22]. Still, we could not adjust this comparison for gender or SES, which are both variables of influence on oral health and therefore the comparison needs to be interpreted carefully. Because the subsample of Dutch elite athletes in the current study had proportional more female and higher educated athletes included, the oral health might be additionally overestimated [29,30]. For reasons of data anonymity, we did not assess which specific kind of sport was performed by the participants. In this way, we could not distinguish between the effect of endurance and strength training, which might differently affect oral health as suggested by Gallagher et al. [11]. As in all observational studies, the accuracy of our results might be limited by information bias. Due to social desirability, athletes might have filled in the questionnaire in a manner that is favored by their trainers, dentists, or themselves. We tried to limit the social desirability bias by keeping collection and linking of the data anonymous. Of course a dental referral cannot be completely anonymous, but in our opinion this was also in the interest of the athlete. Another source of information bias arises from the use of indices during the oral examination, like the DMFT, BEWE, and DPSI index. It is questionable how well these indices distinguish between good and poor oral health. However, these indices are commonly used for objective, quantitative, reproducible, and uniform oral examinations among different dentists and nowadays they have been used and validated extensively in the literature. Information bias generally leads to an attenuation of the associations, which would mean that the present study underestimates the relation between sport performance and bad oral health.

Future research

This study gave a general overview of the prevalence of oral disease, oral health behavior and dental attitude among a subsample of Dutch elite athletes. In the first instance, the results of the present study need to be replicated in a larger sample of Dutch athletes. Future research should also focus on the dental attitude of the athletes in terms of how they

perceive inclusion of oral health in the general preventive care and how they follow up the dentist's advice. This research should review why athletes would or would not attend oral health screening programs. Second, the effect of preventive oral health screenings on dental needs during competition phases should be researched.

Conclusion

The findings of the present study cannot be generalized to Dutch elite athletes more broadly, because the current study population might be more oral health conscious. Still, the oral health of this subsample of Dutch elite athletes was surprisingly affected as 43% of the athletes showed oral findings necessitating dental care. As athletes are expected to be particularly healthy and their final goal is top performance during the Olympic Games without interference of preventable dental problems one might expect not only more awareness of optimal oral health but also a higher response to preventive oral care. Regular screening of oral health incorporated into the general preventive health care of elite athletes is necessary to ensure fully healthy athletes during competitions like the Olympic Games.

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Declaration of interest

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