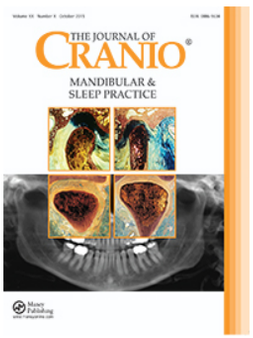

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Self-reported sleep bruxism among Finnish symphony orchestra musicians: Associations with perceived sleep-related problems and psychological stress

Maurits van Selms BDS, MSc, PhD[a], Janine Kroon DDS[a], Henri Tuomilehto MD, PhD[b], Miikka Peltomaa MD, PhD[c], Aslak Savolainen MD, PhD[d], Daniele Manfredini DDS PhD[e], Frank Lobbezoo DDS PhD[a] and Jari Ahlberg DDS PhD[f]

[a]Department of Orofacial Pain and Dysfunction, Academic Centre for Dentistry Amsterdam (ACTA), University of Amsterdam and Vrije Universiteit Amsterdam, Amsterdam, The Netherlands; [b]Department of Clinical Nutrition, University of Eastern Finland, Kuopio, Finland; [c]Department of Otolaryngology, University of Helsinki, Helsinki, Finland; [d]Department of Public Health, University of Helsinki, Helsinki, Finland; [e]School of Dentistry, Department of Biomedical Technologies, University of Siena, Siena, Italy; [f]Department of Oral and Maxillofacial Diseases, University of Helsinki, Helsinki, Finland

ABSTRACT

Objective: This study aimed to evaluate whether self-reported sleep bruxism among musicians is associated with sleep-related problems and/or psychological stress.

Methods: Eight hundred-thirty-one Finnish orchestra musicians completed a questionnaire that covered, among others, indicators of sleep-related problems, possible sleep bruxism, and stress.

Results: In total, 488 questionnaires were completed. The single variable ordinal logistic regression models revealed at least moderate associations between frequency of sleep bruxism and female gender, shorter sleep duration, longer sleep latency, problems in sleeping during concert season, feeling more often tired during the daytime, restless legs, a poor self-rated sleep quality, and more stress experience. The variables that remained in the final model were sleep duration, gender, and stress.

Conclusion: Musicians who sleep 7 hours or less per night report more sleep bruxism, as compared to those who sleep 8 hours or more. Female gender and high-stress experience were associated with more sleep bruxism.

KEYWORDS
Musicians; bruxism; sleep-related problems; stress

Introduction

Sleep is a complex amalgam of physiologic and behavioral processes [1]. To maintain good physical and mental health, adequate sleep is essential [2]. Unfortunately, satisfying sleep is not possible for everyone. The prevalence of sleep-related problems seems to have increased in recent years, and sleep disorders constitute one of the most persistent health problems in western society [3]. This is reflected in an increase in the number of visits to general practitioners for sleep-related problems and an increase in the prescription of sleep medication [4]. A recent epidemiological study, in which a validated questionnaire based on the International Classification of Sleep Disorders [5] was used, concluded that sleep disorders and insufficient sleep are highly prevalent [6]. Sleep-related problems can lead to serious health issues like depression [7]. Insomnia, the most commonly encountered sleep disorder, has been found to be related to cardiovascular diseases, diabetes, and a variety of problems that occur during everyday functioning, such as fatigue, drowsiness, and attention/concentration problems [8,9].

Although sleep is typically accompanied by inactivity of the body and loss of consciousness, several (unwanted) behaviors can occur during sleep, such as jaw clenching and teeth grinding [10]. Both clenching and grinding of the teeth are characterized by repetitive or sustained dental contact and/or mandibular tension, also known as bruxism [11,12]. Bruxism has two distinct circadian manifestations and can occur during sleep (indicated as sleep bruxism) or during wakefulness (indicated as awake bruxism) [13,14]. The etiology of bruxism is complex, and it is acknowledged that a variety of factors can be involved [14,15]. Bruxism is known as one of the important concerns for dentists because it is assumed to be associated (true or false) with a number of clinical problems, including tooth wear and temporomandibular disorders (TMDs) [12,16]. Studies that investigated the relationship between sleep bruxism and sleep-related problems are rare, and the results are, unfortunately, inconsistent. Depending on the study, factors related to sleep quality, such as estimates of sleep duration and sleep latency, may (or may not) be

CONTACT Maurits van Selms m.v.selms@acta.nl Department of Orofacial Pain and Dysfunction, ACTA, Amsterdam 1081 LA, The Netherlands.

associated with sleep bruxism [17,18]. Likewise, even though it is a common opinion that sleep bruxism is related to stress, the evidence to prove this relationship is still insufficient [19]. It is likely that divergences in results and opinions depend upon the inhomogeneity of the bruxer populations. Moreover, only few longitudinal studies have investigated the assumed stress-bruxism association [20–22].

Like any other career option, being a professional musician has its pros and cons. For example, playing the instrument you love to play every day and satisfying a large audience on a concert night can make the job fantastic. On the other hand, the physical demands on professional musicians are high, and musculoskeletal symptoms are highly prevalent among them [23–26]. Besides the fact that a lot is demanded from the body, the mental health is being tested as well. The high job demands, irregular working hours, rivalry, the risk of being judged, and having to concentrate for hours can become a source of stress. A national study of psychosocial work environment and stress showed that symphony orchestra musicians reported more stress than the general Danish work force [27]. It is also known that high working demands and stress can cause impaired sleep, such as shortened sleep and fragmentation [28]. Therefore, the recognition and understanding of the roles that sleep disorders and stress play in the multifactorial etiology of sleep bruxism are more than relevant. This questionnaire study aimed to investigate whether self-reported sleep bruxism is associated with sleep-related problems and/or psychological stress among Finnish symphony orchestra musicians. It was hypothesized that sleep-related problems and stress experience are more common in people who report more sleep bruxism.

Materials and methods

This study was performed with a questionnaire completed by the members of all professional Finnish symphony orchestras. The questionnaire was sent to 19 orchestras, consisting of 831 professional musicians. The participants were given both oral and written information about the questionnaire, and they provided written informed consent. According to the local bylaws, ethics approval is not mandatory for a questionnaire study. The questionnaire covered, among other items, personal information, items on perceived quality of sleep, indicators of sleep-related problems, the use of sleeping pills, and stress experience.

The musicians were asked about their age, gender, and their main musical instrument (string, woodwind, brass, percussion, or other). The following question was used to assess the frequency of sleep bruxism: "Sleep bruxism is involuntary periodical tooth grinding or tooth clenching. Do you have such symptoms?" ("never," "only a little," "occasionally," "almost every night," or "every night"). The questions that referred to sleep-related problems were also used in a previous study [29] and were derived from a previously validated questionnaire (Basic Nordic Sleep Questionnaire [30]. Small amendments were made related to the target population, i.e., musicians. The following sleep-related variables were assessed:

(1) **Sleep duration**: How many hours do you usually sleep per night? (Less than 7 hours, 7–8 hours, 8 hours or more).
(2) **Sleep latency**: How long does it take to fall asleep in the evening? (Less than 10 minutes, 10–30 minutes, more than 30 minutes).
(3) **Disrupted sleep**: How many times do you wake up during the night? (0–1 times per week, 2–3 times per week, 4 times per week or more).
(4) **Problems of sleeping in preseason**: Have you had problems sleeping during holidays? (No, Yes).
(5) **Problems of sleeping in concert season**: Have you had problems sleeping during previous concert season(s)? (No, Yes).
(6) **Feeling tired during the daytime**: How often do you feel tired or non-energetic during the daytime? (0–1 days per week, 2–4 days per week, 5–7 days per week).
(7) **Non-restorative sleep**: How often do you feel refreshed when you wake up in the morning? (0–1 mornings per week, 2–4 mornings per week, 5–7 mornings per week).
(8) **Naps**: How often do you sleep during the day (nap)? (0–1 days per week, 2–4 days per week, 5–7 days per week).
(9) **Duration naps**: How long do you usually sleep during the daytime (nap)? (0–30 minutes, 30 minutes – 1 hour, more than 1 hour).
(10) **Snoring**: When you have been asleep, to the best of your knowledge, do you snore? (0–2 nights per week, 3–4 nights per week, 5 nights per week or more).
(11) **Breathing pauses**: Has anyone told you that you have breathing pauses when you sleep? (No, Yes).
(12) **Restless legs**: Do you have any unpleasant or funny feelings (cold, hot, tingling, creeping, pain etc.) in your legs at rest and during evenings? (0 nights per week, 1–2 nights per week, 3 nights per week or more).

(13) **Use of sleeping pills in preseason**: During the preseason, have you used some sleeping pills? (0–1 nights per week, 2–4 nights per week, 5 nights per week or more).
(14) **Use of sleeping pills in concert season**: During previous concert season(s), have you used some sleeping pills? (0–1 nights per week, 2–4 nights per week, 5 nights per week or more).
(15) **Diagnosed sleeping disorder**: Do you have a doctor-diagnosed sleeping disorder? (No, insomnia, restless legs syndrome, obstructive sleep apnea, other).
(16) **Self-rated sleep quality**: How would you estimate your sleep/sleeping? (Please mark the estimated value on a line from 0 to 10, where 0 is worst and 10 is best).

Additionally, the participants were asked if they had experienced stress, with the following explanation: "Stress means the situation when a person feels tense, restless, nervous, or anxious, or is unable to sleep because his/her mind is troubled at the time. Do you feel that kind of stress these days?" ("not at all," "only a little," "to some extent," "rather much," or "very much") [31].

Statistical methods

Descriptive statistics were used to report the data. Continuous data were reported as mean (SD), categorical data as count (%). For descriptive data, one-way ANOVA was used to compare the response rate between the orchestras and the mean age of males and females. Because only a very small percentage of musicians (3.3%) reported bruxism to be present every night, the items in the original 5-point Likert scale of "Almost every night" and "Every night" were merged to form a new category: "Often." Since the dependent variable consisted of ordered categorical data, i.e., the frequency of bruxism on a 4-point Likert scale, ordinal logistic regression analysis was used to investigate associations with the independent variables. Before building the final model, single variable regression analyses were performed to determine the unadjusted associations of each of the independent variables with sleep bruxism frequency. Age and gender were included in the single regression models as well. Initial analyses were based on the full range of the 3, 4 or 5-point Likert response options, and linearity and additivity of their effect on bruxism frequency was checked by visual inspection of the regression coefficients. In case of a non-linear association, the variable was dichotomized. Variables that showed at least a moderate association (p-value <0.10) with the dependent variable were entered in the multiple variable regression model. Subsequently, independent variables with the weakest association with sleep bruxism frequency were removed using the backward elimination method until all variables that were retained showed a p-value <0.05. Multicollinearity testing was performed before introducing the independent variables into the final model. Analyses were conducted with the IBM SPSS Statistics 26 software package (IBM Corp, Armonk, NY, USA).

Results

In total, 488 questionnaires were completed by musicians, yielding a response rate of 58.7%. Of these, 486 musicians had completed the question about sleep bruxism; hence, this group was used for analysis in the current study. There was no significant difference between the 19 participating orchestras in the response rate. The male respondents (52.3% of all participants) had a significantly higher mean age compared to women (47.7 years (SD 10.3) versus 43.4 years (SD 9.8)). Descriptive data of all variables are shown in Table 1.

The correlation coefficients for all independent variables related to sleep quality were inspected using a Spearman correlation matrix and were determined to be sufficiently low that issues of multicollinearity were not indicated (the highest correlation between the independent variables was below 0.49).

Associations between related factors and the frequency of bruxism symptoms, derived from ordinal logistic regression, are depicted in Table 2. Two variables were dichotomized: non-restorative sleep and snoring; linearity and additivity of their effect on bruxism frequency appeared to be inconsistent. The single variable regression models showed at least moderate associations ($p < 0.10$) between the frequency of sleep bruxism and female gender, shorter sleep duration, longer sleep latency, problems in sleeping during the concert season, feeling tired more often during the daytime, restless legs, a poor self-rated sleep quality, and more stress experience. According to the multiple variable ordinal logistic regression model, female musicians reported a higher frequency of sleep bruxism. In addition, musicians who sleep 7 hours or less per night reported more sleep bruxism compared to those who sleep 8 hours per night or more. Finally, more stress experience was associated with a higher frequency of sleep bruxism.

Several strategies were used to examine the statistical performance of the final regression model. Regarding the goodness-of-fit, both the Deviance and Pearson chi-

Table 1. Descriptive data of the study population (n = 486).

Mean (± SD)					
Age	45.6 ± 10.2	Self-rated sleep quality [0–10]	6.9 ± 1.9		
Percentage for					
Gender		Feeling tired during the daytime		Restless legs	
Male	52.3	0–1 mornings p/w	40.1	0 nights p/w	70.7
Female	47.7	2–4 mornings p/w	50.9	1–2 nights p/w	19.4
Sleep bruxism		5–7 mornings p/w	8.9	5 nights or more p/w	9.9
Never	41.4	Non-restorative sleep		Sleeping pills preseason	
Only a little	22.6	0–1 mornings p/w	21.7	0–2 nights p/w	98.4
Once in a while	23.9	2–4 mornings p/w	55.6	3–4 nights p/w	0.4
Often	12.1	5–7 mornings p/w	22.7	5 nights or more p/w	1.1
Sleep duration		Naps		Sleeping pills concert season	
7 hours or less	20.5	0–1 days p/w	62.4	0–2 nights p/w	90.9
7–8 hours	57.7	2–4 days p/w	30.0	3–4 nights p/w	5.0
> 8 hours	21.8	5–7 days p/w	7.6	5 nights or more p/w	4.1
Sleep latency		Duration naps		Diagnosed sleeping disorder	
< 10 min	41.6	< 30 min	56.6	No	93.0
10–30 min	44.9	30 min – 1 hour	37.1	OSA	3.0
30 min or more	13.6	more than 1 hour	6.3	Restless Legs syndrome	0.4
Disrupted sleep		Snoring		Insomnia	3.6
0–1 times	50.9	0–2 nights p/w	74.4	Stress experience	
2–3 times	43.1	3–4 nights p/w	12.5	not at all	6.2
4 times or more	6.0	5–7 nights p/w	13.1	only a little	36.4
Problems sleeping preseason		Breathing pauses		to some extent	36.6
Yes	22.3	Yes	14.2	rather much	14.0
No	77.7	No	85.8	very much	6.8
Problems sleeping concert season					
Yes	54.2				
No	45.8				

SD: Standard deviation; p/w: per week.

square tests were non-significant, indicating a fine match between observed and expected results. The test of parallel lines for ordinal logistic regression was satisfied ($\chi 2(14) = 16.94$, $p = 0.259$), which means that the slope coefficients in the model are the same across the different categories of the dependent variable. In other words, the relationship between each pair of sleep bruxism category, i.e., never, only a little, occasionally, often, was the same. The final model accounted for 8.5% of the variance in bruxism frequency (Nagelkerke's $R^2 = 0.085$).

Discussion

The aim of this study was to investigate whether self-reported sleep bruxism is associated with sleep-related problems and/or psychological stress among Finnish symphony orchestra musicians. The final ordinal logistic regression model indicated an association between the frequency of sleep bruxism and shorter sleep duration. In addition, sleep bruxism was found to be associated with female gender and with psychological stress.

The interest in sleep medicine seems to be growing over the last decades, whereby the role of sleep disorders on sleep quality has drawn attention. Although the diagnosis and treatment of sleep disorders belong to medicine, some of these are related to dentistry [32]. For example, based on a study on oral health-related quality of life, Câmara-Souza et al. [33] reported poorer sleep quality and excessive daytime sleepiness in bruxers compared to a control group. Comparable to the findings of the present study, they also found that sleep bruxism was negatively associated with the total number of hours of sleep. Additionally, a polysomnography (PSG) study on sleep architecture revealed that subjects diagnosed with sleep bruxism reported more complaints of insomnia [34]. On the other hand, two other studies found no association between sleep bruxism and self-reported sleep duration [17,18]. Of course, impaired sleep duration is just one of the many potential sleep-related problems. Therefore, even though it still remains a matter of debate whether sleep bruxism may directly impact perceived sleep quality (or vice versa), the findings of the present study are in line with the suggestion that the reports of sleep bruxism and disturbed sleep seem to go hand in hand [35,36].

Several mechanisms have been proposed that explain how sleep and sleep bruxism are connected. In one of these papers, Lavigne et al. [37] gave an overview on the neurophysiology and neurochemistry of sleep bruxism and how the repetitive jaw muscle contractions result from the integration of various influences. For example, it is assumed that the neuronal activity that preserves

Table 2. Single and multiple ordinal logistic regression models for associations of sleep bruxism frequency (never, only a little, occasionally, often) with sleep-related problems and psychological stress in professional Finnish symphony orchestra musicians (n = 486). Associations are expressed as odds ratio (OR) and 95% confidence interval (CI).

	Single regression models			Multiple regression model; n = 486		
Independent variable	OR	95% CI	*p*-value	OR	95% CI	*p*-value
Gender (Reference: Female)						
Male	−0.511	−0.838 – −0.185	**0.002**	−0.565	−0.905 – −0.224	**0.001**
Age	−0.011	−0.26–0.005	0.197			
Sleep duration (Reference: > 8 hours)						
7–8 hours	−0.025	−0.436–0.386	0.905	0.028	−0.390–0.446	0.895
7 hours or less	0.619	0.122–1.117	**0.015**	0.634	0.109–1.158	**0.018**
Sleep latency (Reference: < 10 minutes)						
10–30 minutes	−0.054	−0.405–0.297	0.763	-	-	-
30 minutes or more	0.461	−0.042–0.964	**0.073**	-	-	-
Disrupted sleep (Reference: 0–1 times)						
2–3 times	0.244	−0.093–0.581	0.155			
4 times or more	0.550	−0.145–1.245	0.121			
Problems sleeping preseason (Reference: No)						
Yes	0.179	−0.209–0.568	0.366			
Problems sleeping concert season (Reference: No)						
Yes	0.494	0.164–0.824	**0.003**	-	-	-
Feeling tired during the daytime (Reference: 0–1 days p/w)						
2–4 days p/w	0.227	−0.120–0.574	0.199	-	-	-
5–7 days p/w	0.727	0.128–1.326	**0.017**	-	-	-
Non-restorative sleep (Reference: 2–7 days p/w)						
0–1 days p/w	−0.226	−0.618–0.166	0.259			
Naps (Reference: 0–1 days p/w)						
2–4 days p/w	−0.188	−0.551–0.174	0.308			
5–7 days p/w	−0.224	−0.859–0.412	0.490			
Duration naps (Reference: < 30 minutes)						
30 minutes – 1 hour	−0.13	−0367 – 0.341	0.943			
More than 1 hour	−0.046	−0.748–0.656	0.899			
Snoring (Reference: 0–2 nights p/w)						
3 or more nights p/w	−0.239	−0.616–0.138	0.214			
Breathing pauses (Reference: no)						
Yes	−0.222	−0.695–0.251	0.357			
Restless legs (Reference: 0 nights per week)						
1–2 nights p/w	0.106	−0.311–0.523	0.618	-	-	-
3 or more nights p/w	0.618	0.072–1.164	**0.026**	-	-	-
Sleeping pills preseason (Reference: 0–2 nights p/w)						
3–4 nights p/w	0.667	−1.826–3.159	0.600			
5 nights or more p/w	0.835	−0.749–2.418	0.302			
Sleeping pills concert season (Reference: 0–2 nights p/w)						
3–4 nights p/w	0.251	−0.508–1.009	0.517			
5 nights or more p/w	0.528	−0.299–1.355	0.211			
Diagnosed sleeping disorder (Reference: No)						
OSA	−0.462	−1.467–0.544	0.368			
Restless Legs syndrome	0.663	−1.828–3.155	0.602			
Insomnia	0.162	−0.714–1.039	0.716			
Self-rated sleep quality (0–10)	−0.135	−0.221 – −0.050	**0.002**	-	-	-
Stress experience (Reference: not at all)						
Only a little	0.393	−0.369–1.154	0.312	0.509	−0.259–1.276	0.194
To some extent	0.760	0.001–1.520	**0.050**	0.815	0.051–1.578	**0.037**
Rather much	1.199	0.368–2.031	**0.005**	1.100	0.263–1.936	**0.010**
Very much	1.658	0. 714–2.603	**0.001**	1.586	0.635–2.536	**0.001**

Bold: significant at the 0.10 (single regression) or 0.05 (multiple regression) level; p/w: per week.

sleep continuity is disrupted by the occurrence of spontaneous motor events, such as sleep bruxism, during non-REM (rapid eye movement) sleep. At the same time, the present study found that more stress experience was associated with a higher frequency of sleep bruxism. The finding of this stress-bruxism association corresponds to the outcomes of several previous studies, which revealed that a relationship between bruxism and stress could exist [38,39]. At the same time, it is known that more stress is associated with a shorter sleep duration [28]. Since it is very likely that stress, sleep, and sleep bruxism are interrelated, future studies should, therefore, not only focus on neurophysiological mechanisms involved in sleep bruxism but should also take the neuropsychological effects of stress on both sleep bruxism and sleep insufficiency into account.

This questionnaire study identified a significant difference between men and women in sleep bruxism frequency, with the frequency being higher in women. The opinions about this male-female

division, with respect to bruxism, are divided. For example, Ahlberg et al. [40] and Wetselaar et al. [41] reported bruxism more often in women than in men, whereas, other studies found an equal prevalence among both genders [42,43]. For the gender dissimilarity observed in the present study, several conditions that can impact sleep may play a role. For instance, it is known that stress-related disorders are more prevalent in women than in men Since it has been suggested that self-reported bruxism mirrors stress [38], it can be hypothesized that the female predominance in the frequency of sleep bruxism was due to stress.

The diagnosis of sleep bruxism is challenging. Even though PSG is still considered the gold standard for diagnosing "definite" sleep bruxism, it is an expensive and time-consuming facility. As a result, most large-scale studies make use of self-reported diagnosis of sleep bruxism, in which the reports of tooth grinding sounds during sleep determine part of the outcome ("possible" bruxism). Even though self-reported bruxism is often measured on an ordinal scale, e.g., never, only a little, occasionally, almost every night, or every night, data of this type are generally reduced for analysis to a single dichotomy: either sleep bruxism is present, or sleep bruxism is absent. Of course, dichotomization simplifies the statistical analysis and may lead to an easy interpretation and presentation of results. However, converting categorical data into two groups has some serious drawbacks [44]. The initial gradient is lost, so the statistical power to detect associations is reduced. In some cases, dichotomization may even increase the risk of a positive result being a false positive [45]. According to recent guidelines, standard cut-off points should not be considered optimal for the "gold-standard" assessment of sleep bruxism by means of instrumental approaches [11]. In such cases, it is advocated that bruxism-related masticatory muscle activity should be assessed in its continuum. In line with this, it can be argued that cut-off points should not be used in case of non-instrumental approaches either. A better way for representing self-reported bruxism activity in its continuum, thereby, not only focusing on the presence or absence of grinding sounds, would be by including its gradient. The discrimination between ranked categories would form a better representation of the amount and pattern of bruxism-related masticatory muscle activity. In order to study the effects of independent variables on all levels of ordered categorical responses, an ordinal regression method must be appropriately chosen in order to obtain valid results [46]. Therefore, the present paper used ordinal logistic regression analysis because this model makes full use of the rank ordering of the bruxism report categories.

Limitations of the present study include the potential unreliable nature of subjective reports. For example, it can be expected that some of the musicians may have been unaware of their sleep bruxism activities. As a result, the prevalence of sleep bruxism may have been under- or overestimated compared to the definite PSG-established diagnosis [34]. In addition, self-report does not take into account the natural fluctuation in sleep bruxism activity over time [47]. It should, however, be remembered that this also accounts for single-night instrumental recordings. Stress experience was measured using a single question. Even though this instrument has been shown as being valid for monitoring stress at work on a group-level [31], it is questionable as to whether the subjective response to this single question properly captures the complex meaning of what experts define as stress. Finally, it should be mentioned that the proportion of explained variance in the final multiple variable regression model was relatively low (8.5%). An explanation for this might be that self-reported sleep bruxism data are subject to a large amount of inherent variation.

Conclusion

Within the limitations, the present study suggests that self-reported sleep bruxism is associated with a shorter sleep duration and is more prevalent among female musicians. In addition, frequent bruxism seems to mirror higher stress levels among professional musicians.

Disclosure statement

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ORCID

Maurits van Selms BDS, MSc, PhD http://orcid.org/0000-0002-0792-4930
Henri Tuomilehto MD, PhD http://orcid.org/0000-0002-7127-9964
Daniele Manfredini DDS PhD http://orcid.org/0000-0002-4352-3085
Frank Lobbezoo DDS PhD http://orcid.org/0000-0001-9877-7640
Jari Ahlberg DDS PhD http://orcid.org/0000-0002-6052-0441

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