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INTRODUCTION

In 2013, a group of experts defined bruxism as a repetitive jaw-muscle activity characterised by clenching or grinding of the teeth and/or by bracing or thrusting of the mandible. It was stated that bruxism has two distinct circadian manifestations: it can occur during wakefulness (indicated as awake bruxism) or during sleep (indicated as sleep bruxism). Recently, a revision of the definition was made, in which awake bruxism (AB) and sleep bruxism (SB) are considered to be different behaviours observed during wakefulness and during sleep. Bruxism should not be considered as a disorder in otherwise healthy individuals, but rather as a behaviour, a physiological phenomenon, that can be a risk (and/or protective) factor for certain clinical consequences. Bruxism may be considered as pathological when a person experiences possible negative consequence, like pain in the masticatory system. Additionally, a diagnostic grading system was proposed of "possible," "probable" and "definite" awake bruxism or sleep bruxism. Possible awake bruxism or sleep bruxism is based

The prevalence of awake bruxism and sleep bruxism in the Dutch adult population

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Dutch National Health Care Institute (ZIN), Grant/Award Number: Approval No. m1501261

Summary

Background: Awake bruxism and sleep bruxism are common conditions amongst adult populations, although prevalence data are scarce.

Objective: This study aimed to assess the prevalence of awake bruxism and sleep bruxism in the Dutch adult population.

Methods: As part of a large epidemiologic survey on oral health of the general Dutch adult population, a total of 1209 subjects were asked about their bruxism behaviour during the day and during their sleep. The collected data were subjected to stratified analysis by five age groups (25-34, 35-44, 45-54, 55-64 and 65-74 years), socioeconomic status, and gender.

Results: A prevalence of 5.0% of the total population was found for awake bruxism and of 16.5% for sleep bruxism. Regarding the five age groups, prevalence of 6.5%, 7.8%, 4.0%, 3.2% and 3.0%, respectively, were found for awake bruxism, and of 20.0%, 21.0%, 16.5%, 14.5% and 8.3%, respectively, for sleep bruxism. Women reported both awake bruxism and sleep bruxism more often than men. These differences were statistically significant. Concerning socioeconomic status (SES), both awake bruxism and sleep bruxism were more often found in high SES groups, being statistically significant for awake bruxism only.

Conclusion: Sleep bruxism is a common condition in the Dutch adult population, while awake bruxism is rarer.

KEYWORDS
adult population, awake bruxism, bruxism, gender, prevalence, sleep bruxism
on a positive self-report only, while probable awake bruxism or sleep bruxism is based on a positive clinical inspection, with or without a positive self-report. Definite awake bruxism is based on a positive instrumental assessment, with or without a positive self-report and/or a positive clinical inspection. A review regarding prevalence data amongst adult populations shows that studies on this topic are scarce and have a wide variety. For this variety, several factors play a role, namely the fact that some researchers did not make the distinction between awake bruxism and sleep bruxism, nor the distinction between "possible," "probable" and "definite" awake or sleep bruxism. For the assessment of "possible" awake or sleep bruxism, no consensus is reached on which questions and/or questionnaires should be used to set the diagnosis. Nevertheless, chairside questions and/or questionnaires are tools that can be applied relatively easy to larger groups of individuals. More studies are performed regarding sleep bruxism than awake bruxism. Studies using questionnaires resulted in varying prevalence data regarding sleep bruxism. Prevalence data were reported with questionnaires alone, the prevalence was 12.5%. Studies using questionnaires, so to set a "possible" awake bruxism diagnosis. These studies were also mentioned above, since these authors report on both sleep bruxism and awake bruxism. The Swedish study reported prevalence data of "possible" awake bruxism of 20.0%, the Danish study of 22.1% and the Israeli study of 31.0% (see Tables 4 and 5).

Regarding the assessment of awake bruxism, to our knowledge, no study regarding the "definite" diagnosis of awake bruxism has been performed. The aim of this study was to assess the prevalence of awake bruxism and sleep bruxism in the Dutch adult population in different age groups, for both genders and for different socioeconomic status. Because this research was part of a comprehensive investigation of the oral health of the general Dutch adult population in 2013, it was only possible to assess awake bruxism and sleep bruxism with the use of chairside history taking, leading to the diagnosis "possible" awake bruxism and "possible" sleep bruxism.

### 2 | MATERIALS AND METHODS

#### 2.1 | Study sample and recruitment

Data were collected from April 2013 to November 2013 as part of a large epidemiologic survey of oral health and preventive behaviour amongst Dutch adults. The survey was performed in 's-Hertogenbosch, a medium-sized city in the southern part of The Netherlands that can be considered to be representative of the general Dutch population in terms of sociodemographic indicators. Health Insurance companies were asked (under the authority of the National Health Care Institute (Zorginstituut Nederland, ZINL) to provide the names and addresses of their clients aged 25-75. A total of 87,075 names and addresses were provided. A stratified sample of 6904 people (including edentulous individuals) was selected.

All eligible individuals were invited to participate in this study and visit a mobile dental examination facility temporarily located in their city of residence. Eighty-two per cent of those invited to participate (5661 individuals) stated that they were not interested in participation (51% of this group were male, 36% had higher education, 77% indicated that they did not have enough time or interest to participate, and 10% declined because of dental anxiety). A total of

#### TABLE 1 Prevalence of self-reported awake bruxism and sleep bruxism divided by age groups

<table>
<thead>
<tr>
<th>Age</th>
<th>n</th>
<th>No</th>
<th>% Yes</th>
<th>( \chi^2 )</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awake bruxism</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-34</td>
<td>230</td>
<td>215</td>
<td>6.5</td>
<td>9.282</td>
<td>0.054</td>
</tr>
<tr>
<td>35-44</td>
<td>257</td>
<td>237</td>
<td>7.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45-54</td>
<td>272</td>
<td>261</td>
<td>4.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>55-64</td>
<td>283</td>
<td>274</td>
<td>3.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>65-74</td>
<td>167</td>
<td>162</td>
<td>3.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1209</td>
<td>1149</td>
<td>5.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sleep bruxism</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-34</td>
</tr>
<tr>
<td>35-44</td>
</tr>
<tr>
<td>45-54</td>
</tr>
<tr>
<td>55-64</td>
</tr>
<tr>
<td>65-74</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>
1755 adults (56% of which were female) were included in the epidemiologic study. For the purpose of this study, all edentulous participants were excluded from the analyses so only data of the dentate participants were analysed (n = 1209).

This study was judged by the Central Committee on Research Involving Human Subjects (CCMO) not to fall under the provisions of the Medical Research Involving Human Subjects Act. It was furthermore decided that the study met all requirements of the Personal Data Protection Act (Approval No. m1501261).

2.2 | Procedure

All participants filled in a questionnaire giving details of their sociodemographic and dental status, and their dietary and oral hygiene behaviour. Before they underwent an oral health assessment in a dental chair, the questions regarding awake bruxism and sleep bruxism were asked. The interviews were performed by experienced and calibrated dentists. Socioeconomic status was defined by the level of education. Level of education was divided into low and high, based upon the intellectual challenges offered by the Dutch education system. High education was defined as higher general secondary education or higher. All other education was defined as low education.

2.3 | Questioning

For the purpose of this study, the following two questions were asked, modified from van der Meulen and coauthors: 17 (a) do you grind your teeth or do you clench your jaws during wakefulness? and (b) did someone notice or are you aware yourself that you grind your teeth or clench your jaws during sleep? Regarding these questions, the participants could only answer yes/no/I don’t know; additional questions regarding frequency and timeframe were not asked.

2.4 | Statistical analysis

Participants were stratified in five age groups (25-34, 35-44, 45-54, 55-64 and 65-74 years), gender and socioeconomic status (SES). Based on the power calculations, a total minimum of participants in each age group was calculated. As soon as this required number was reached, further efforts to include participants of that age were ceased. For every age group, this minimum number of participants was reached.

To identify whether the people that declined to participate differed from the participants, a modest non-respondents survey was executed. This included amongst others age, gender and SES. It was found that this differed somewhat in SES. Because of that reason, the results were weighed by the factors that were calculated by Statistics Netherlands.

Kruskal-Wallis tests and chi-square tests were used to identify possible differences between age groups, gender and SES. All analyses were performed using IBM SPSS Statistics 22.0 software (IBM Corp., Armonk, NY, USA).

### Results

3.1 | Response rates

The response rate in this study was 17.5%. Of the total sample, female respondents made up 55.5% of the study population. Of all participants, 44.7% had a low SES.

3.2 | Age

Table 1 shows the prevalence of awake bruxism and sleep bruxism stratified in age groups of 10 years (25-34, 35-44, 45-54, 55-65 and 65-74). Participants in the two youngest age groups reported more frequently to have this condition (6.5% and 7.8%) than the three older age groups. This difference is marginally statistically significant (P = 0.05). Considering sleep bruxism, higher prevalence rates were reported than for awake bruxism, with the two youngest age groups showing the highest rates (P < 0.01).

3.3 | Gender

Both awake bruxism and sleep bruxism were reported more frequently by women than by men: 6.4% vs 3.2% for awake bruxism and 18.6% vs 13.9% for sleep bruxism (see Table 2). This difference is statistically significant for awake bruxism only (P = 0.05).

3.4 | Socioeconomic status

Awake bruxism and sleep bruxism were reported more frequently by participant with high SES than by those with low SES: 6.3% vs

Table 2 Prevalence of self-reported awake bruxism and sleep bruxism divided by gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>n</th>
<th>% Yes</th>
<th>χ²</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awake bruxism</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>538</td>
<td>3.2</td>
<td>6.681</td>
<td>0.010</td>
</tr>
<tr>
<td>Female</td>
<td>671</td>
<td>6.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleep bruxism</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>538</td>
<td>13.9</td>
<td>4.754</td>
<td>0.029</td>
</tr>
<tr>
<td>Female</td>
<td>671</td>
<td>18.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3 Prevalence of self-reported awake bruxism and sleep bruxism divided by SES

<table>
<thead>
<tr>
<th>SES</th>
<th>n</th>
<th>% Yes</th>
<th>χ²</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awake bruxism</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>505</td>
<td>3.6</td>
<td>4.199</td>
<td>0.040</td>
</tr>
<tr>
<td>High</td>
<td>624</td>
<td>6.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleep bruxism</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>505</td>
<td>16.2</td>
<td>0.070</td>
<td>0.791</td>
</tr>
<tr>
<td>High</td>
<td>624</td>
<td>16.8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.6% for awake bruxism and 16.8% vs 16.2% for sleep bruxism (see Table 3). This difference is statistically significant for awake bruxism and sleep bruxism ($P = 0.05$).

4 | DISCUSSION

This study aimed to assess the prevalence of awake bruxism and sleep bruxism in the Dutch adult population. Sleep bruxism is a common condition in the Dutch adult population, while awake bruxism is rarer. We will discuss about the results in the following sequence: (a) bruxism, awake bruxism and sleep bruxism; (b) possible, probable and definite bruxism; (c) the exact question regarding awake bruxism and sleep bruxism; (d) age patterns; (e) gender; (f) SES; (g) sample and sample size; and (h) future perspectives.

4.1 | Bruxism, awake bruxism, sleep bruxism

Awake bruxism (AB) and sleep bruxism (SB) are considered to be two different behaviours observed during wakefulness and during sleep.$^2$ Of course, this concept change is of influence how we look back to previous research, and how we will perform research in the future, meaning not assess bruxism, but assess awake bruxism and sleep bruxism separately. The strength of this study was that we assessed awake bruxism and sleep bruxism separately. Moreover, it is of importance to collect as much as prevalence data as possible, in order to broaden the available information of the “normality” that is bruxism considered now.

4.2 | Possible, probable, definite

As mentioned in the introduction, to our knowledge, no epidemiological studies are performed in which a comprehensive clinical diagnosis was performed, meaning leading to the diagnosis “probable” awake bruxism or “probable” sleep bruxism. Important issue is that there is no agreement which signs and symptoms should be included in a comprehensive clinical assessment, consensus towards this is a necessity to compare future research. One can reason that so far, research is lacking due to the fact that performing such a prevalence study with a large sample size is too time-consuming and therefore not executable. The same is applied regarding the assessment of the “definite” diagnosis of sleep bruxism, although recently a study was published by Maluly et al.$^{14}$ This study is until now, the only one using polysomnographic recordings on such a large scale. Of course, this kind of research is of great importance, but difficult to implement because of the high costs. Furthermore, it is important to realise that a polysomnographic recording of only one night has to be considered with caution, since it is known that there is a variation between different nights.$^{18}$ Moreover, using certain cut-off criteria to determine the diagnosis “definite” sleep bruxism is on debate.$^2$ Therefore, the strength of this study was that we assessed “possible” awake bruxism and ” sleep bruxism in order to collect more prevalence data.

4.3 | Exact question

For epidemiological studies on a large scale, interviewing persons by questionnaires or during an oral history remains the most easily accessible. This is the reasons why such studies are performed in the past$^{4-9}$ and remain necessary in the future. Shortcoming at this moment, is the fact that there is no consensus about which question(s) need to be asked, nor for awake bruxism nor for sleep bruxism. In the above-mentioned epidemiological studies, different questions were used regarding sleep bruxism, as we did as well. Not only the used questions itself are different, also answer possibilities (yes, no,) or different time intervals (rarely, occasionally, often, very often, never, times per night, times per day, times per month) were asked for.$^{4-9,19}$ In our study, we used the following question: did someone notice or are you aware yourself that you grind your teeth or clench your jaws during sleep? (yes/no). Remarkable is that the question itself seems more or less equal, but the difference is in the frequency-part
of the questions. That the question itself can influence the results remarkably, was shown by Khoury and coauthors, who reported an overall prevalence of 8.6% when asking regularly and an occasion prevalence of 22.3% when asking regularly and on occasion behavior together. Regarding the questions used for assessing awake bruxism, the same fluctuations in questioning were found as mentioned above regarding sleep bruxism.

In our study, we used the following question: do you grind your teeth or do you clench your jaws during wakefulness? These differences make comparison difficult and conclusions must be drawn with caution. Regarding the questioning, both for awake bruxism and sleep bruxism, consensus is needed for future research. Therefore, the weakness of this study was that the questions we used are difficult to compare with other studies, the strength of this study was that we collected more prevalence data.

### Age patterns

Another important issue is the age pattern of awake bruxism and sleep bruxism, in other words, are these conditions increasing with age, stable over time, or self-limiting conditions? Regarding sleep bruxism, research was performed in which the population was divided in several age groups in order to detect a pattern over time. Two studies reported a clear diminishing over time (4, 6) (see Table 4). Two studies showed first a stable period followed by a decline (7, 9) (see Table 4). In our study, a similar pattern was found although the percentages are higher in all age groups. In a study assessing bruxism (without separating awake bruxism and sleep bruxism), a stable prevalence was shown as well (20) (see Table 4), although the percentages are higher than in the previous discussed studies. Most probably because of the summation effect. Regarding awake bruxism, research was performed in which the population was divided in several age groups in order to detect a pattern over time. Two studies reported a clear diminishing over time (4, 5) (see Table 5). Two studies showed first a stable period followed by a decline (7, 9). In our study, a similar pattern was found although the percentages are higher in all age groups. In a study assessing bruxism (without separating awake bruxism and sleep bruxism), a stable prevalence was shown as well (20). Although the percentages are higher than in the previous discussed studies, most probably because of the summation effect. Regarding age group 45-54 (see Table 5), our study found also a stable prevalence, with the highest percentage in the first two age groups followed by a decrease in the third and fourth age group, with a decline in the oldest age group.

Three studies used the same age groups, namely Agerberg & Carlsson, 4 Khoury et al, 9 and in our study as well. Age groups are divided in 51-64. In our study, we found also a stable prevalence, with the highest percentage in the first two age groups followed by a decrease in the third and fourth age group, with a decline in the oldest age group.

### Table 5: Comparison of different prevalence studies regarding both “possible” awake bruxism and “possible” sleep bruxism, assessing overall rates or overall rates and age patterns

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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>AB</td>
<td>SB</td>
<td>AB</td>
<td>SB</td>
<td>AB</td>
<td>SB</td>
<td>AB</td>
<td>SB</td>
</tr>
<tr>
<td>Age</td>
<td>Age</td>
<td>↓Age</td>
<td>↓Age</td>
<td>↓Age</td>
<td>↓Age</td>
<td>↓Age</td>
<td>↓Age</td>
<td>↓Age</td>
</tr>
<tr>
<td>Gender</td>
<td>Female = male</td>
<td>Female = male</td>
<td>Female &gt; male</td>
<td>Female &gt; male</td>
<td>Female &gt; male</td>
<td>Female &gt; male</td>
<td>Female &gt; male</td>
<td>Female &gt; male</td>
</tr>
<tr>
<td>Age groups</td>
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<td>25-64</td>
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<td>25-64</td>
<td>1</td>
<td>18-70</td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>n</td>
<td>n</td>
<td>n</td>
<td>n</td>
<td>n</td>
<td>n</td>
<td>n</td>
</tr>
<tr>
<td>25-34</td>
<td>19.0</td>
<td>19.0</td>
<td>975</td>
<td>975</td>
<td>402</td>
<td>402</td>
<td>1209</td>
<td>1209</td>
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<td>35-44</td>
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<td>9.0</td>
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<td>18-70</td>
<td>18-70</td>
<td>7.8</td>
<td>21.0</td>
</tr>
<tr>
<td>45-54</td>
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<td>5.0</td>
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<td>1</td>
<td>6.5</td>
<td>20.0</td>
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<td>55-64</td>
<td>24.0</td>
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<td>5 see below</td>
<td>3.2</td>
<td>14.5</td>
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<td>3.2</td>
</tr>
<tr>
<td>65-74</td>
<td>19.0</td>
<td>2.0</td>
<td>5 see below</td>
<td>5 see below</td>
<td>3.0</td>
<td>8.3</td>
<td></td>
<td>3.0</td>
</tr>
<tr>
<td>overall</td>
<td>20.0</td>
<td>10.0</td>
<td>22.1</td>
<td>15.3</td>
<td>31.0</td>
<td>14.0</td>
<td>5.0</td>
<td>16.5</td>
</tr>
</tbody>
</table>

NM, Not Mentioned.
Table 5). The strength of this study was that we divided in age groups in order to detect patterns, we followed the most followed division in age groups so far.

4.5 | Gender

With reference to gender differences, regarding sleep bruxism, the majority of studies reported equal prevalence for men and women,4,6,7,9 that was also the case in the study regarding bruxism in general20 (see Tables 4 and 5). One study found a higher prevalence amongst women, this was the case both for awake bruxism and sleep bruxism3 (see Table 5). Also, in our study, both awake bruxism and sleep bruxism were reported more frequently by women than by men (see Table 2). This difference is statistically significant for awake bruxism only (P = 0.01).

4.6 | SES

Since our study was part of a large epidemiologic survey on oral health of the general Dutch adult population, also the SES was assessed. It was revealed that awake bruxism and sleep bruxism were reported more frequently by participant with high SES (see Table 3). This difference is statistically significant for awake bruxism only (P < 0.05). In the other prevalence studies, Agerberg and Carlsson determined the level of education,4 Jensen and coworkers determined the sociodemographic variables,5 and Khoury and coworkers determined the SES, namely the years of education,9 but neither of them reported regarding the prevalence of awake bruxism and/or sleep bruxism and the SES.

4.7 | Sample and sample size

Regarding the sample of the prevalence studies, all the authors could explain that the chosen target group is representative for the adult population. The Swedish study included 1.106 participants4 (Table 5), the Danish study included 975 participants5 (Table 5), and the Canadian study included 2.019 participants6 (Table 4). In the European study, a total of 13.057 participants were included (in the United Kingdom, 4972 in Germany, 4115 subjects respectively)7 (Table 4). Furthermore, in the Israeli study 402 participants were included8 (Table 5), in the Canadian study 6.357 participants9 (Table 4), and in the Italian study 483 participants20 (Table 4). It was mentioned in the Methods section that all edentulous participants were excluded from the analyses so only data of the dentate participants were analysed (n = 1209), this was done to make a comparison possible with the other prevalence studies. The selection procedure of our study is described in the Methods section. In addition, it can be reported that because of the fact that bruxism appeared to have a socioeconomic gradient and we have found that there was a slight difference in SES between respondents and non-respondents, we have weighted the outcomes using the socioeconomic status of the different age groups. These weight factors were retrieved of the Health survey of Statistics Netherlands.21 Repeating the analyses using the weighted data did not result in statistically significant different results: Percentage of self-reported sleep bruxism decreased by 0.4% to 16.2% and by 0.1% to 4.9% for awake bruxism. It was concluded that the used sample of 1209 participants can be regarded as representative for the Dutch adult population, which is a strength of this study. Also here, agreement is necessary, how to select representative samples amongst general adult populations.

4.8 | Future perspectives

Awake bruxism and sleep bruxism are considered as two separate normal behaviours. There is a need to collect prevalence data for these conditions separately, in representative populations, that can be used for constructing a framework of “normality” (with respect to gender and age patterns). Consensus should be achieved regarding the exact questioning, since the questions itself can influence the results.

5 | CONCLUSION

The results of assessing possible awake bruxism and possible sleep bruxism, being part of a large epidemiologic survey on oral health of the general Dutch adult population, revealed a prevalence of 5.0% of the total population for awake bruxism and 16.5% for sleep bruxism. Women reported to have both awake bruxism and sleep bruxism more often, these differences were statistically significant. Concerning socioeconomic status (SES), both awake bruxism and sleep bruxism were more often found in high SES groups, being statistically significant for awake bruxism only. Therefore, it was concluded that sleep bruxism is a common condition in the Dutch adult population while awake bruxism is seen more seldom.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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