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Promoting Safe Sunlight Exposure among School Students in Saudi Arabia: A National Comparative Study

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Abstract

Background: Skin exposure to solar ultraviolet β radiation is the major source of vitamin D in our bodies. This is of particular interest to students with accelerated childhood and adolescence growth phases. This study aimed to examine the effects of Saudi Ministry of Health (MoH) educational campaign on promoting Saudi students' knowledge, attitudes and practices related to safe sunlight exposure (SSE).

Methods: A national comparative observation study was conducted on two stratified random samples of governmental school students in the five geographical regions of Saudi Arabia. Students were randomly selected from two groups; first group attended the educational campaign while the second was a control group who don't attend the campaign. Data were collected four weeks after MoH campaign (between April and May 2018) using a specially designed self-administered questionnaire. Data were collected, tabulated, and statistically analyzed using SPSS, version 22.

Results: 3032 questionnaires were completed, returned, and included in the data analysis (1611 in the intervention group and 1421 in the control group). A statistically significant better knowledge, attitude about SSE and intention to increase sun exposure in the future were recorded among students who attended the educational program compared to the control group (p value < 0.01). However, no significant difference in practice was detected between the two groups.

Conclusion:

Educational campaigns among school-aged children could be effective in improving students' knowledge and attitudes about safe sunlight exposure.

Keywords: Bone health; Saudi Arabia; Students; Sunlight-exposure; Vitamin D**.**

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1. Introduction

Sunlight is composed of three major wavelength bands: visible light, UVR, and infrared radiation [1]. Exposure of the skin to solar ultraviolet B radiation is the major source of vitamin D in our bodies and only a small proportion is derived from dietary intake [2]. The solar UVR penetrates deeper into the epidermis to induce vitamin D synthesis [3]. Modifiers of this synthesis include the UV index (time of year or day season, geographic latitude, altitude, cloud cover, and surface type) [4], and personal factors (e.g., skin pigmentation, clothing, and genetics) [5].

Vitamin D is essential for musculoskeletal health [4] and its deficiency is associated with a range of bone diseases such as rickets, osteopenia, osteoporosis, and osteomalacia [6]. Frequent appropriate exposure has been associated with significant reduction in the incidence of cancers including breast, prostate, colon/rectum, and non-Hodgkin's lymphoma [7,8,9,10]. On the other hand, excessive or acute exposure is strongly associated with some negative health consequences such as skin cancer. Therefore, it is very important to "get the balanced SSE" to ensure benefits without increasing harm [11,12]. Vitamin D deficiency (VDD) is now recognized as a pandemic [13]. Furthermore, owing to a variety of factors, including sun-avoiding behaviors,[14] decreased levels of SSE awareness,[15] and reduced dietary intake of vitamin D,[16] more than 50 percent of the world's population are at risk for VDD.

The American Academy of Family Physicians (AAFP) advises talking to children and young adults (10 to 24 years of age) about SSE, [17] and the U.S. Food and Drug Administration (FDA) guidelines recommended to plan for sunlight exposure [18]. Meanwhile, in Saudi Arabia, the Ministry of Health (MOH) has expended considerable efforts to launch and activate a series of nationwide educational campaigns to raise awareness about SSE. The main message of these campaigns was designed based on Al-Amri et. al. study, (2015) that determined the optimum time for SSE in Saudi Arabia. The study concluded that the optimum SSE timing for vitamin D3 production during summer is from 8:30 to 10:30 am as well as 2:00 to 4:00 pm [19]. As for winter season; another local study concluded that the optimum SSE timing for vitamin D3 production in Saudi Arabia is from 10:00 am to 2:00 pm [20].

The national educational campaign: "Strengthen Your Bones" is a national SSE educational campaign targeting Saudi governmental school students from each of the five geographical regions of Saudi Arabia. The campaign was launched on February 28, 2018 and lasted for five weeks. It covered 639 schools, which represented 2.6% of all governmental schools distributed throughout Saudi Arabia. The educational intervention was conducted by public health experts, school personnel, and health professionals from the National Program for Osteoporosis Prevention. The campaign was designed to improve children's knowledge about SSE and positively modify their attitudes and practices by way of four main messages: the importance of sunlight exposure for bone health, recommended safe exposure techniques, optimal SSE duration, and the appropriate time of day for exposure during the summer and winter. Educational messages were presented through lectures, posters, discussions, and feedback. Also, practice sessions were conducted at the end of each learning session to reinforce knowledge retention and post-campaign behavioral changes. The effects of national health educational campaigns targeting students have not been evaluated before in Saudi Arabia. Therefore, this study aimed to evaluate the effect of a safe sunlight exposure promotion campaign among school students in Saudi Arabia.

2. Subjects and Methods

2.1 Study design and setting

The study was a national comparative study between two groups: one was exposed to the SSE educational campaign and another group served as the control. Data was collected between April and May 2018; four weeks after completion of the "Strengthen Your Bones" national educational campaign.

2.2 Participants

The study was conducted among two stratified random samples of male and female Saudi governmental primary, intermediate and secondary school students aged 6 to 19 years old. Data were collected from both groups of students, with one group attending the national educational campaign about SSE and the other as a control).The sample size was calculated using epi info and hypothesized 15% improvement in the knowledge level among students who attended the educational campaign compared to the control group within a one-month period and with a 95% confidence level and 5% margin of error. The sample was estimated to include 1250 students and increased to include 1500 students in each study group "to make allowance for invalid or incomplete data. A multistage sampling technique was adopted with the first stage encompassing the twenty Health Affairs Directorates in the five municipal regions of Saudi Arabia. The second stage was divided according to the three educational levels: primary, intermediate, and secondary. The third stage categorized each educational level into boys' and girls' schools. The fourth stage was a simple random sample class from each school (25

students each). The same technique was used to select students from schools not included in the educational campaign to serve as a control group.

2.3 Instrumentation & Procedure

Data were collected in Arabic using a predesigned self-administered content-validated questionnaire (internal consistency = 0.73). Students in intermediate and secondary school completed the questionnaire independently, while younger students in the primary grades 1, 2, and 3 were provided individual assistance. The questionnaire included the following items:

1. Socio demographic variables, including age, sex, and school grade
2. Assessment of knowledge regarding SSE i.e. the appropriate duration, method, and time of exposure for SSE
3. Assessment of attitudes regarding the importance and sufficiency of sunlight exposure
4. Assessment of sunlight exposure practices
5. Intentions to increase SSE in the future
6. Opinions about the educational campaign

A knowledge score was used to assess knowledge levels with correct answers encoded as one mark and wrong answers and don't know encoded as zero. The total knowledge score ranged from 0 to 4. Practice of SSE per week was measured using a four-point Likert scale: always (daily) =4, often (3-4 times per week) =3, sometimes (1-2 times per week) =2, never =1). Attitude was measured as a positive, negative, or neutral attitude (yes, no, or maybe).

2.4 Statistical analysis

Data were collected, tabulated, and statistically analyzed using SPSS, version 22. Descriptive statistics in the form of frequency and percentage for categorical data were computed, as well as measures of central tendency (mean and median) and measures of dispersion (standard deviation and range) for continuous variables. χ^2 statistical test was used to compare categorical data. According to data distribution, independent t-test or Mann–Whitney statistical test was utilized for comparison of two groups, and Kruskal–Wallis test for comparison of more than two groups regarding continuous and ordinal variables. Differences were considered as statistically significant when the p value was less than 0.05.

3. Results

The questionnaire was distributed to 3125 students in the two groups. A total of 3032 questionnaires were completed, returned, and included in the data analysis (1611 in the interventional group and 1421 in the control group), corresponding to a response rate of 97%. The two study groups

had good demographic parity with no statistically significant differences in age, sex, or school level (p values > 0.05). The demographic records of the study groups are depicted in Table (1).

Table (1) Demographic Data of the Study Groups

Characteristics	Intervention Group N (%) 1611	Control Group N (%) 1421	P value
Gender			
Male	749 (46.5)	712 (50.1)	0.051
Female	862 (53.5)	709 (49.9)	
School level			
Primary	562 (34.9)	498 (35.0)	
Intermediate	490 (30.4)	434 (30.5)	0.986
Secondary	559 (34.7)	489 (34.4)	
Age (year)			
Mean (SD)	14.2(2.6)	14.2(2.6)	0.841
Range	6:19	6:19	

The level of SSE awareness among the two study groups is shown in Table (2). Statistically significant differences (*P values* < 0.01) were recorded between the two study groups on all knowledge questions, with higher knowledge levels among students who attended the educational campaign compared to the control group. Knowledge about appropriate methods for sun exposure was the highest correctly answered question by the intervention group, while also being the question with the greatest variation compared to the control group (82.4% vs 66.4%, respectively). Knowledge regarding the appropriate time for exposure during the winter was the least correctly answered (59.8% and 47.4% among intervention and control groups respectively). The total knowledge score for students who attended the educational campaign was statistically significantly higher than the control group (Median score 3, IQR 2:4 vs 3, 2:3 respectively; p value < 0.001).

Table (2) Knowledge about SSE among the Study Groups

Knowledge regarding SSE*	Intervention Group N (%) 1611	Control Group N (%) 1421	P value
1- Safe time of day for exposure during summer season	1287 (79.9)	970 (68.3)	< 0.001**
2- Safe time of day for exposure during winter season	964 (59.8)	673 (47.4)	< 0.001**
3- Optimal duration for exposure	1253 (77.8)	915 (64.4)	< 0.001**

4- Optimal method for exposure	1328 (82.4)	943 (66.4)	< 0.001**
5- Total Knowledge score; Median (IQR)***	3 (2:4)	3 (2:3)	< 0.001**

* Correct answers
** Highly significant
*** Interquartile range

Table (3) shows that attitudes were significantly higher among students who attended the educational program compared to the control group as 49.8% vs 44.1% respectively thought that their quantity of sun exposure was sufficient for their health (p value = 0.001), while 96.0% vs 93.5% respectively thought that sun exposure is essential for their health (p value = 0.008), and 60.6% vs 51.6% respectively had the intention to increase their sun exposure in the future (p value < 0.001). However, no significant difference in practice was detected between groups (p value = 0.814).

Table (3) Attitudes towards SSE among the Study Groups

Attitude towards SSE*	Intervention Group	Controls Group	P value
	N (%) 1611	N (%) 1421	
1- Do you think you get a sufficient healthy amount of sun exposure?	802 (49.8)	626 (44.1)	0.001**
2- Do you think that there is a relationship between sun exposure and bone health?	1547 (96.0)	1329 (93.5)	0.008**
3- Do you intend to increase your sun exposure in the future?	976 (60.6)	733 (51.6)	< 0.001**

* Positive answers
** Highly significant

Among students attended the educational campaign (intervention group), the campaign's aim and messages were understood and comprehended among 85.8% and 82.8% of students, respectively. Gender wasn't associated with any significant differences in the following studied variables: total knowledge score, comprehensiveness of the campaign messages, and understanding the aim of the campaign (p values > 0.05). Females were shown to be significantly higher in their intentions to increase their sun exposure than males (63.2% vs 57.5% respectively, p value = 0.041), while significantly more males thought that their quantity of sun exposure was sufficient for their bone health (53.8% vs 46.2% respectively, p value = 0.002). The majority of both females and males had the attitude that sun exposure is essential for their health with no statistically significant difference (96.8% vs 95.2% respectively, p value = 0.198) while males were significantly higher in the exposure practice compared

to females (45.5% vs 29.9% respectively, p value < 0.001) (Table, 4).

Table (4) Gender Differences related to Different Study Variables among the Intervention Group

Different study variables among the intervention group*	Males	Females	P value
	N (%) 749	N (%) 862	
Total Knowledge Score of SSE			
Total Knowledge score; Median (IQR)***	3 (2:4)	3 (2:4)	0.093
Comprehensiveness of the campaign messages			
Campaign message was clear & understandable	609 (81.3)	725 (84.1)	0.076
Understanding the aim of the campaign			
Actual aim of the campaign (Right answer)	654 (87.3)	728 (84.5)	0.101
Attitude towards SSE			
1- Do you think you get a sufficient healthy amount of sun exposure?	**403 (53.8)**	399 (46.3)	0.002**
2- Do you think that there is a relationship between sun exposure and bone health?	713 (95.2)	834 (96.8)	0.198
3- Do you have the intention to increase your sun exposure in the future?	431 (57.5)	**545 (63.2)**	0.041
Practice of SSE			
Almost daily (Always)	**341 (45.5)**	258 (29.9)	< 0.001**
3-4 times a week (Often)	184 (24.6)	219 (25.4)	
Once or twice a week (Sometimes)	165 (22.0)	318 (36.9)	
Never	59 (7.9)	67 (7.8)	

* Positive answers; ** Highly significant; *** Interquartile range

On the other hand, among the same study group (intervention group), school grade was found to be significantly associated with all the studied variables, e.g. Primary school students showed higher total knowledge score, better attitude and intentions to increase their future sun exposure, comprehensiveness of the educational messages, and understanding the aim of the campaign and significant higher exposure practice than students from intermediate and secondary school grades (p values < 0.05) (Table 5).

Table (5) Educational Stage Differences Related to Different Study Variables among the Intervention Group

Different study variables among the intervention group*	Primary	Intermediate	Secondary	P value
	N (%) 562	N (%) 490	N (%) 559	
Total Knowledge Score of SSE				
Total Knowledge score; Median (IQR)***	3 (2:4)	3 (2:4)	3 (2:4)	0.045
Comprehensiveness of the campaign messages				
Campaign message was clear & understandable	484 (86.1)	406 (82.9)	444 (79.4)	0.002**
Understanding the aim of the campaign				
Actual aim of the campaign (Right answer)	503 (89.5)	424 (86.5)	455 (81.4)	< 0.001**
Attitude towards SSE				
1- Do you think you get a sufficient healthy amount of sun exposure?	342 (60.9)	233 (47.6)	227 (40.6)	< 0.001**
2- Do you think that there is a relationship between sun exposure and bone health?	546 (97.2)	473 (96.5)	528 (94.5)	0.041
3- Do you have the intention to increase your sun exposure in the future?	386 (68.7)	276 (56.3)	314 (56.2)	< 0.001**
Practice of SSE				
Almost daily (Always)	225 (40.0)	174 (35.5)	200 (35.8)	< 0.001**
3-4 times a week (Often)	176 (31.3)	123 (25.1)	104 (18.6)	
Once or twice a week (Sometimes)	130 (23.1)	155 (31.6)	198 (35.4)	
Never	31 (5.5)	38 (7.8)	57 (10.2)	

* Positive answers
** Highly significant
*** Interquartile range

4. Discussion

Saudi Arabia has a desert climate with consistently high daytime temperatures. From May to September, temperatures reach 45°C or higher throughout the country, with somewhat cooler coastal temperatures and with the exception of the mountainous regions of the southwest where temperatures can reach as low as 10°C even during the summer [21].

Little is known about SSE knowledge and behaviors among Saudi students. A broad literature review revealed three previous studies about SSE among the Saudi population; one was a national study of the general public,[21] another was conducted among school children in a single province of Saudi Arabia,[7] and the third was conducted among non-medical female students in the Sulaymaniyah campus of King Abdul-Aziz University [22] and all were cross-sectional observational studies.

It is now becoming clear that apart from several risk factors, the lack of awareness is also posing a serious threat for low vitamin D levels almost in every age group [7]. The present educational campaign utilized information, motivation, and behavior-based interventions as a strategy to improve knowledge, attitude, intentions, and practice regarding safe and ideal sunlight exposure among school students in Saudi Arabia. The results of this comparative study demonstrate that a significant improvement in students' knowledge and intentions about SSE practice may be affected by school-based health educational interventions.

SSE knowledge among study groups: Given that skin exposure to sunlight fulfills 80-100% of the body's vitamin D requirement, insufficient SSE is the main cause of vitamin D deficiency [23,24]. In this study, significantly higher knowledge scores about SSE were seen in the intervention group compared to the control group, revealing that there was an improvement in knowledge among respondents from the schools which were covered by the educational campaign. This finding is similar to the findings of other existing studies [25,26]. This can be explained by the continuous cumulative MOH awareness efforts about vitamin D over the past 3 years. Consequently, further efforts in providing similar health educational interventions to students will have a positive impact on their SSE knowledge, awareness, and intentions to practice.

Although there wasn't a significant gender difference in the total knowledge score among the intervention group, which inconsistent with other studies demonstrated that a lack of vitamin D basic knowledge is more prevalent among girls than boys. Siddiqui et al. also reported a lack of awareness about the role of vitamin D among schoolgirls (12–15 years) [27]. This finding may be due to the balanced educational campaign efforts on both boys and girls' schools.

On the other hand, the increase of knowledge among the intervention group was found to be higher among primary school students compared to intermediate and secondary school students; this might be due to the language used and health messages being designed to be accessible to the lowest participating age group, resulting in greater engagement among the younger study participants. This supposition is supported by the reverse correlation between students' ages and their evaluation of the campaign's aim and messages. This mixed result illustrates the importance of taking into consideration UNICEF's report that challenges, concerns, and capacities vary by age, requiring professionals to design health messages according to the targeted age to ensure that intellectual needs are met, and behavioral changes are addressed in the most effective way [28].

SSE attitude and intentions among studied groups: Both the reported attitude and intention of respondents in the intervention group were higher than in the control group. It's possible that the attitude difference is actually greater since the phrasing of the attitude questions may have implied to students in the control group that a relationship exists between SSE and bone health, although they were not actually previously aware of a relationship. Although the majority of students in both groups agreed that sun exposure is vital for bone health, this was not reflected in their self-report of sufficient SSE practice. While almost all respondents indicated their intention to increase their level of SSE, previous research has shown that only half of such intentions are likely to translate successfully into actions [29,30].

In the current study, while there wasn't a significant gender difference in attitudes towards the importance of sun exposure for bone health among the intervention group, yet a greater proportion of girls reported an intention to increase their sun exposure compared to boys.

Almost half of the intervention group (49.8%) believed that their SSE was sufficient, yet 96% indicated their intention to increase their SSE. One possible explanation for this apparent discrepancy is that the respondents are children, and when asked by the adult interviewer if they intend to change their behavior, they may have felt pressured to answer affirmatively. Another possibility is that some students considered themselves to have a sufficient but still sub-optimal level of SSE, and therefore still intend to increase.

Sunlight exposure practice among study groups: In this study, there wasn't a significant difference in the practice score between the two study groups (P =0.814) because of the immediate collection of data after the educational campaign. Most students reported low to moderate levels of sunlight exposure. This is unsurprising owing to the high daytime temperatures in Saudi Arabia which limit time spent outdoors during daylight hours,[30] resulting in an indoor lifestyle in Saudi Arabia which is an obstacle for children and adults to obtain sufficient amounts of direct sunlight [31]. However, boys in the current study reported significantly more frequent sunlight exposure than girls. This is consistent with other studies conducted in Saudi Arabia[7] also with a similar study that was carried out in Hong Kong showed that despite of having good knowledge about vitamin D, younger (middle-aged) women lacked awareness about the role of sunlight in vitamin D production and expressed negative opinions regarding optimum exposure to sunlight [32]. In Saudi Arabia, sociocultural factors are also likely to play a role, as boys have more opportunity than girls to spend time outdoors and thus receive greater sunlight exposure; this is also reflected in another finding in the current study, that boys were more satisfied by their amount of sun exposure.

Girls in Saudi Arabia receive little or no sunlight due to the covering of their bodies -including their arms and faces [30] when going out for cultural traditions and religious reasons. Evenings are the preferred outing time for girls. On the other hand, Sedrani and colleagues reported that veils could minimize exposure to sun irradiation but was not a major factor for VDD as a whole, in female Saudi students [33].

A number of girls' schools in this study also reported that their outdoor yards are fully covered, preventing proper sunlight exposure during school recesses. This matches the findings in a study by Christie (2011) conducted among female students in Saudi Arabia. They reported limited sun exposure due to intense heat, cultural reasons for covering the body, and an infrastructure that makes sun exposure difficult [29]. Although the campaign's educational program included a practice session, some schools did not apply that session because students were busy, they had no outdoor yards in the school, or all school yards were covered. These barriers pose a challenge to decision-makers, who need to balance between protecting students from sunburn and the health benefits of sunlight [34].

The aim and messages clarity and comprehensibility of the educational campaign: The educational campaigns' messages were comprehended in 86% and the aim of the campaign was understood by 91% of students. These percentages are considered high and it might relate to the effective communication through using multiple educational tools (lectures, discussions, practice focus groups, posters and giveaway educational packages).

Studies that evaluated children's awareness levels about vitamin D and bone health in Saudi Arabia are scarce especially those comparing students in different educational stages. Therefore, we were constrained in comparing the effect size of our intervention with other studies among students in Saudi Arabia. Another limitation in this study was the immediate collection of data after the educational campaign without allowing sufficient time to assess changes in practice. The effect of a national health educational campaigns targeting students has not been evaluated before in Saudi Arabia. To the best of our knowledge, this is the first national study from Saudi Arabia to evaluate the effect of a health education campaign in improving knowledge, intentions and practice regarding SSE among school students. The study was carried out nationwide covering all school levels and both sexes. The sample was selected over a multistage, well stratified random method, resulting in an excellent match pair.

5. Conclusion

This study has shown that educational intervention campaigns are effective in improving knowledge and intentions regarding SSE. It seems that primary school is an appropriate site and period

to communicate messages about SSE. It is recommended to involve school staff in the health educational interventions and modifying the schools' designs to create environment that allow enough SSE and provide alternative applicable solutions especially for girls. Further research is needed to assess the long-term effects of such educational campaigns.

5.1 Implications for School Health

Considering the low knowledge regarding recommended SSE guidelines among school students found in this and previous studies, [25,26] tailoring SSE messages and interventions to the special characteristics of this age group is an important step to translate intentions successfully into actions. However, health education interventions need careful consideration as adolescent students may actively resist health messages directly targeting them especially secondary school students. This may be especially true for SSE measures that were imposed on them during childhood. Clearly, school-based SSE educational campaigns play a key role in educating younger age groups at school, but these campaigns may be less successful for adolescents, resulting in the necessity for complementary strategies for older children. Such complementary strategies should directly address the factors influencing practice.

This study and previous research highlighted gender differences in school students SSE practices with boys reported significantly more frequent sunlight exposure than girls.[7,32] This is unsurprising owing to the sociocultural factors in Saudi Arabia.[30] Gender considerations should be taken during the design of the educational campaigns in addition to outdoor yard of girls' schools to permit sufficient SSE. A further complication for the development of appropriate interventions is the need to balance sun exposure with other potentially conflicting health goals. Excessive exposure of the skin to UV radiation is a major cause of skin cancer.[35,36] Hence, sun exposure guidelines for people living in high-UV regions like Saudi Arabia should consider the interplay between various health-related behaviors, such as the appropriate time and duration of SSE during different seasons.

Finally, a key intervention implication for the results in this study is that there is a room for improvement across almost all aspects of SSE. This highlights the need for intensified efforts to approach adolescents with messages and media formats they consider trustworthy and relevant to their lifestyles.

5.2 Recommendations

Future studies may include a follow up questionnaire to measure actual changes in SSE practice post-intervention. These studies will need to include a self-report of estimated current SSE times (e.g. number of minutes per week), which will give more context to answers about sufficiency of current

practices. They may also wish to consider taking proactive steps to reduce the number of inclined abstainers, i.e. those who are in favor of change and yet persist in existing behaviors. This may include identifying necessary resources, ways to overcome forgetfulness and establish new habits, motivations for setting priorities, and suggesting detailed implementation steps [31].

6. Declarations

6.1 Abbreviations

KAP	Knowledge, Attitude & Practice
MOH	Ministry of Health
SSE	Safe Sunlight Exposure
VDD	vitamin D Deficiency

6.2 Conflict of Interest Statement

The authors have no conflict of interests to declare.

6.3 Funding Disclosure

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

6.4 Ethical Considerations

Ethical approval for the study was obtained from the Institutional Review Board at King Fahad Medical City, Riyadh, Saudi Arabia (Category of Approval: Exempt). Consent was received from each participating student prior to administration of the questionnaire and after explaining the nature and benefit of participation. The researcher informed participants about their right to withdraw from the study at any time without giving a reason, causing no penalty. Data gained from the study were kept in a secure place of storage only accessible by the research team.

6.5 Authors Contributions

NJA, NKA and SAA contributed to the design and implementation of the research and writing of the manuscript. WAA performed the analysis, aided in interpreting the results and worked on the manuscript. MAN helped in facilitating data collection and contributed to the final version of the manuscript. SBA contributed to the final version of the manuscript. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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