

The Effect of Listening to Music on Stress Reduction among Twelfth-grade Students

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ABSTRACT

OBJECTIVE To examine the effects of listening to music on stress reduction among twelfth-grade students.

METHODS A quasi-experimental study was conducted with 116 twelfth-grade students recruited from a public school in Bangkok, Thailand, of whom 82 completed the study. During a 20-minute period, an intervention group (47 students) listened to music drawing upon nature sounds, while a control group (35 students) read about stress reduction techniques. Measurements were made of heart rates and stress levels using the Thai Stress Test (TST) and a 5-point Likert scale (stress 5-PL) at baseline and immediately after the activities. The t-test and chi-squared test for linear-by-linear association were used to compare changes in the stress parameters.

RESULTS Analysis of the baseline and post-intervention data revealed that music listening significantly reduced heart rates and scores for TST and stress 5-PL ($p = < 0.001$, 0.016 , and < 0.001 , respectively). However, reading about stress reduction produced no significant lowering of heart rates or scores for TST and stress 5-PL ($p = 0.057$, > 0.999 , and 0.070 , respectively). In a comparison between the groups, there were no significant differences in the reductions in heart rates or scores for TST and stress 5-PL ($p = 0.490$, 0.182 , and 0.199 , respectively).

CONCLUSIONS Listening to music for 20 minutes significantly decreased both physical and psychological stress, but the reduction did not differ from that achieved by reading about stress reduction.

KEYWORDS stress, music listening, students, adolescents, relax

INTRODUCTION

Stress is the body's reaction to changes that require physical and mental responses (1, 2). Appropriate stress levels allow individuals to be alert and prepared. On the other hand, excessive stress can lead to physical and mental illnesses (3).

Adolescence—the transitional stage of development between childhood and adulthood—is a critical period of change (4, 5). During that time, the brain, behavior, and hormonal systems undergo heightened remodeling (6). Additionally, the challenges of relationships, academic expect-

tations, and the responsibilities to the family render adolescents vulnerable to stress (3).

A previous study of twelfth-grade students from a public school in Bangkok, Thailand, found that most students (66.2%) had an above-average level of stress. More specifically, slightly higher-than-average stress was experienced by 51.4% of the students, moderately higher-than-average stress by 12.6%, and much higher-than-average stress by 2.2% (7).

Another study in Thailand also reported a positive correlation between adolescents' stress levels and depressive symptoms (5). Stress in

adolescents has also been associated with suicide attempts (3, 8). Therefore, stress reduction intervention is important for Thai high-school students.

Music has been shown to beneficially affect stress-related physiological (9, 10), cognitive, (11) and emotional processes (12, 13). Vibroacoustic therapy has also been used for the treatment of insomnia, anxiety disorders, self-injurious behavior, challenging behavior, autism, depression, and stress (14).

Several hypotheses about the mechanism of stress reduction by listening to music have been proposed. First, the music rhythm alters emotions as well as physiological functioning, e.g., heart rate, muscle tone, blood pressure, and respiration (15, 16). The sound is converted into electrical impulses which are sent by the reticular activating system (RAS) in the brain stem to the thalamus before being relayed to multiple areas of the cerebral cortex, cerebellum, corpus callosum, limbic system, and neuroendocrine systems (14, 17). Furthermore, the autonomic nervous system under the influence of music exhibits a relaxation response which can be seen in the alpha brain wave frequency observed on an electroencephalogram, and by a physiological manifestation: a state of muscular relaxation with regular, deep breathing and a lowered heart rate and blood pressure (18).

A meta-analysis study found that listening to either participants' own choice of music or relaxation music could reduce physiological stress (effect size = 0.285 and 0.393, respectively) and psychological stress (effect size = 0.521 and 0.609, respectively) (19). Characteristics of relaxing music include a constant rhythm with a 60–80 beats/min tempo, a frequency of 600–900 Hz, and little change in dynamics (14, 19). Twenty minutes is the minimum duration of music listening that has been associated with stress reduction (20).

Music listening is an interesting stress management method because of its simplicity, non-invasive approach, and cost-effectiveness. However, previous studies on the effect of music listening on adolescent stress in Thailand are limited. We therefore conducted this study to examine the effectiveness of listening to music in reducing the stress levels of twelfth-grade Thai students.

METHODS

Study design

This quasi-experimental study was registered in Thai Clinical Trials Research (TCTR 20210126001) and conducted in January 2020.

Participants and recruitment

The study took place at a public school (Chinorotwittayalai School) in Bangkok, Thailand. The researcher explained details of the investigation to students and faculty at the school. Twelfth-grade students who were able to read, write, and understand Thai were invited to participate, while students with a hearing impairment were excluded. Before commencement of the study, the formal assent of the participants was obtained in addition to parental consent.

A total of 184 students were initially enrolled (Figure 1). Of that number, 68 students did not meet the inclusion criteria, leaving 116 available for the study who were randomly assigned in equal numbers to an intervention and a control group (58 students each). Unfortunately, a number of students did not attend the study activity session so only 47 participants received the music intervention, while 37 participants were in the control group, a total of 82 students.

Interventions

Participants were asked to provide basic demographic data via a self-report questionnaire. Before the session activity commenced, their heart rates were measured with a hand-held pulse oximeter (MD300M, ChoiceMMed, Beijing, China) to establish baseline values.

The members of the intervention group listened to relaxing piano pieces with nature sounds as a background composed by Chamras Saewataporn. The pieces were entitled "Rainbow", "Strolling in the Garden", "Butterflies and Flowers", "Fog", "Fly to Imagination", and "Forest Wind". All had a constant rhythm of 60–80 beats/min (14). Each participant could adjust the volume of the compositions via their smartphones to suit their individual preferences. The researcher provided participants with download link for the relaxing music to the intervention group. They were asked to rest, follow the flow of the relaxing music for 20 minutes, and not to sleep or do any other activity.

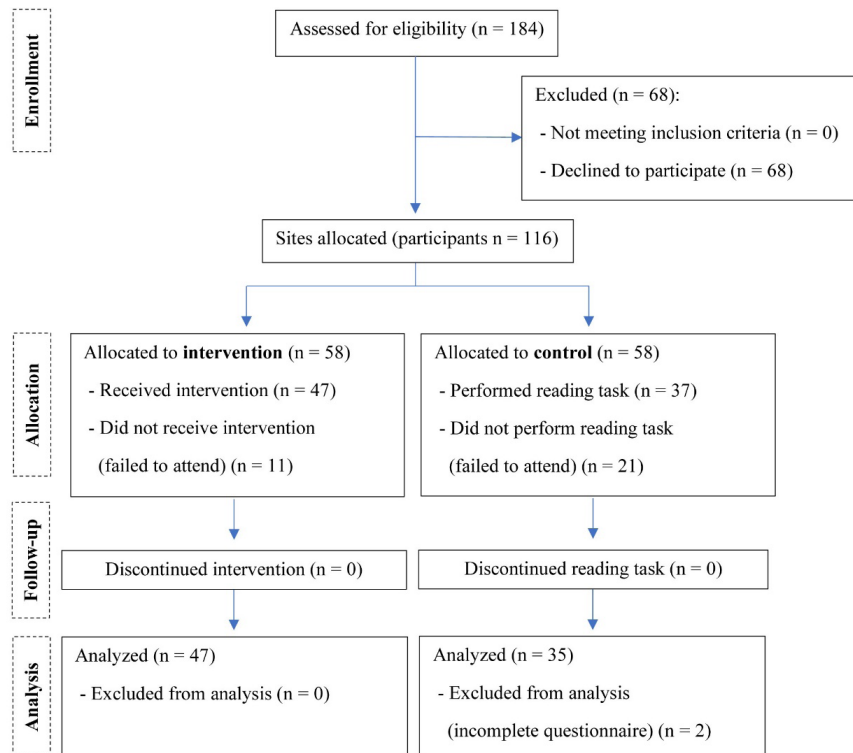


Figure 1. Study flowchart

Concurrently, the control group spent the 20 minutes reading about stress reduction methods provided by the research assistants. Participants in the intervention and control groups sat in separate meeting rooms which were quiet and calm.

Upon conclusion of the assigned activities, the heart rates of all participants were remeasured, and they were asked to again complete the questionnaires.

Outcome measurements

Primary outcome: stress reduction

The students' stress reduction was assessed by both physiological and psychological testing. Stress reduction was measured by change of heart rate, Thai Stress Test (TST) scores and a 5-point Likert scale (stress 5-PL) from baseline to post intervention.

A physiological response to stress, the heart rate was measured by a pulse oximeter at baseline and immediately after the completion of the session activity (16).

The TST and stress 5-PL were used to determine the level of psychological stress. The TST was developed by Phattharayuttawat et al. of the Department of Psychiatry, Faculty of Medicine Siriraj Hospital, Bangkok, Thailand (21)

based on the results of a study of individuals ranging in age from 12 to 60 years. The 24 items of the TST have high construct validity and reliability. The alpha reliability coefficient of the total test is 0.84, and the subscale alpha values range between 0.85 and 0.91. The construct validity of the test consists of 2 factors: negative and positive scales. The values of the 2 scales range from 0.83 to 0.86. In addition, the split-half reliability coefficient of the total test is 0.88.

As to the stress 5-PL, the participants were asked to report their stress level at the time of the assessment by assigning a numerical score in response to the statement, "At this moment, I feel stressed". The score range was 0–4, with a higher score signifying a greater degree of stress (22, 23).

Secondary outcome: music genre

We asked the participants to indicate their favorite music genre by adding this open question to the questionnaire.

Sample size

A previous study of 770 Thai students revealed that two-thirds had higher-than-normal levels of stress (7). In the current investigation, it was estimated that, following the intervention,

the percentage of participants with a higher-than-normal stress level would be 33%, compared with 65% for the members of the control group. Using a 2-sided type I error of 0.05 and an 80% power, 38 samples per group were required. We therefore decided to recruit 42 samples for each group to compensate for the possibility of a 10% participant loss.

Allocation

Participants were allocated equally to the intervention and control groups by purposive sampling. The proportions of science- and art-program students were controlled so that they were the same in each group.

Statistical analysis

Demographic data and favorite music genre are presented using descriptive statistics. The pretest and posttest heart rates, TST scores, and stress-5-PL ratings were compared both within the same group and between the intervention and control groups. Pearson's chi-square test and Fisher's exact test were used to compare the categorical variables of the 2 groups, while the chi-squared test for linear-by-linear association was used for ordinal variables. A paired t-test and the Wilcoxon signed-rank test were used to test the differences between the pretest and posttest values for variables with and without normal distribution, respectively. In addition, an independent t-test was employed to test the differences between the intervention and control groups.

To account for the differences in the baseline data of the intervention and control groups, multiple linear regression was employed for the quantitative outcome, i.e., the heart-rate difference, whereas multiple logistic regression was utilized to analyze the binary outcomes, i.e., reductions in the stress-5-PL and TST values. The data analyses were performed using IBM SPSS Statistics for Windows (version 21.0; IBM Corp., Armonk, N.Y., USA). Two-tailed p-values of less than 0.05 were deemed statistically significant.

Ethical considerations

Prior to the implementation of the study, ethical approval was obtained from the Siriraj Institutional Review Board (COA: Si 843/2019).

The students were provided with a full explanation of the study and were invited to participate. Confidentiality and anonymity were strictly observed. Informed consent to participate was obtained from all participants. Participants were advised that they had the right to withdraw at any time during the study, and that non-participation would not have any detrimental effect on their academic results or academic services received.

RESULTS

A total of 184 students were reviewed for eligibility (Figure 1). After exclusions and losses, 82 participants completed the study. The demographic characteristics of the 2 groups are detailed in (Table 1). Most participants were 18-year-old women with a grade point average (GPA) of more than 2.5. Their main sources of stress were study and their upcoming university (college) entrance examinations. The students in the 2 groups demonstrated no statistically significant differences in age or in their most stressful issues; however, there were statistically significant differences in the sex and GPAs of the intervention and control groups. However, sex and GPA level were not significantly associated with stress level changes in a multiple linear regression analysis of heart rate differences (Table 2) and a multiple logistic regression analysis of the value differences for TST (Table 3) and stress 5-PL (Table 4). A baseline comparison of the stress parameters of the intervention and control groups found they were not statistically different (Table 1).

The pretest-posttest score comparison of the intervention group indicated that there was a significant reduction in heart rate and in the scores for TST and stress 5-PL ($p = < 0.001$, 0.016, and < 0.001 , respectively). In contrast, the pretest-posttest score comparison for the control group found no significant differences in the heart rates and the TST and stress-5-PL scores ($p = 0.057$, > 0.999 , and 0.070 , respectively). There were also no significant differences in the mean heart rates, TST scores, and stress-5-PL ratings of the 2 groups ($p = 0.490$, 0.182, and 0.199, respectively) (Tables 5, 6 and 7).

The favorite music genres of the intervention group were popular music (31.7%), rhythm and blues (17.1%), rap (7.3%), rock (4.9%), hip

Table 1. Demographic and clinical characteristics of intervention and control groups (n=82)

Demographics	Group			p-value
	Total (n=82)	Music (n=47)	Control (n=35)	
Sex, n (%)				
Male	30 (36.6)	22 (46.8)	8 (22.9)	0.026 ^z
Female	52 (63.4)	25 (53.2)	27 (77.1)	
Age (years), n (%)				
17	5 (6.1)	5 (10.6)	0	0.099 ^y
18	73 (89.0)	39 (83.0)	34 (97.1)	
19	4 (4.9)	3 (6.4)	1 (2.9)	
Grade point average, n (%)				
≤ 2.50	4 (4.9)	1 (2.1)	3 (8.6)	0.019 ^y
2.51–3.00	25 (30.5)	10 (21.3)	15 (42.9)	
3.01–3.50	29 (35.4)	17 (36.2)	12 (34.3)	
3.51–4.00	24 (29.3)	19 (40.4)	5 (14.3)	
Most stressful issue in the past month, n (%)				
Studying	17 (21.3)	7 (14.9)	10 (30.3)	0.222 ^y
Entrance examination	40 (50.0)	27 (57.4)	13 (39.4)	
Peer relationships	2 (2.5)	1 (2.1)	1 (3.0)	
Family relationships	4 (5.0)	2 (4.3)	2 (6.1)	
Love	2 (2.5)	2 (4.3)	0	
Finances	9 (11.3)	3 (6.4)	6 (18.2)	
Health	2 (2.5)	2 (4.3)	0	
Other	4 (5.0)	3 (6.4)	1 (3.0)	
Baseline heart rate				
Mean (SD)	81.4 (9.9)	80.5 (9.5)	82.6 (10.4)	0.345 ^z
Baseline TST, n (%)				
Excellent mental health	1 (1.2)	1 (2.1)	0	> 0.999 ^y
Normal mental health	31 (37.8)	18 (38.3)	13 (37.1)	
Mild stress	47 (57.3)	26 (55.3)	21 (60.0)	
Stressed	3 (3.7)	2 (4.3)	1 (2.9)	
Baseline Stress (5-PL), n (%)				
0	10 (12.2)	9 (19.1)	1 (2.8)	0.153 ^y
1	17 (20.7)	7 (14.9)	10 (28.6)	
2	31 (37.8)	17 (36.2)	14 (40.0)	
3	20 (24.4)	12 (25.5)	8 (22.9)	
4	4 (4.9)	2 (4.3)	2 (5.7)	

^z, Pearson's chi-squared test; ^y, Fisher's exact test; ^z, Independent t-test;

SD, standard deviation; TST, Thai Stress Test; stress (5-PL), 5-point Likert scale; p-value < 0.05

Table 2. Results of multiple linear regression of heart-rate differences (post-pre)

	b*	SE(b)	p-value
Group			
Control	–	–	–
Music	–2.841	1.875	0.134
Sex			
Female	–	–	–
Male	1.139	1.831	0.536
GPA			
≤ 3.00	–	–	–
3.01–3.5	0.15	2.022	0.762
3.51–4.00	0.901	2.298	0.696

b*, linear regression coefficient; GPA, grade point average; SE, standard error; p-value < 0.05

hop (4.9%), jazz (2.4%) and other (31.7%). The favorite music genres of the control group were popular music (35.4%), rhythm and blues (9.7%), rock (9.7%), indie (8.1%), rap (6.5%), classical (3.2%), and other (27.4%).

DISCUSSION

This study was conducted to examine the effects of listening to music on the stress response of twelfth-grade students. It was hypothesized that participants in the intervention group would show a greater stress reduction than those in the control group. The results found that the participants who listened to music had a greater decrease in heart rate and

Table 3. Multiple logistic regression analysis of reduction in Thai Stress Test scores

	Change in stress		Univariable analysis		Multivariable analysis	
	No decrease*	Decrease	Crude OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Group, n (%)						
Control	31 (88.6)	4 (11.4)	1		1	
Music	40 (85.1)	7 (14.9)	1.36 (0.36–5.05)	0.65	1.03 (0.22–4.80)	0.966
Sex, n (%)						
Female	48 (92.3)	4 (7.7)	1		1	
Male	23 (76.7)	7 (23.3)	3.65 (0.97–13.74)	0.055	3.35 (0.75–14.98)	0.113
GPA, n (%)						
≤ 3.00	25 (86.2)	4 (13.8)	1		1	
3.01–3.50	23 (79.3)	6 (20.7)	1.63 (0.41–6.52)	0.489	1.81 (0.41–7.98)	0.430
3.51–4.00	23 (95.8)	1 (4.2)	0.27 (0.03–2.61)	0.259	0.34 (0.03–3.58)	0.368

No decrease*, either no change or increase in stress levels; GPA, grade point average; p-value < 0.05

Table 4. Multiple logistic regression of reduction in stress scores for 5-point Likert scale (5-PL)

	Change in stress		Univariable analysis		Multivariable analysis	
	No decrease*	Decrease	Crude OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Group, n (%)						
Control	28 (80.0)	7 (20.0)	1		1	
Music	35 (74.5)	12 (25.5)	1.38 (0.48–3.94)	0.558	1.45 (0.42–4.98)	0.553
Sex, n (%)						
Female	41 (78.8)	11 (21.2)	1		1	
Male	22 (73.3)	8 (26.7)	1.36 (0.48–3.86)	0.569	1.13 (0.34–3.76)	0.840
GPA, n (%)						
≤ 3.00	24 (82.8)	5 (17.2)	1		1	
3.01–3.50	18 (62.1)	11 (37.9)	2.93 (0.87–9.95)	0.084	2.76 (0.79–9.71)	0.113
3.51–4.00	21 (87.5)	3 (12.5)	0.69 (0.15–3.22)	0.633	0.61 (0.11–3.25)	0.559

No decrease*, no change or increase in stress levels; GPA, grade point average; p-value < 0.05

Table 5. Heart rates of intervention and control groups

Heart rate	Mean (SD)		p-value
	Music (n=47)	Control (n=35)	
Pre	80.5 (9.5)	82.6 (10.4)	–
Post	75.5 (9.7)	79.9 (10.9)	–
Post-Pre	–4.9 (6.8)	–2.6 (7.9)	0.160 [§]
p-value	< 0.001 [†]	0.057 [†]	–

[§], Independent t-test; [†], Paired t-test; SD, standard deviation; p-value < 0.05

TST and stress 5-PL scores than those in the control group, but the differences were not statistically significant. Despite the differences in the sex and GPA profiles of the participants in the 2 groups, multiple linear regression (Table 2) and a multiple logistic regression (Table 3 and 4) determined that those factors did not influence the changes in stress levels.

Comparison with other studies

Previous studies have reported that listening to music significantly reduces stress, both physically and psychologically (15, 24–26). The contradiction of the results between the previous studies and the current investigation can be explained in several ways.

First, the populations of previous studies were adults and included unhealthy individuals (24, 26), whereas the participants in our study were all healthy adolescents.

In addition, the duration of the intervention in Han's study (26) was 30 minutes, while in our study it was 20 minutes. Nevertheless, research has found that 20 minutes of listening to music is sufficient to achieve a significant decrease in stress levels (20).

Moreover, the participants in the control group in Han's study (26) were asked to rest,

Table 6. Thai Stress Test of intervention and control groups (n=82)
(a) Comparison of pre- and post-intervention stress levels of each group

Thai stress test (TST), n	Music			Control		
	Pretest (n=47)	Posttest (n=47)	p-value	Pretest (n=35)	Posttest (n=35)	p-value
Excellent mental health	1	5	< 0.016 [¶]	0	1	> 0.999 [¶]
Normal mental health	18	17		13	12	
Mild stress	26	23		21	21	
Stressed	2	2		1	1	

(b) Comparison between the changes in the stress levels of the 2 groups

TST difference (pre-post), n (%)	Music (n=47)	Control (n=35)	p-value
-1 (stress elevation)	0 (0)	3 (8.6)	0.182 [°]
0 (no change)	40 (85.1)	28 (80)	
1 (stress reduction)	7 (14.9)	4 (11.4)	

[¶], Wilcoxon signed-rank test; [°], chi-squared test for linear-by-linear association; p-value < 0.05

Table 7. Stress (5-point Likert scale) of the intervention and control groups (n=82)
(a) Comparison of the pre- and post-intervention stress levels of each group

Stress test (5-PL), n	Music			Control		
	Pretest (n=47)	Posttest (n=47)	p-value	Pretest (n=35)	Posttest (n=35)	p-value
0 (no stress)	9	11	< 0.001 [¶]	1	2	0.070 [¶]
1	7	12		10	11	
2	17	16		14	14	
3	12	7		8	7	
4 (most stress)	2	1		2	1	

(b) Comparison of changes in stress levels between the 2 groups

Difference in stress (5-PL) (pre-post), n (%)	Music (n=47)	Control (n=35)	p-value
-1 (stress elevation)	0 (0)	1 (2.9)	0.199 [°]
0 (no change)	35 (74.5)	27 (77.1)	
1 (mild stress reduction)	9 (19.1)	7 (20)	
2 (moderate stress reduction)	2 (4.3)	0 (0)	
3 (high stress reduction)	1 (2.1)	0 (0)	

[¶], Wilcoxon signed-rank test; [°], chi-squared test for linear-by-linear association; Stress (5-PL), 5-point Likert scale; p-value < 0.05

while the control group members in the present work were asked to read information about stress reduction. By assigning the reading task, we aimed to reduce the likelihood that our control group members would become distracted by some other activity, such as a physical activity. On the other hand, resting without doing any activity (such as reading) might inadvertently increase stress levels by making individuals feel like they are being imprisoned or confined. A meta-analytic review found that psychoedu-

cation had a positive effect on stress reduction with a small effect size (standardized mean difference = 0.27) (27). The intervention in one of the studies examined in that meta-analysis, namely, by Cousineau, involved providing educational material only once and for a short period, which is similar to the intervention in the present article. The research by Cousineau found no significant effects of psychoeducation on stress reduction.

Finally, as the baseline stress levels of the participants in the current study were mild, the pretest–posttest score changes might not have reached statistical significance.

Clinical implications

Listening to music that incorporates nature sounds might help to reduce mild stress, e.g., stress before an examination or a class presentation.

Strengths and limitations

The current work was conducted with adolescents. To date, there have been few studies of the effects of listening to music on stress reduction in adolescents. Moreover, the assessment measures used included both objective (heart rate) and subjective (self-rating questionnaire) elements.

On the other hand, the small sample size of the control group in the study may have lacked the statistical power needed to determine the effectiveness of the intervention. Having a larger sample size is recommended for further studies. Moreover, there was no statistically significant difference in the stress reduction scores of the groups. As the TST scores showed that 40% of participants had a normal stress level at baseline, there may have been a ceiling effect for the stress reduction resulting from the intervention. The differences in the favorite music genres of the 2 groups and the percentage of participants favored popular music in the intervention group may have also affected the results. Additionally, the reading of the stress reduction material by the members of the control group might in itself have had a stress-lowering effect, even though that influence was not statistically significant. Rather than reading stress-reduction literature, using a control condition which does not impact on stress levels is advised for future studies. Doing so may provide an increased opportunity to identify statistically significant differences in stress reduction scores of the groups and thus reveal the true effects of listening to music. In addition, this study used per-protocol analysis to analyze the results. We did not use intention-to-treat analysis because 32 participants (27.6%) from both groups did not come to

school and failed to participate in the music listening or stress management reading activities. They also did not complete any of the questionnaires. The amount of missing data might have affected the reliability of the results interpretation using intention-to-treat analysis. The results of our study could represent only the efficacy of the intervention. Further study of the effectiveness is required.

CONCLUSIONS

Listening to music for 20 minutes can significantly reduce both physical and psychological stress. However, the reduction in stress from listening to music for 20 minutes does not differ from that achieved by reading about stress reduction methods for the same period.

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CONFLICTS OF INTEREST

None

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