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Exploring the Link Between Hepatitis A and B Vaccination and Social Support in the US Population: Insights from the NHANES 2005-2006 Cohort

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Abstract

Background: *High social support is easily assessed and associated with a healthier lifestyle, including vaccination adherence. Similarly, immunization is a widely available public health statistic associated with healthier behaviors. However, the link between the hepatitis immunization status and social support needs to be explored.*

Methods: *We assessed the association between levels of social support and hepatitis immunization status using the National Health and Nutrition Examination Survey (NHANES), a cross-sectional multidisciplinary database publicly available for researchers. With 2005–2006 data, 2997 participants were included. Statistical analyses were conducted using STATA 18.5v software, including the odds ratio of both univariable logistic regression and multivariable logistic regression. After adjusting for clinically relevant confounders, two distinct models were designed: 1) full immunization, and 2) incomplete immunization.*

Results: *Multivariable analysis revealed significantly greater odds of high social support for participants fully or partially immunized against both hepatitis A and B: 3.15 (95% CI 1.03–9.66, $p = 0.04$) and 3.35 (95% CI 1.15–9.75, $p = 0.03$), respectively.*

Conclusion: *Our findings show an association between vaccination and social support in both adjusted models. Individuals not vaccinated at all may behave differently from those willing to be, at least partially, immunized. It seems that a similar behavior that may lead to vaccination may also lead to increased social support. Therefore, our study suggests that hepatitis vaccination could perhaps be a surrogate marker for public-health-related outcomes.*

Introduction

The global burden of Hepatitis A (HAV) and B (HBV) remains a significant public health challenge. Globally, 387 million individuals are reported to be infected with HBV alone (Bhandari et al., 2024; Obeagu, 2023). Vaccination is the primary preventive strategy against these infections and has been an integral part of public health strategies recommended to all infants and adults at risk in the United States since 1991 (Schillie et al., 2018). It prevents serious infections that can lead to chronic liver failure and hepatocellular carcinoma (HBV) or diarrhea with life-threatening dehydration (HAV). (Bhandari et al., 2024; Obeagu, 2023). In addition to direct health benefits, vaccines may be associated with social determinants of health such as income and education (Alsharif et al., 2022). Social risk factors are increasingly recognized as important moderators of public health (Echouffo-Tcheugui et al., 2016; Reeder et al., 2022). Social support, defined as a network of interpersonal relationships providing emotional, informational, and tangible assistance, has been related to many health behaviors and outcomes, including chronic physical and mental diseases (Chapman & Santos-Lozada, 2020; Echouffo-Tcheugui et al., 2016; Reeder et al., 2022; Teoh & Hilmert, 2018). Previous research has described vaccination rate as an indicator of better objective and subjective health status (Wang et al., 2022; Wong et al., 2021), this association has been primarily reported in the context of influenza vaccination. Thus, the link between hepatitis immunization and social support remains unclear. This study performed a secondary cross-sectional data analysis on the association between hepatitis A and B vaccination status and social support among U.S. adults aged 40 years and older. We hypothesized that hepatitis immunization may serve as a lifestyle surrogate associated with mental, physical, and social health indicators.

Materials and Methods

We evaluated the association between immunization against hepatitis A and B and levels of social support in the general adult population through logistic regression. A secondary analysis of the 2005–2006 National Health and Nutrition Examination Survey (NHANES), a publicly available cross-sectional database, was performed (CDC, 2005–2006). The main outcome was social support, measured by a social support score previously proven valid in other studies (Nicklett et al., 2012; Lindsay Smith et al., 2017; Teoh & Hilmert, 2018; Wang et al., 2024). It comprises five variables: emotional support, financial support, religious service attendance, number of close friends, and marital status. Each positive answer contributes one point to the score, ranging from 0 to 5 (Wang et al., 2022). Participants with a score of 0–3 were classified as having low social support, whereas those scoring 4–5 were categorized as having high social support. The original data were collected at home by trained interviewers after obtaining appropriate informed consent. This analysis included 2,997 individuals aged 40 years or older who completed the NHANES Social Support and Immunization Questionnaires. Hepatitis immunization status was measured using two different approaches. First, participants were considered fully immunized if they received two doses of the hepatitis A vaccine and three doses of the hepatitis B vaccine. The remaining patients were considered not to be fully immunized. Second, individuals were considered immunized if they reported at least one dose of each vaccine and were not immunized otherwise. The following clinically relevant confounders were included in the multivariate analysis (Andrea et al., 2016; Reeder et al., 2022; Wang et al., 2024). Age, gender, race/ethnicity, family poverty index ratio (PIR), educational level, smoking status, alcohol consumption, food insecurity, sleep habits, physical activity, caffeine intake, comorbidities, and mental health status (PHQ-9 score) were controlled for demographic, socioeconomic, lifestyle, and past medical history. All variables were coded as follows:

Independent variable - Hepatitis Immunization (binary)

1- Full immunization: if the participant declared having two Hepatitis A doses and three Hepatitis B doses of vaccination. Having incomplete schemes or no doses were grouped together as "not fully immunized."
2- Some immunization: if the participant declared having at least one dose of both Hepatitis A and B vaccinations. Lacking at least one dose of either Hepatitis A or B immunization was grouped together as “not vaccinated”.

Outcome - Social support assessment (binary)

Five dichotomous social support variables were used to create the social support scoring index. The struc-

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ture and predictive effectiveness of this index for the NHANES have been reported in previous studies. This score comprises emotional support, financial support, frequency of attending religious services, number of close friends, and marital status (Nicklett et al., 2012; Lindsay Smith et al., 2017; Teoh & Hilmert, 2018; Wang et al., 2024).

More specifically, 1 point was assigned to the answer "yes" for the question on emotional support (Can you count on anyone to provide emotional support such as talking over problems or helping make a difficult decision?) and financial support (Could you count on anyone to help, for example, by paying any bills, housing costs, hospital visits, or providing food or clothes?). The answers "no," "don't need," or "don't accept" were assigned as "0" (Nicklett et al., 2012; Lindsay Smith et al., 2017; Teoh & Hilmert, 2018; Wang et al., 2024).

In addition, one point was assigned for being married or living as married, attending at least four religious services per year (how often do you attend church or religious services?), and having four or more close friends (in general, how many close friends do you have?). For any of these questions, participants who refused to answer the question or answered "don't know" were considered as missing data. Answers that were not assigned one or missing data were coded as "0" (Nicklett et al., 2012; Lindsay Smith et al., 2017; Teoh & Hilmert, 2018; Wang et al., 2024).

The sum of the social support score indices ranged from zero to five. The social support score was then classified into two groups: low social support (social support score = [0–3] and high social support (social support score = [4–5].

Covariates

Confounders associated with social support include age, sex, race, family poverty-to-income ratio (PIR), body mass index (BMI), marital status, educational attainment, and smoking status (Andrea et al., 2016; Reeder et al., 2022). In addition, social support was also previously linked to cardiovascular diseases in a study that identified significant baseline differences in social support groups by age, BMI, education level, race, and smoking status (Wang et al., 2024).

Demographic:

Age was a continuous variable. Sex was a binary variable (0 for females and 1 for males). Race was described as a four-level factor: non-Hispanic White, Mexican American, other Hispanics, non-Hispanic Black, and Other.

Socio-Economic:

Education Level was coded as five five-level factor: including less than high school graduates, high school graduates or associate of arts degree, and college graduates.

The Family Poverty Index Ratio (PIR) was coded as a 6 level ordinal variable: [0-1];]1-2];]2-3];]3-4];]4-5]; [5+; The PIR is calculated by dividing family (or individual) income by the poverty threshold specific to each survey year (Jia et. al, 2024).

Food Insecurity was coded as a binary variable: 1 if answering "yes," 0 if answering "no" to the question "Have the Household eaten less for not having enough money?".

Healthy Habits:

Smoking status: Two questions from the NHANES were combined to determine whether the participants smoked. Individuals who answered "yes" to the questions "Have you smoked at least 100 cigarettes in life?" and "Do you now smoke cigarettes?" were placed in the smoking group (Reeder et al., 2022; Wang et al., 2024).

Drinking status: Two questions were combined to determine whether participants drink or not. Answering "yes" to the questions "Have you drunk at least 12 drinks in the last year?" and "Have you ever drunk 5 or more drinks a day?" were placed in the drinking group.

Sleeping hours was coded as 3 factors ordinal category: Low: less than 6 hours a day; Average: 6-9 hours a day; High: 9 or more hours a day.

Caffeine use in mg a day was transformed to a log10 base variable and later coded as a binary variable: low caffeine use if < log10(2.082) and High caffeine use if >= log10(2.082).

Physical activity was a binary variable. "Yes" if the participant reported having performed any activity in the last 30 days.

General and Mental Health:

Mental Health was coded as 5 5-level ordinal variable, using PHQ9 questionnaire score: minimal or no symptoms of depression: 0-4, mild depression: 5-9, moderate depression 10-14, moderately severe depression: 15-19, 20 or more: severe depression.
Other comorbidities: 1 if answering "yes", 0 if answering "no" to the question "Do you have any comorbidity?"

Statistical Analysis

Statistical analysis was performed using the Stata software version 18.5 (StataCorp, 2023). Alpha was set at 0.05 and power at 80%. Continuous variables were described as medians and standard deviations, while categorical variables were described as frequencies (percentages). Pearson's Chi-square test was used for categorical variables. Non-normally distributed continuous variables were analyzed using Spearman's correlation, Mann-Whitney U test, and Kruskal-Wallis test. Odds ratios (OR) were calculated by logistic regression with univariable analysis and adjusted OR (aOR) by the final models using multivariable logistic regression. Our study followed the STROBE guidelines for observational studies.

Results

Population and description

In our analyses, we included a total of 2,997 participants from the NHANES, recruited between 2005 and 2006. Among them, 1,486 (49.6%) were female and 1,511 (50.4%) were male. The ethnic composition was as follows: 558 participants (18.6%) were Mexican American and other Hispanics; 1,650 (55.1%) were non-Hispanic white; and 684 (22.8%) were non-Hispanic black. Most participants were married or in a stable union (61.8%), reported an annual household income of $75,000 or more (22.3%), and were under 65 years of age (61.1%). Regarding food security, 397 out of 549 participants (72.3%) reported that they had never had to eat less than they should due to financial problems.

Most participants were classified as not exhibiting signs of depression (79.2%), non-smokers (61.3%), non-consumers of alcoholic beverages (85.6%), or those with adequate sleep patterns (68.3%). The majority of the participants did not receive vaccination against Hepatitis A (86.2%) or Hepatitis B (81.3%). Apart from age, hepatitis immunization status, gender, and amount of sleep ($p = 0.49$; $p = 0.47$ and $p = 0.22$; $p = 0.49$; $p = 0.69$, respectively - Pearson chi-square test), baseline characteristics showed a significant imbalance ($p < 0.001$) at each level of the Social Support Score groups (Table 1).

Model 1 included 247 complete observations, and Model 2 included 217 observations. Data were missing for 11.2% of the complete vaccination and 19.7% of the partial vaccination independent variables.
Univariable analysis: Immunization status was not positively associated with high social support level in both Model 1 (OR 0.84, 95% CI 0.63– 1.11, $p = 0.22$) and Model 2 (OR 0.9, 95% CI 0.70–1.18, $p = 0.47$) (Table 2).

Multivariable analysis:
Model 1: Complete immunization with both hepatitis vaccines, $n = 245$.

Primary outcomes:
Receiving complete immunization against hepatitis A and B is associated with high social support (OR 3.15, 95% CI 1.03–9.66, $p = 0.04$) after adjustment for income, food insecurity, education, race, age, sex, smoking status, caffeine consumption, sleeping hours, depression, and comorbidities.

Secondary outcomes:
Having a PIR between 2 and 3 (aOR = 4.42, 95% CI 1.41–13.93, $p = 0.01$) and sleeping more than 9 hours a day (aOR = 2.83, 95% CI 1.04–7.74) were also associated with better social support. Smoking status (aOR = 0.39, 95% CI 0.19–0.78, $p = 0.01$) and eating less due to food insecurity were associated with lower social support (aOR = 0.26, 95% CI 0.11–0.57, $p = 0.001$). (Table 2) (Figure 1).

Model 2: At least one dose for both hepatitis vaccines, $n = 217$.

Primary outcomes:
Receiving at least one dose of vaccine for both hepatitis A and B was associated with higher social support (OR 3.35,95% CI 1.15–9.75, $p = 0.03$) after adjustment for income, food insecurity, education, race, age, sex, smoking status, caffeine consumption, sleeping hours, depression, and comorbidities.

Secondary outcomes:
Having a PIR between 2 and 3 (aOR = 4.27, 95% CI 1.21–15.11, $p = 0.02$) was also associated with better social support. Smoking status (aOR = 0.39, 95% CI 0.18–0.84, $p = 0.02$) and eating less due to food insecurity were associated with lower social support (aOR = 0.31, 95% CI 0.13–0.74, $p = 0.01$). (Table 3) (Figure 1).

Post-regression diagnosis (including ROC curve, Goodness-of-fit, and VIF collinearity are reported in the appendix).

Discussion

The results of this exploratory analysis showed that vaccination against Hepatitis A and B was significantly associated with higher social support. Since vaccination most likely occurred before the establishment of social support, our findings suggest that vaccination may be associated with individual characteristics associated with the building of social support networks. Wang et al., 2022, reported that engage-

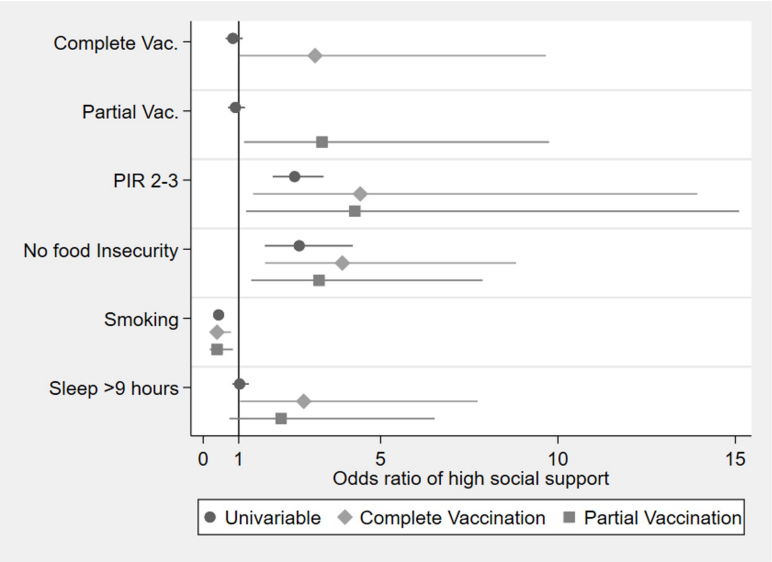

Figure 1: *Adjusted odds ratio for univariable, model 1 and model 2.*

	Low Social Support (N=1,352)	**High Social Support (N=1,645)**
Partial Vaccination		
no shots	1,023 (89.5%)	1,230 (90.4%)
partially HAV HBV	120 (10.5%)	131 (9.6%)
Complete Vaccination		
incomplete	1,107 (91.8%)	1,391 (93.0%)
complete HAV HBV	99 (8.2%)	104 (7.0%)
Age	60.6 ± 13.7	60.3 ± 13.6
Gender		
female	659 (48.7%)	827 (50.3%)
male	693 (51.3%)	818 (49.7%)
Education Level		
< High School	263 (19.5%)	185 (11.3%)
Some High School	235 (17.4%)	204 (12.4%)
Complete High School	338 (25.1%)	380 (23.1%)
Some College	327 (24.2%)	456 (27.7%)
Complete college or >	186 (13.8%)	419 (25.5%)
PIR		
0	274 (20.3%)	142 (8.6%)
PIR 1-2	389 (28.8%)	338 (20.5%)
PIR 2-3	194 (14.3%)	259 (15.7%)
PIR 3-4	155 (11.5%)	247 (15.0%)
PIR 4-5	82 (6.1%)	149 (9.1%)
PIR >5	258 (19.1%)	510 (31.0%)
smoking		
no	398 (51.2%)	563 (70.7%)
smoke	380 (48.8%)	233 (29.3%)
sleep hours		
sleep <6 hrs/day	420 (31.1%)	524 (31.9%)
sleep 6-9 hrs/day	735 (54.4%)	869 (52.8%)
sleep >9 hrs/day	197 (14.6%)	252 (15.3%)

Table 1: *Baseline characteristics of the study population.*

High Social support Model 1 Variable	OR	p-value	aOR	p-value	[95% conf. interval]	
Full HAV and HBV immunization	0.84	0.22	3.15*	0.04	1.03	9.66
PIR						
1-Feb	1.68***	<0.001	1.82	0.1	0.89	3.76
2-Mar	2.58***	<0.001	4.42**	0.01	1.41	13.93
3-Apr	3.07***	<0.001	1.66	0.47	0.42	6.58
4-May	3.51***	<0.001	3.34	0.45	0.15	75.87
>5	3.81***	<0.001	0.76	0.71	0.19	3.1
Smoking						
Yes	0.43***	<0.001	0.39**	0.01	0.19	0.78
Household Eat less than should						
Yes	0.37***	<0.001	0.26***	<0.001	0.11	0.57
Sleeping hours						
6-9 hrs/day	0.95	0.51	1.16	0.67	0.59	2.29
>9 hrs/day	1.03	0.83	2.83*	0.04	1.04	7.74
PHQ9	0.91***	<0.001	0.98	0.51	0.91	1.05
At least 1 comorbidity						
Yes	0.9	0.17	1.1	0.79	0.52	2.33
Race / Ethnicity						
Other Hispanic	0.99	0.96	1			
White non-Hispanic	1.66***	<0.001	1.28	0.59	0.52	3.12
Black non-Hispanic	1.28*	0.04	1.87	0.2	0.71	4.91
Other	1.13	0.57	3.2	0.17	0.62	16.48
Education						
Some High School	1.23	0.12	2.16	0.13	0.8	5.8
Complete High School	1.6***	<0.001	0.46	0.17	0.15	1.38
Some College	1.98***	<0.001	1.01	0.98	0.36	2.86
Complete college or >	3.2***	<0.001	0.4	0.21	0.1	1.67
Age	1	0.49	0.99	0.46	0.96	1.02
Gender						
Male	0.94	0.4	1.3	0.46	0.65	2.64
Any activity in last 30d						
Yes	1.88***	<0.001	1.06	0.86	0.55	2.04
Alcohol consumption						
Yes	0.54***	<0.001	0.97	0.93	0.46	2.06
Caffeine Consumption (log10) High	1.15	0.2	1.3	0.55	0.55	3.07

Table 2: *Crude (univariate) and adjusted odds ratio (multivariate) logistic regression.*

High Social support						
Model 2						
Variable	**OR**	**p-value**	**aOR**	**p-value**	**[95% conf. interval]**	
Partial HAV and HBV immunization	0.91	0.47	3.35	0.03	1.15	9.75
PIR	1.68***	<0.001	1.45	0.35	0.67	3.16
1-Feb	2.58***	<0.001	4.27	0.02	1.21	15.11
2-Mar	3.07***	<0.001	2.35	0.28	0.49	11.19
3-Apr	3.51***	<0.001	2.05	0.68	0.07	59.59
4-May	3.81***	<0.001	0.55	0.45	0.12	2.61
>5						
Smoking	0.43***	<0.001	0.39	0.02	0.18	0.84
Yes						
Household Eat less	0.37***	<0.001	0.31	0.01	0.13	0.74
Yes						
Sleeping hours						
6-9 hrs/day	0.95	0.51	1.1	0.81	0.51	2.35
>9 hrs/day	1.03	0.83	2.2	0.16	0.74	6.52
PHQ9	0.91***	<0.001	0.93	0.1	0.86	1.01
At least 1 comorbidity						
yes	0.9	0.17	0.85	0.69	0.38	1.9
Race / Ethnicity						
Other Hispanic	0.99	0.96	1			
White non-Hispanic	1.66***	<0.001	1.51	0.41	0.57	4.03
Black non-Hispanic	1.28*	0.04	1.6	0.39	0.55	4.68
Other	1.13	0.57	1.43	0.72	0.2	10.48
Education						
Some High School	1.23	0.12	2.56	0.08	0.89	7.35
Complete High School	1.6***	<0.001	0.49	0.24	0.15	1.6
Some College	1.98***	<0.001	1.5	0.48	0.5	4.51
Complete college or >	3.2***	<0.001	0.64	0.56	0.14	2.92
Age	1	0.49	1	0.92	0.97	1.03
Gender						
male	0.94	0.4	1.71	0.17	0.79	3.73
Any activity in last 30d						
yes	1.88***	<0.001	1.13	0.74	0.55	2.32
Alcohol consumption						
yes	0.54***	<0.001	0.89	0.77	0.4	1.98
Caffeine (log10)	1.15	0.2	1.82	0.26	0.65	5.15
High						

Table 3: *Crude (univariable) and aOR (multivariable) logistic regression.*

ment with healthcare systems and community networks, strengthening social connections, is associated with vaccination acceptance. Owing to the likely bidirectional association between these variables, this engagement probably explains why individuals vaccinated against HAV and HBV had higher odds of high social support in our study. Of note, univariate analysis did not show a significant association with social support, probably due to multiple confounders.

Socioeconomic status also emerged as a key determinant of social support, both before and after adjustment for confounders. Higher income, as indicated by the family PIR, was correlated with greater social support, suggesting that financial stability may allow greater social engagement and community access. Additionally, those who did not experience food insecurity were more likely to report higher levels of social support. These findings align with Berkman et al. (2000) and Kawachi and Berkman (2001), who highlighted the role of socioeconomic status in fostering social networks.

Among lifestyle factors, sleeping more hours a day was associated with higher social support. Possible reasons for this association are the known effects of sleep health, which induces lower stress levels and better health status (Hirotsu et al., 2015). Another possible explanation for this finding could be related to the social loneliness and poor mental health induced by sleep deprivation (Ben Simon & Walker, 2018).

Physical activity was associated with social support in univariate analysis, but this finding was not observed after adjustment. Exercising is probably a marker of a healthy lifestyle, and the supposed association is better explained by other variables in our models (Li et al., 2024).

Smoking's strong association with lower social support, even after adjustment, is likely due to the social stigma attached to smoking in the younger generations (Lozano et al., 2020). Interestingly, Homayuni and Hosseini (2023) found that some tobacco consumers received more social support, indicating the complexity of this relationship and the need for further research on targeted interventions.

While depression was strongly associated with lower social support, this association was not significant after adjustment. Previous research has indicated a bidirectional relationship between mental health and social support (Holt-Lunstad et al., 2010), and our findings suggest that this interaction is mediated by other health factors. Identifying these confounders in future research could lead to a synergistic effect on social support and mental health.

Gender did not significantly affect social support levels, consistent with the findings of McKenzie et al. (2018). His group hypothesized that insignificant gender differences in social support simply reflect the overall narrowing of gender differences in modern society. In addition, Taylor et al., 2000, reported that gender differences in social support converged where both men and women had equal access to social networks even two decades ago.

Educational level and alcohol consumption were not significantly associated with social support, after adjustment. Helliwell et al. (2020), suggest that education may not directly relate to social support, with broader socioeconomic context and social environment playing a more substantial role. Alcohol consumption is also known to be associated with various health-risks that may better explain social support impairment (MacArthur et al., 2018).

This study has some limitations. The cross-sectional exploratory nature of our analysis cannot establish causality. Secondary data analysis of the cohort that did not target our outcomes may introduce selection bias. In addition, the final multivariable analysis had only 7.2%– 8.2% complete observation of the 2,997 total. The strengths of our study were the robustness of the result for both fully vaccinated and partially vaccinated participants. In addition, vaccination and social support temporal relationships may suggest a directional relationship.

Notably, vaccination showed a consistently positive effect across our models, further supporting the hypothesis that vaccination may serve as an indicator of healthier behaviors and increased social support. Those who are completely unvaccinated may differ in lifestyle and health choices, ultimately culminating in differences in social support.

Conclusion

Promoting HAV and HBV vaccination could provide the additional benefit of strengthening social support, leading to synergistic health benefits. In addition, policymakers should direct resources into strategies that increase social support, benefit from increasing vaccination coverage, and reduce chronic diseases in the general population. Future research should explore the temporal dynamics and causality between vaccination and social support, to better understand this complex relationship.

Supplementary Materials

Figure 2. GOF model 1
Figure 3. GOF model 2
Figure 4. ROC curve model 1
Figure 5. ROC curve model 2

Table 4. Collinearity diagnostics, model 1
Table 5. Collinearity diagnostics, model 2

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Conflicts of Interest

The authors declare no conflict of interest.

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