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SCIENTIFIC INVESTIGATIONS

Predictors of Intervention Interest Among Individuals With Short Sleep Duration

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Study Objectives: Over one-third of the United States population sleeps less than the recommended 7 hours a night, which increases risk for chronic diseases. The aim of this study was to evaluate the acceptability of sleep extension interventions and preferences in sleep extension interventions among adults with short sleep duration.
Methods: Participants aged 18 to 65 years with self-reported sleep duration ≤ 6.5 hours completed an online survey including reported sleep behaviors, barriers to adequate sleep, interest in sleep extension interventions, and a sleep disturbance questionnaire. Data were analyzed using chi-square and binary logistic regression.
Results: Participants (n = 92; 61 females; mean age = 45.6 years, standard deviation = 13.5) reported an average sleep duration of 5:49 (standard deviation = 0:49). More than half of the participants reported current health comorbidities (64%), including insomnia (n = 12, 13%) and sleep apnea (n = 9, 10%). Many participants (38%) reported sleep disturbance. The most common barrier to adequate sleep included insomnia or other sleep problems (55%). Most respondents (84%) indicated an interest in increasing sleep duration. Of the treatment options suggested, most (84% of those interested) were interested in a wrist-worn device. Participants with insomnia or other sleep disorders were more likely to be interested in extending sleep, (χ^2 = 12.86, P < .001) and in a wrist-worn device (χ^2 = 5.24, P = .022). Higher Patient-Reported Outcomes Measurement Information System sleep disturbance t scores were also associated with interest in monitoring sleep with a wrist-worn device (b = .18, P < .001).
Conclusions: Sleep extension interventions using wearable technology are attractive to individuals with short sleep duration, particularly those with greater sleep disturbance and comorbid sleep disorders.
Keywords: sleep disturbance, sleep duration, sleep extension
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BRIEF SUMMARY
Current Knowledge/Study Rationale: Over one-third of United States adults sleep less than the recommended 7 hours of sleep per night, which increases risk for chronic diseases. However, little is known about short sleepers' interest in interventions or the type of interventions preferred by this population.
Study Impact: Results of this survey demonstrate that participants with short sleep duration desire intervention and wearable technology interventions are preferred over face-to-face or telephone treatment. Participants with short sleep and sleep disturbance had the highest interest in wearable technology, despite the lack of existing validated sleep interventions using this technology.

INTRODUCTION

Sleep is an essential biological function and short sleep duration is associated with increases in chronic illnesses. A recent consensus panel of sleep experts that concluded "at least 7 hours" is the amount of sleep needed for health and performance among adults.[1] The Centers for Disease Control and Prevention estimated a total of 34.8% of the US population reports sleeping fewer than 7 hours per night.[2] Of importance, short sleep duration has been linked to higher obesity rates, cardiovascular disease, diabetes, and hypertension by numerous studies.[3–6] Despite the high prevalence of short sleep duration and effect on health, there are few resources available to extend sleep among individuals with short sleep duration.

Existing sleep duration research has mainly focused on epidemiologic studies that examine the predictors of short sleep duration. These studies have demonstrated that short sleep is more prevalent in males, blacks compared to whites, and middle-aged adults compared to older adults, and is associated with lower socioeconomic status and being unmarried.[7–9] Psychosocial factors, including depression, stress, and loneliness, are associated with short sleep duration.[10] Additionally, work hours, longer commutes, and living in an urban area have been shown to affect sleep duration.[11,12] Research has also evaluated sleep duration through the lens of social cognitive theories. Using the health belief model, self-efficacy most strongly predicted sleep behavior in a college sample.[13] Similarly, in another study, perceived behavioral control, subjective norms, and attitudes toward adequate sleep behavior all affected behavioral intentions to sleep 7 to 8 hours.[14] Finally, a study evaluating the self-control theory found that bedtime procrastination is associated with poor self-regulation and insufficient sleep in a community sample.[15] Despite extensive research on the determinants of short sleep duration, more research is needed to understand how to provide effective and engaging interventions to address this important health behavior.

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There are currently only a few studies of sleep extension interventions and no studies have evaluated patient attitudes and preferences toward sleep extension interventions. These studies demonstrate the potential benefits of sleep extension interventions including increased sleep duration; improved blood pressure, glucose levels, and insulin levels; and less sleepiness and desire for high-calorie foods.[16–18] Existing studies use one-on-one meetings and sleep logs to deliver the intervention and little has been written about the content of these interventions. We have been studying the use of consumer wearable technology to monitor sleep among individuals with short sleep duration.[19] Wearable technology offers an opportunity to engage users in collecting data on their behavior and viewing progress.[20] However, it is currently unknown whether there are advantages to these technologies over existing traditional interventions, such as face-to-face or telephone interventions. If technology interventions are preferred by patients, they may confer benefits in terms of adherence to and enjoyment of the intervention. Given the popularity of wearable sleep technology, it is important to known whether these monitors may be desirable to short sleepers for intervention.

Therefore, the goal of this article is to examine predictors of interest in sleep-extension interventions among adult short sleepers. We conducted a survey of individuals with short sleep duration to determine attitudes toward short sleep and perceptions of interventions. We predicted that interest in extending sleep duration would be high among individuals with short sleep duration and that participants would favor consumer technology-related interventions over traditional face-to-face or telephone interventions. We also evaluated predictors if there was interest in interventions including demographics and presence of sleep disturbance, in addition to short sleep duration and depressive symptoms.

METHODS

Participants and Procedure

Participants were recruited via online sources (researchmatch.org, craigslist.org) to complete an online survey. Participants were recruited using the following ad: "Survey Participants Needed. We are looking for men and women ages 18 and older with short sleep duration (6.5 hr or less per night) to answer questions about your health, mood, and sleep for a study of attitudes and behaviors about sleep. The questions will take approximately 15 min. Compensation for your time will be provided. If you would like to take our survey please click the link below:" Recruitment for the study included ResearchMatch, a national health volunteer registry that was created by several academic institutions and supported by the US National Institutes of Health as part of the Clinical Translational Science Award program.[21] ResearchMatch has a large population of volunteers who have consented to be contacted by researchers about health studies for which they may be eligible. Inclusion criteria included: age 18 to 65 years with a self-reported average sleep duration of ≤ 6.5 hours. This online survey was approved by the Rush University Institutional Review Board. Study data were collected and managed using REDCap electronic data capture tools hosted at Rush University Medical Center.[22] REDCap (Research Electronic Data Capture) is a secure, Web-based application designed to support data capture for research studies, providing (1) an intuitive interface for validated data entry; (2) audit trails for tracking data manipulation and export procedures; (3) automated export procedures for seamless data downloads to common statistical packages; and (4) procedures for importing data from external sources. Participants first viewed a study information page and then provided consent by proceeding to the online survey.

Measures

Demographics

Age, sex, race, education, and income were assessed by self-report.

Sleep Duration

Participants were asked, "During the past week, how many hours of sleep per day on weekdays/workdays, including naps (please include decimals of hours if it describes your sleep eg, 5, 6.5, 8 hours)?" Sleep duration was calculated by taking the weighted average of self-reported weekday/workday sleep duration (hours and decimal × 5) + (weekends/nonwork days × 2) / 7. The sleep duration questions were based on those previously used in epidemiologic studies.[8,23]

Sleep Disturbance

The Patient-Reported Outcomes Measurement Information System (PROMIS) sleep disturbance questionnaire was used to measure self-reported sleep disturbance.[24] T scores higher than 60 indicate moderate to severe symptoms.

Health Conditions

Participants were provided with a list of common health conditions (ie, heart disease, stroke, diabetes, chronic pain, cancer, headaches, depression, anxiety, insomnia, sleep apnea, restless legs syndrome, or other) and asked to check all that apply to their current health.

Depression

Participants completed the Patient Health Questionnaire 8 (PHQ-8) to assess current depressive symptoms. [25] A PHQ-8 ≥ 10 was used to determine elevated depressive symptoms.

Reasons for Short Sleep Duration

Participants were asked to select reasons for their inadequate sleep (select all that apply). Response options included social events, spending time on the computer/TV or phone, housework, work or homework from home in the evening, child care, sleep disrupted by partner or pet, work schedule too early/too late, insomnia or other sleep problem, other (write in), or not applicable.

Interest in Sleep Extension

Participants responded to two questions assessing their interest in increasing the amount of sleep per night (yes/no), and if they responded yes, they were asked what intervention type they would be interested in attending (select all that apply). Response options included in-person coach, coach over the Web, and wearing a sleep-tracking device.

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Data Analysis

Data were analyzed using SPSS Version 25 (IBM Corp, Armonk, New York, United States). Participant demographics were described using means, standard deviations, and percentages. Sleep duration, reasons for short sleep duration, interest in sleep extension, and sleep duration were reported as means, standard deviations, and percentages. Chi-square tests and binary logistic regression analyses were used to evaluate predictors of interest in consumer technology-delivered sleep extension interventions. Statistical significance was defined as $P < .05$ on two-tailed tests.

RESULTS

Sample Characteristics

Table 1 presents descriptive statistics of the participants included in this analysis. A total of 391 potential participants opened the survey link and 252 participants provided valid responses (nonrandom responding, completed the survey). For this analysis, we evaluated only the 92 individuals with sleep duration ≤ 6.5 who were included in our analyses (participants were permitted to take the survey regardless of their sleep duration). The mean age was 45.6 years (standard deviation [SD] = 13.5; range = 20–66 years). The majority were female (n = 61, 66.3%) and most participants were white (n = 61, 66.3%) or black/African American (n = 19, 20.7%). The average sleep duration was 5 hours, 42 seconds (SD = 49 seconds). According to scores on the PROMIS sleep disturbance, n = 35 (38.0%) of respondents reported elevated scores on this measure, indicating greater sleep disturbances. According to scores on the PHQ-8, n = 21 (22.8%) respondents endorsed moderate to severe depressive symptoms and more than half also reported having one or more current chronic condition(s) (n = 59, 64.1%). Twelve participants (13%) reported a current diagnosis of insomnia and 9 (10%) reported a current diagnosis of sleep apnea.

Perceived Causes of Short Sleep Duration

Participants endorsed one to nine items and the average number of perceived causes was 2.4 (SD = 1.4). Nearly half (n = 44, 46.7%) endorsed three or more perceived causes of their short sleep duration. Figure 1 lists the frequency of each item. The most common reason endorsed was insomnia or other sleep problem (n = 51, 55.4%). Approximately one-third of participants (n = 33, 35.9%) reported that time on the computer, TV, or phone (for leisure) interfered with sleep, and (n = 27, 29.3%) reported their work schedule as a perceived cause of short sleep duration. Of those participants who wrote in reasons not listed, (n = 15, 16.2%), common reasons listed included worry or stress (n = 6), physical discomfort such as pain or frequent urination (n = 5), and time to unwind after work and childcare (n = 1).

Interest in Sleep Extension and Sleep Extension Interventions

Most of the participants (n = 77, 83.69%) endorsed they would be interested in increasing the amount of sleep obtained each night. Figure 2 presents the interest in different types of sleep extension interventions. On average, two (SD = 1.1, range 0–4) of the four intervention options were endorsed. The least preferred option was face-to-face sleep coaching (n = 23, 29.9%) and the most popular was sleep monitoring using a wrist-worn device (84.4%).

Table 1—Participant characteristics (n = 92).

Age (years)	45.6 ± 13.5
Sex	
Female	61 (66.3)
Male	32 (33.7)
Race	
American Indian/Alaskan Native	3 (3.3)
Asian	2 (2.2)
Black or African American	19 (20.7)
White	61 (66.3)
More than one race	6 (6.5)
No not wish to provide	1 (1.1)
Ethnicity	
Hispanic or Latino	9 (9.8)
Not Hispanic or Latino	83 (90.2)
Employment	
Full time (32 h/wk or more)	53 (57.6)
Part time (< 32 h/wk)	13 (14.1)
Unemployed	10 (10.9)
Retired	8 (8.6)
Disabled	3 (3.3)
Student	5 (5.4)
Education	
Graduate degree or above	20 (21.7)
Bachelor degree	35 (38.0)
Some college or associate degree	30 (32.6)
High school graduation or below	7 (7.6)
Marital Status	
Single, never married	35 (38.0)
Separated, divorced or widowed	15 (16.4)
Married or partnered	42 (45.7)
Reported Medical Disorders	
High blood pressure	36 (39.1)
Diabetes	17 (18.5)
Arthritis	15 (16.3)
Insomnia	12 (13.0)
Asthma	10 (10.9)
Sleep apnea	9 (9.8)
Average Hours of Sleep	
Under 3 hours	1 (1.1)
3–3.9 hours	3 (3.3)
4–4.9 hours	7 (7.6)
5–5.9 hours	27 (29.3)
6–6.5 hours	54 (58.7)

Values are presented as n (%) or mean ± standard deviation.

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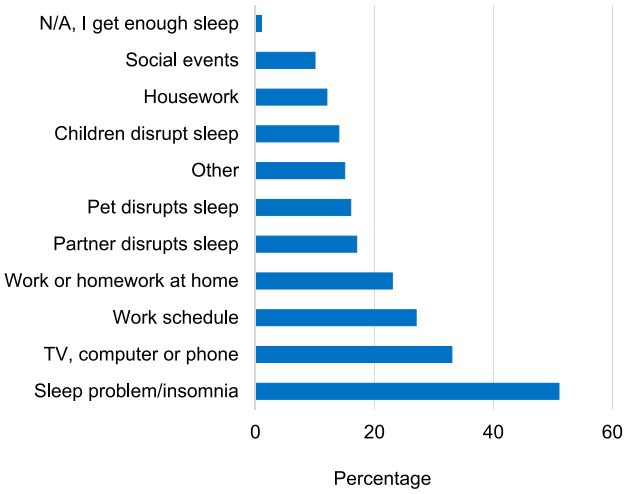
Figure 1—Self-reported reasons for inadequate sleep among short sleepers.



Predictors of Interest in Sleep Extension and Intervention With Wearable Sleep Monitors

Figure 3 presents the interest in wearable sleep monitors based on average hours slept. Age, sex, income, education, race, depressive symptoms, and sleep duration were not significant predictors of interest in extending sleep or in interventions monitoring sleep with a wrist-worn device. Participants who reported a diagnosis of insomnia or other sleep problem were more likely to be interested in extending sleep ($\chi^2(1) = 12.86$, $P < .001$), and they were also more likely to be interested in monitoring their sleep with a wrist-worn device ($\chi^2(1) = 5.24$, $P = .022$). Those with greater sleep disturbance were more likely to indicate an interest in monitoring sleep with a wrist-worn device ($b = .18$, $P < .001$).

DISCUSSION

Despite the considerable research linking short sleep duration to the development of chronic illnesses, few studies have examined the interest in sleep extension among individuals with short sleep duration as well as acceptability of intervention types. In this study, we examined perceived causes of short sleep duration and evaluated the attitudes toward interventions among individuals with short sleep duration. In line with previous research, results indicated that short sleep duration was highly comorbid with other sleep disorders and that individuals often attributed their short sleep duration to several factors, including their medical and sleep disorders. Additionally, individuals also frequently attributed short sleep duration to employment and lifestyle choices, including time spent on the computer, TV, or phone, and their work schedule. This suggests that interventions to address these disparate contributors of short sleep duration will need to be flexible and multifactorial.

Our results also demonstrated that most individuals with short sleep duration were interested in extending their sleep and that interest was particularly high for technology-based interventions, including Internet-delivered and wearable sleep monitors. Participants with greater sleep disturbance and or a diagnosis of insomnia or other sleep disorders were more likely to indicate an interest in interventions using wearable sleep monitors. In this study, none of the other examined variables (demographics, depressive symptoms) predicted interest in interventions or in wearable sleep monitors. Given that more than 8 of 10 participants were interested in sleep extension interventions using a wearable monitor, these devices provide a critical opportunity to engage short sleepers. The high interest in wearable sleep monitors among individuals with short sleep duration mirrors the general population trends. Wearable sleep monitors are a growing segment of the health and fitness technology sector. For example, in 2016, more than 12% of United States adults owned a fitness monitor and surveys suggest that sleep was rated as the most popular feature to track.[26]

The high interest in wearable sleep monitors among this population should also be viewed with caution because of lack of validated interventions with this technology. The marketing materials for consumer sleep-tracking devices often claims to improve sleep, despite having no data to support these claims.[27] Given that most wearable sleep tracking devices are not regulated by the Food and Drug Administration as medical devices, there is less oversight into the claims that can be made by companies. Therefore, the role of wearable sleep monitors in sleep interventions is somewhat of a paradox—they are well liked but can they deliver interventions? We recently completed a systematic review of wearable monitors and sleep and our conclusion was that even though these devices are not a substitute for polysomnography or actigraphy, perhaps there is a role in behavioral intervention, such as motivating behavior change.[20] Therefore, we have recently developed and field tested a sleep extension intervention using wearable monitors and brief motivational coaching.[19] Our experience demonstrated that the intervention was liked by participants and adherence to brief telephone coaching sessions was excellent.

Results of this survey suggest that technology-assisted sleep extension interventions may enhance the user experience, which may in turn increase intervention engagement and outcomes. The body of literature supporting the health benefits of extending sleep duration is growing. Studies have demonstrated improvement in blood pressure in individuals with prehypertension/stage 1 hypertension, appetite in overweight individuals and in sports performance.[16–18,28] Soon there will be a need to deliver larger-scale interventions for sleep extension efficacy studies and public health intervention. Researchers have an opportunity to utilize wearable technology in design of evidence-based interventions to extend sleep and promote health.

Our results are limited because of the use of self-reported sleep duration and the use of a convenience sample. As always, there is possible bias related to recruiting individuals to conduct a survey about their sleep. However, fewer than half of the overall survey respondents had short sleep duration, which suggests that this survey did not only appeal to individuals with short sleep duration and/or poor sleep quality. Future research

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Figure 2—Interest in sleep extension interventions among short sleepers.

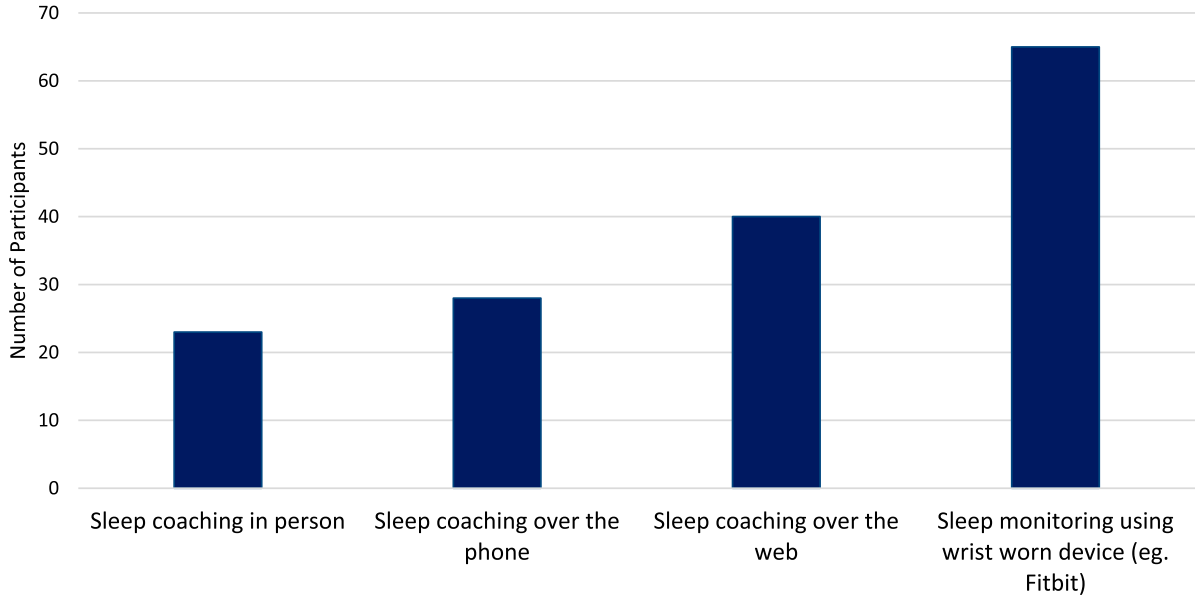
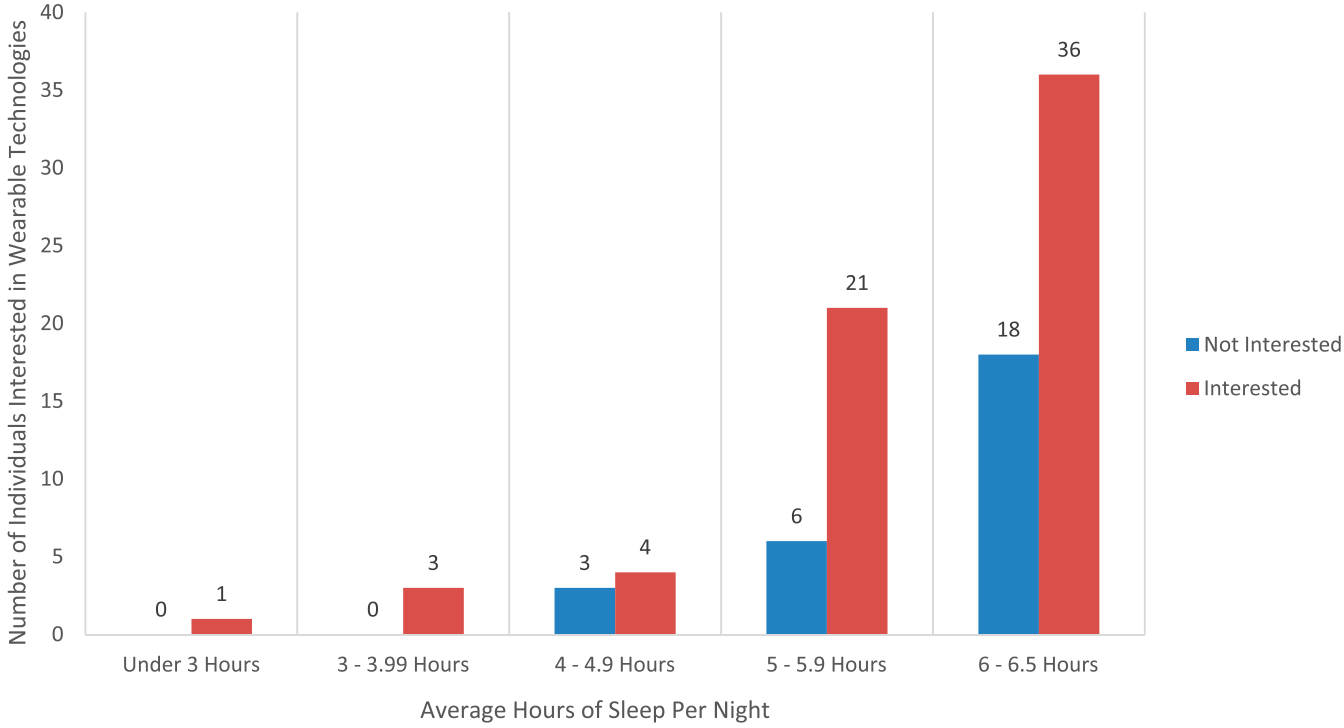


Figure 3—Wearable technology interest based on average hours of sleep.



is needed in the area of sleep extension interventions to further understand how to engage individuals with short sleep duration, which components are most effective, and how to sustain behavior change over time. Additional research should further assess if there are differences in interest among those with insomnia as a function of age, disease severity, or other factors.

In summary, this study demonstrates sleep extension interventions using wearable technology for tracking sleep are attractive to individuals with short sleep duration, particularly those with greater sleep disturbance and comorbid sleep disorders. More research needs to be conducted to evaluate the effectiveness of using wearable sleep trackers to aid in sleep extension interventions.

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ABBREVIATIONS

PHQ-8, Patient Health Questionnaire 8
PROMIS, Patient-Reported Outcomes Measurement Information System
REDCap, Research Electronic Data Capture

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DISCLOSURE STATEMENT

The work for this project was performed at Rush University Medical School. All authors have seen and approved the manuscript. The authors report no conflicts of interest.

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