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Smartphone Dependence and Domain-Specific Sleep Problems among Art University Students' in China: An Exploratory Component-Level Analysis

Shuai Shan[1,2], Syaza Hazirah Binti Mohd Hashim[2]

[1] Qingdao Film Academy, No. 689 Jinshatan Road, Huangdao District, Qingdao, Shandong 266520, China, [2]Faculty of Education & Liberal Studies, City University Malaysia, Menara City U, No. 8, Jalan 51A/223, 46100 Petaling Jaya, Selangor Darul Ehsan, Malaysia

Corresponding Author Email: syaza.hazirah@city.edu.my

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Abstract

The Pittsburgh Sleep Quality Index (PSQI) combines seven distinct aspects of sleep, yet smartphone-related studies often rely on its global score. This exploratory secondary analysis examined component-level associations between smartphone dependence and self-reported sleep difficulties in 450 students from three art-focused universities in China. Smartphone dependence was assessed with the Smartphone Addiction Scale–Short Version (SAS-SV). Seven Spearman rank correlations were evaluated with false discovery rate adjustment, and component scores of 2–3 versus 0–1 were examined using logistic regression adjusted for gender and year of study. All seven components showed positive rank associations with SAS-SV (rho = .334–.421, adjusted $p < .001$). Six adjusted models converged and also indicated positive associations (adjusted odds ratios = 1.98–4.23); the sleeping-medication model could not be reliably estimated because of sparse outcomes. These findings suggest that difficulties regulating smartphone use co-occur with several aspects of sleep rather than one isolated domain. The cross-sectional design, exploratory outcome contrast, and sparse categories preclude causal and clinical conclusions.

Keywords: Smartphone Dependence, Sleep Quality, Pittsburgh Sleep Quality Index, Art University Students, Digital Self-Regulation

Introduction

In art-focused higher education, a smartphone may be a learning resource, a means of organising creative work, and a source of personal communication. Its academic usefulness, however, does not rule out difficulties in regulating use. Wang and Yu (2024), for example, examined how technostress, perceived usefulness, and satisfaction relate to art students continued use of mobile educational applications. Although their study focused on educational applications rather than problematic use, it illustrates why duration alone is insufficient for judging students' smartphone behaviour. University research uses several

overlapping terms, including smartphone addiction, problematic smartphone use, and smartphone dependence, and varies substantially in the instruments used to assess them (Sánchez-Fernández & Borda-Mas, 2023). In this article, smartphone dependence is a descriptive shorthand for the difficulties captured by the Smartphone Addiction Scale–Short Version (SAS-SV), not a clinical diagnosis or an inference drawn simply from extensive screen time.

Sleep is one area in which difficulty regulating smartphone use may affect daily life. Reviews and large surveys of university students have found associations between higher problematic-use scores and poorer self-reported sleep (Leow, Chiang, Chua, Wang, & Tan, 2023; Okunlola et al., 2026; Tao et al., 2024; Zhu, Liu, Lou, Mu, & Li, 2024). These findings do not establish that smartphone use caused the sleep problems reported by participants. Bedtime habits, pre-sleep arousal, existing sleep difficulties, and other circumstances may also play a part. Tu et al. (2023), in a four-week randomised study, found improvements in sleep quality when undergraduates restricted smartphone use in bed, alongside reduced pre-sleep cognitive arousal. That study examined a specific behaviour; the present analysis considers associations with overall SAS-SV scores.

The Pittsburgh Sleep Quality Index (PSQI) provides a global summary of self-reported sleep, but it combines seven components that capture distinct experiences: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, sleeping-medication use, and daytime dysfunction (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). A single global score may therefore conceal variation in the specific sleep difficulties reported by students.

Recent studies have begun to examine sleep outcomes beyond a single global score. Liebig et al. (2026) investigated night-time screen behaviour alongside multiple sleep outcomes among medical students, whereas Luo, Xu, Lin, and Chen (2025) used network analysis to examine smartphone-addiction and sleep symptoms among Chinese art students. These studies illustrate growing interest in more differentiated analyses, although they address different populations, measures, and analytical questions.

The present study was motivated by three related considerations. Academically, although research has linked problematic smartphone use with poorer sleep, it remains unclear how an overall SAS-SV score is associated with distinct PSQI components among students at Chinese art-focused universities. A component-level analysis can describe whether the observed association extends across different sleep domains rather than relying only on a global score. Theoretically, the pathways account proposed by Billieux, Maurage, Lopez-Fernandez, Kuss, and Griffiths (2015) and the multifaceted model examined by Pivetta, Harkin, Billieux, Kanjo, and Kuss (2019) caution against treating problematic smartphone use as a single, uniform behaviour. These perspectives support a differentiated description of sleep-related associations, but the present data do not test specific motivational or regulatory pathways. Practically, smartphones may serve legitimate educational purposes in art-focused programmes, as illustrated by research on art students' continued use of mobile educational applications (Wang & Yu, 2024). Frequent use should therefore not automatically be equated with problematic behaviour. Identifying the sleep domains associated with SAS-SV scores may provide a more nuanced basis for student-support discussions than relying on screen time

alone. Accordingly, this study examines associations between SAS-SV total scores and all seven PSQI components among students at three art-focused universities in China.

Literature Review

Smartphone Dependence in University Contexts

Research on difficult-to-regulate smartphone behaviour has not adopted a single label or measurement standard. In a systematic review of university studies, Sánchez-Fernández and Borda-Mas (2023) documented variation in terminology, instruments, and prevalence estimates. Such variation matters when findings are compared: frequent use, perceived dependence, loss of control, and interference with daily life are related but not identical concepts. The present article uses smartphone dependence for consistency with part of the literature, while retaining the name of the SAS-SV and interpreting its scores as a continuous measure of dependence-related behaviour. A higher score should not be equated with a diagnosis of behavioural addiction.

The SAS-SV was developed by Kwon, Kim, Cho, and Yang (2013) as a ten-item instrument assessing problematic smartphone engagement. Zhao, Rafik-Galea, Fitriana, and Song (2022) subsequently examined a Chinese-language version among college students and provided psychometric evidence for its use in that setting. These studies support the use of an overall SAS-SV score, but do not show whether a particular aspect of smartphone behaviour is responsible for a given sleep difficulty. For this reason, the present analyses concern the association between the total SAS-SV score and sleep outcomes; they do not distinguish compulsive checking, reassurance seeking, or bedtime-specific exposure as separate predictors.

Theoretical Framework: A Pathways View of Problematic Smartphone Use

Billieux et al. (2015) proposed an integrative pathways account in response to the tendency to describe problematic mobile-phone behaviour as a single form of addiction. The account considers problematic use heterogeneous, with different motivational and regulatory processes potentially involved. Pivetta et al. (2019) later examined a multifaceted model of problematic smartphone use. For the present article, the value of this perspective is primarily conceptual: it cautions against equating intensive smartphone engagement with impaired control and against assuming that all students use their phones for the same reasons.

In art-focused courses, students may use smartphones to consult visual references, coordinate production work, exchange drafts, and communicate about assignments. Time spent on these tasks does not necessarily indicate impaired control. Other use may continue even after a student intends to stop for the night. Because the questionnaire did not record the purpose or timing of individual smartphone activities, this analysis cannot identify the pathways proposed by Billieux et al. (2015). It examines the narrower question of whether overall SAS-SV scores are associated with different aspects of reported sleep.

The pathways account offers a way of thinking about these associations, rather than a causal model tested by the data. It does not predict which PSQI component should have the strongest relationship with smartphone dependence. Bedtime delay and continued mental engagement are plausible explanations worth examining, particularly in light of the intervention by Tu et al. (2023), but neither process was measured here. The present cross-

sectional findings should therefore be read as associations, not as evidence of a particular mechanism or temporal sequence.

Smartphone Dependence and Sleep

Evidence for an overall relationship between problematic smartphone use and sleep has accumulated across different university populations. In a systematic review and meta-analysis of medical students, Leow et al. (2023) reported a pooled SAS-SV–PSQI correlation of .30 (95% CI [.24, .36]). They also reported an association between SAS-SV score and sleep duration (pooled r = .27, 95% CI [.18, .36]), although that duration estimate drew on only two studies. In China, Tao et al. (2024) analysed 21,314 valid college-student questionnaires and reported an association between smartphone dependence and poorer sleep within a model also involving negative emotions and health-promoting behaviours. Zhu et al. (2024) examined smartphone addiction and sleep quality in another large Chinese student sample. A more recent systematic review by Okunlola et al. (2026) likewise considered smartphone addiction and sleep disruption in young adults. These studies establish the relevance of the global association but do not resolve how its magnitude or interpretation varies across the PSQI components in art-university settings.

Studies of night-time behaviour offer a closer look at possible circumstances surrounding sleep difficulties. Tu et al. (2023) evaluated a four-week intervention that limited smartphone use in bed and examined sleep quality and pre-sleep cognitive arousal. Tay and Law (2025) studied smartphone-related bedtime procrastination and daytime sleepiness among Malaysian undergraduates, while Liebig et al. (2026) examined night-time screen use and sleep outcomes among medical students in four countries. Their measures and designs differ, so the reported associations should not be treated as interchangeable. Together, they indicate why the timing and context of use may matter alongside overall dependence-related behaviour.

Why Component-Level Sleep Analysis Matters

The PSQI combines seven ordinal component scores into one global total (Buysse et al., 1989). This provides a recognised summary of self-reported sleep over the preceding month, but the components capture different aspects of that experience. Validation work in Chinese-language populations supports the usefulness of the instrument while also identifying questions about its dimensional structure (Guo, Sun, Liu, & Wu, 2016; Liu et al., 1996; Tsai et al., 2005). In particular, Guo et al. (2016) drew attention to the sleeping-medication component in Chinese undergraduates. Carpi, Dias, Marques, and Liguori (2026) further argued that the conventional global cutoff should not be used as though it were a diagnostic boundary. These cautions make component-specific interpretation preferable to assuming that every point on the global scale has the same substantive meaning.

A global PSQI score can conceal differences in the difficulties students report. To examine these differences, this study estimates rank correlations for all seven components and uses an exploratory binary comparison of scores 2–3 against 0–1 in adjusted models. The comparison is not a clinical cutoff. Nor can the numerical size of odds ratios be used to rank components without a formal test of between-component differences. Sparse outcomes are treated as a limitation of estimation.

Art University Students as a Distinct Educational Context

Art-focused higher education gives this question a specific educational context, but should not be treated as an inherently higher-risk environment. Wang and Yu (2024) studied mobile educational application use among Chinese art undergraduates, showing that digital activity can have a clear academic purpose even when technostress is relevant. Studio assignments, rehearsal, portfolio preparation, and collaborative production may call for frequent communication or access to reference materials. These are plausible features of the setting, not activities individually measured in the present dataset. Consequently, the argument for examining this population is not that art students necessarily experience more sleep problems, but that interpreting their smartphone engagement requires attention to legitimate educational functions as well as possible difficulties with self-regulation.

Luo et al. (2025) offer a useful comparison with another sample of Chinese art students. In their network study of 2,057 students, daytime dysfunction appeared among the bridge symptoms, and inefficiency and loss of control featured in the smartphone-addiction findings. However, the researchers used a different smartphone instrument and a symptom-network approach. Their results do not independently confirm the relationships estimated here; rather, they show why it is worth studying sleep components in this population using complementary methods.

Research Gap and Research Questions

Taken together, recent studies have examined multiple sleep outcomes among medical students and symptom networks among Chinese art students, but they do not directly answer whether an overall SAS-SV score is associated with each of the seven PSQI components among students at Chinese art-focused universities. The present study addresses this focused gap through unadjusted Spearman rank correlations and exploratory logistic regression models adjusted for gender and year of study, contrasting component scores of 2–3 with scores of 0–1. Because this is a cross-sectional secondary analysis, component scores are treated as self-reported indicators of sleep difficulty rather than diagnoses, and the observed associations are not interpreted causally.

RQ1: How is the SAS-SV total score associated with each of the seven PSQI components in unadjusted rank-based analyses?

RQ2: After adjustment for gender and year of study, what associations can be estimated between SAS-SV total score and more pronounced difficulty in each PSQI component, taking account of sparse outcomes?

Methodology

Study Design and Data Source

The first author collected the questionnaire data as part of a broader doctoral survey on smartphone-related behaviour and student well-being. This article conducts a secondary analysis of the same survey data, focusing on associations with individual PSQI components; it does not reproduce the parent study's construct-level models or mediation findings. The analysis includes the same 450 respondents as the broader survey.

The survey was conducted in June 2026 at three art-focused universities in Shandong Province, China. Participants were recruited through undergraduate classes and student groups using convenience sampling. Participation was voluntary and based on informed consent. No

names or contact details were included in the variables used for the present analysis, and survey-platform technical metadata were excluded from the statistical models. The number of eligible students invited was not recorded, so a conventional recruitment response rate cannot be calculated.

Participants and Data Quality

Of 618 returned questionnaires, 168 were excluded because completion times were below 120 seconds. The remaining 450 records provided complete SAS-SV and PSQI component information. No cases were removed on the basis of unusually high or low scale scores.

Academic discipline was not included among the adjusted covariates because discipline-group sizes were uneven and several PSQI component outcomes had few events. Gender and categorical year of study were included to provide basic demographic adjustment. This restricted set of covariates cannot eliminate residual confounding, and the analysis was not designed to establish causal effects.

Measures

Smartphone dependence was assessed with the Smartphone Addiction Scale–Short Version (SAS-SV; Kwon et al., 2013). The scale contains 10 items with six response options, giving a total score from 10 to 60; higher scores indicate greater dependence-related smartphone behaviour. Zhao et al. (2022) examined the Chinese version among college students. In this sample, Cronbach's alpha was .902. SAS-SV scores were analysed continuously rather than used to assign a diagnostic category.

Sleep was assessed with the Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989). Its Chinese-language measurement properties have been examined by Liu et al. (1996), Tsai et al. (2005), and Guo et al. (2016). The present article analyses only the seven ordinal component scores, each ranging from 0 to 3, with higher values indicating greater self-reported difficulty. These domains are subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, sleeping-medication use, and daytime dysfunction. Component scores are not treated as separate clinical diagnoses.

Statistical Analysis

Analyses were conducted using Python, SciPy 1.17.0, and statsmodels 0.14.6. SAS-SV totals were standardised for the regression analyses (1 SD = 10.07 points). Gender and year of study were entered as categorical covariates. All tests were two-sided.

Spearman rank-order correlations were estimated between the SAS-SV total score and each of the seven PSQI components. To account for parallel inference across components, the seven p values were adjusted using the Benjamini–Hochberg false discovery rate (FDR) procedure (Benjamini & Hochberg, 1995). The resulting coefficients describe associations with ordered self-report outcomes; they do not identify causal mechanisms or permit formal ranking of the component associations.

For each component, adjusted binary logistic regression contrasted scores of 2–3 with scores of 0–1. This was an exploratory, non-clinical contrast. The family of seven correlation tests and the six successfully estimated regression tests were separately controlled with the Benjamini–Hochberg false discovery rate procedure. The sleeping-medication model did not

converge because higher component scores were too sparse; no comparable adjusted odds ratio is reported. Associations are interpreted descriptively rather than causally.

Ethical Considerations

The parent doctoral study received ethical approval from the City University Malaysia Research Ethics Committee (CUM-REC) before data collection. The study protocol described voluntary participation, informed consent, withdrawal rights, and aggregate reporting. Participants were informed that the findings could be used for a doctoral thesis and reported in peer-reviewed academic publications. The present secondary analysis used only the relevant questionnaire responses and demographic variables; platform-generated technical identifiers were not part of the statistical models.

Results

The analysis included 450 students. Table 1 reports the Spearman correlations for each PSQI component and the adjusted odds ratios, with confidence intervals, for the six binary models that converged.

Component-Level Associations

Table 1

Associations of SAS-SV with Seven PSQI Components

PSQI component	Spearman rho	Adjusted aOR [95% CI]
Subjective sleep quality	.403	2.79 [2.10, 3.71]
Sleep latency	.334	1.98 [1.59, 2.46]
Sleep duration	.370	4.23 [2.77, 6.46]
Habitual sleep efficiency	.359	3.39 [2.46, 4.66]
Sleep disturbances	.382	2.70 [2.05, 3.56]
Sleeping-medication use	.421	Not estimable
Daytime dysfunction	.379	2.44 [1.93, 3.09]

Note. rho = Spearman rank correlation; aOR = adjusted odds ratio; CI = confidence interval; FDR = false discovery rate. All seven component correlations and all six converged regression tests remained statistically significant after separate Benjamini–Hochberg corrections (adjusted $p < .001$). The aORs represent a one-SD higher SAS-SV score (10.07 points) and are adjusted for gender and year of study. Binary outcomes compare PSQI component scores 2–3 with 0–1; this contrast is exploratory, not diagnostic. Sleeping-medication use: the adjusted model did not converge because of sparse outcomes, so no comparable aOR is shown.

All seven rank correlations were positive (rho = .334–.421). The six converged adjusted models also yielded positive associations (aOR = 1.98–4.23). The sleep-duration estimate was based on a relatively uncommon higher-score outcome, and the corresponding medication-use model could not be reliably estimated. The odds ratios should not be ranked across components, because their numerical differences were not formally compared.

Discussion

Across the seven PSQI components, higher SAS-SV scores were associated with higher scores in the rank-based analyses. The six adjusted binary models that converged showed associations in the same direction. A comparable adjusted estimate was not available for sleeping-medication use because the higher-score outcome was too sparse. This pattern suggests that dependence-related smartphone behaviour accompanies several kinds of reported sleep difficulty. It does not show that smartphone use caused those difficulties or that one component is more strongly associated than another.

The overall association between problematic smartphone use and poorer sleep is not a new finding (Leow et al., 2023; Okunlola et al., 2026; Tao et al., 2024; Zhu et al., 2024). The contribution of this analysis is narrower: it reports separate component-level associations in an art-university sample, with demographic adjustment where the data allowed reliable estimation. Liebig et al. (2026) have already applied component-level approaches in medical students. Accordingly, the value of these findings lies in the particular educational setting and the estimates reported, including the limits of modelling a sparse outcome, rather than in claiming a previously unknown smartphone–sleep relationship.

Billieux et al. (2015) described problematic mobile-phone use as a heterogeneous pattern rather than a single addiction-like process, and Pivetta et al. (2019) provided further evidence for a multifaceted account. This distinction matters for art students, whose phones may also be part of everyday learning and creative work (Wang & Yu, 2024). The survey cannot establish why any participant used a phone or which regulatory process was involved. Nevertheless, the associations raise a practical question for student support: when does otherwise useful smartphone engagement become difficult to manage around sleep and daily functioning?

The association with subjective sleep quality also requires care in interpretation. This component reflects students' own assessment of their sleep, while the SAS-SV is likewise self-reported. Shared measurement method may therefore account for some of the relationship. There is no basis here for concluding that smartphone use directly changed students' perceptions of sleep.

Bedtime smartphone behaviour is one possible context for the sleep-latency association. Tu et al. (2023) found improvements in sleep quality and pre-sleep cognitive arousal after limiting phone use in bed. Tay and Law (2025) reported links between smartphone-related bedtime procrastination and daytime sleepiness, and Liebig et al. (2026) examined night-time screen activity alongside several sleep outcomes. This evidence supports examining bedtime disengagement in future interventions. The present study, however, did not record bedtime phone use and cannot attribute its sleep-latency association to that behaviour.

Daytime dysfunction has a direct relevance to student life because the PSQI asks about staying awake and sustaining enthusiasm during daily activities. Its association with SAS-SV was positive in both the rank correlation and adjusted binary model. Luo et al. (2025) also identified daytime dysfunction as a bridge symptom in their network analysis of Chinese art students. Academic performance was not measured in the present survey, so these results

should not be read as evidence of lower achievement. They do indicate that daytime functioning deserves attention in future work on students' sleep and smartphone habits.

Sleep duration showed the numerically largest estimated binary association. However, relatively few respondents met the higher-score outcome, and no formal cross-domain coefficient comparisons were conducted. This estimate should therefore not be interpreted as evidence that sleep duration is the most strongly affected domain. The binary contrast is exploratory and does not measure clinically established sleep insufficiency.

Sleeping-medication use needs a different interpretation from the other components. Too few students had scores of 2–3 for the adjusted binary model to converge. The PSQI item also gives no information about the medication, whether it was prescribed, or why it was taken. Guo et al. (2016) raised measurement concerns about this component among Chinese undergraduates. These data cannot support conclusions about medication misuse or a causal explanation for reported use.

Educational Implications

For art-focused universities, the findings do not justify treating all smartphone activity as harmful. Students use mobile devices for class communication, access to references, and creative collaboration. It may be more useful to help them recognise situations in which use becomes difficult to stop or carries into time intended for sleep. This places the emphasis on manageable habits and daily functioning rather than on screen time alone.

Student guidance could therefore address practical situations: continuing to check messages in bed, difficulty putting a phone away after coursework, irregular sleep schedules, or tiredness the following day. These are possible topics for education and support, not behaviours measured directly in this study. Tu et al. (2023) showed that changing in-bed phone use is feasible, but any similar programme for art-focused universities would need to be evaluated in that setting.

Daytime tiredness may be easy to overlook during periods of intensive creative work. Discussions about sleep and smartphone habits could offer student-support staff a non-diagnostic starting point when students report difficulty staying alert or functioning well during the day. Persistent or severe concerns should prompt appropriate professional assessment, not a clinical judgment based on a PSQI component score.

The different PSQI domains also argue against relying on a single piece of advice. Difficulty falling asleep and difficulty functioning during the day may call for different conversations and forms of support. Such suggestions follow from the questionnaire domains and observed associations; this study did not test an educational intervention.

Limitations and Future Research

The principal limitation is the cross-sectional design. Smartphone dependence and sleep were measured in the same survey, so temporal direction cannot be established. Dysregulated smartphone use may interfere with sleep, students who sleep poorly may engage more with smartphones at night, or both may reflect other influences. Longitudinal and experimental designs are required to separate these possibilities.

Both focal measures are self-reported. No device logs, actigraphy, or polysomnography were available. Future studies could combine SAS-SV scores with recorded night-time unlocks or screen-on time and objective or diary-based sleep measures. Such data would help distinguish perceived dependence from recorded exposure and clarify the timing of smartphone activity relative to sleep.

The sample was recruited through non-probability convenience procedures from three art-focused institutions in one Chinese province, and the number of eligible students approached was not recorded. A conventional response rate is therefore unavailable. Although several disciplines and academic years were represented, the findings should not automatically be generalised to all art students, all Chinese university students, or students in other countries. Probability-based or multisite replication would strengthen external validity.

The binary contrast of component scores 2–3 versus 0–1 was exploratory rather than clinically validated, and dichotomisation loses ordinal information. The sleeping-medication outcome was too sparse for a convergent standard adjusted model. Some other component estimates also involved relatively uncommon higher-score outcomes and warrant cautious interpretation. Larger studies could preregister clinically meaningful comparisons and use methods appropriate for sparse ordinal outcomes.

Potential covariates such as chronotype, caffeine consumption, workload, physical activity, health conditions, bedtime procrastination, and actual night-time smartphone activity were unavailable or outside this secondary analysis. Academic discipline was not adjusted for because group sizes were uneven and some component outcomes had limited event counts. Adjustment for gender and study year cannot eliminate residual confounding.

The sleeping-medication component also warrants more detailed measurement in future research. Information about medication type and reason for use would help researchers interpret the PSQI frequency response, particularly in samples with few higher-score cases.

Finally, the SAS-SV total provides an overall measure of dependence-related smartphone behaviour. It does not indicate whether loss of control, reassurance seeking, compulsive checking, or another process is most closely connected with a particular sleep domain. Symptom-level smartphone measures, ecological momentary assessment, and network or longitudinal designs could test these finer-grained pathways.

Conclusion

In this secondary analysis of 450 undergraduates at art-focused universities in China, the SAS-SV total score was positively associated with all seven PSQI components in rank-based analyses. Six corresponding adjusted binary models also showed positive associations; the sleeping-medication model using the same outcome contrast could not be reliably estimated because of sparse higher-score responses. These findings provide component-specific evidence, but do not establish causal effects, differences in association strength between components, or clinical sleep disorders.

For educators, the findings suggest paying attention to the kinds of sleep difficulties students report rather than assuming that all intensive smartphone use is problematic. Digital self-

regulation and bedtime habits are reasonable topics for student support, although their effectiveness was not tested here. Further work with independent samples, more detailed covariates, and methods suitable for sparse ordinal outcomes is needed before stronger conclusions can be drawn.

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Conflict of Interest
The authors declare no conflict of interest.

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