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Original Article

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Effects of digitally delivered mindfulness-based interventions in reducing burnout in healthcare workers: a systematic review and meta-analysis of randomized controlled trials

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ABSTRACT

Introduction: Burnout among healthcare workers is a growing concern that compromises both professional well-being and patient safety. Digitally delivered mindfulness-based interventions (dMBIs) offer scalable and accessible solutions, but their impact on burnout and related psychological outcomes remains unclear. This review aimed to synthesize the evidence on the effectiveness of dMBIs in reducing burnout, depression, and mindfulness among healthcare workers.

Methods: A systematic review and meta-analysis of randomized controlled trials (RCTs) were conducted according to the PRISMA 2020 guidelines. Six databases were searched through June 25, 2025. Eligible studies evaluated dMBIs among healthcare workers with burnout as a primary or secondary outcome. Standardized mean differences (SMDs) were pooled using a random-effects model. The risk of bias was assessed using the Cochrane Risk of Bias tool, version 2.0.

Results: Nine RCTs were included, with 1,603 participants contributing to the analyzable data. dMBIs reduced emotional exhaustion (SMD = −0.34; 95% CI: −0.60 to −0.07) and depersonalization (SMD = −0.31; 95% CI: −0.55 to −0.07), and increased personal accomplishment (SMD = 0.48; 95% CI: 0.16 to 0.80). The dMBIs also improved mindfulness (SMD = 0.44; 95% CI: 0.07 to 0.82) and reduced depressive symptoms (SMD = −0.20; 95% CI: −0.37 to −0.03). The heterogeneity was moderate to high, and most studies were at a high risk of bias.

Conclusions: dMBIs may improve burnout, mindfulness, and depression in healthcare workers, and their flexible digital format may support their use in workplace wellness programmes. However, the heterogeneity was moderate to high, and most trials were at a high risk of bias; therefore, the findings should be interpreted cautiously. Further high-quality trials are needed to confirm these effects and to identify the best delivery formats and engagement strategies.

Keywords: burnout, depression, health personnel, mindfulness, mobile applications

Introduction

Burnout among healthcare workers is a pervasive and escalating global concern. Prevalence rates exhibit high variability, ranging from approximately 35% to over 42%, depending on the professional group, geographical region, and the measurement instruments used (Nagarajan *et al.*, 2024). The challenges associated with occupational stress have been further intensified by

events, such as the COVID-19 pandemic, highlighting the urgent need for effective and scalable solutions to support the mental health of healthcare workers (Kim and Hunter, 2023).

The burden of burnout extends beyond individual well-being and imposes significant consequences on healthcare systems. Burnout was associated with reduced professional efficacy, lower job satisfaction, and increased staff turnover intention (Özkan, 2022). Furthermore, these symptoms adversely affect patient care quality and safety, leading to clinical errors and compromising organizational performance (Li *et al.*, 2024).

Burnout is a syndrome formally characterized by three key dimensions: emotional exhaustion, which reflects feelings of being overwhelmed and drained; depersonalization, which involves cynicism or detached responses toward recipients of care; and a diminished sense of personal accomplishment (Maslach, Jackson and Leiter, 1997). Crucially, these symptoms are often accompanied by other forms of psychological distress as healthcare professionals face high rates of depression and anxiety, especially those on the frontline (Cui *et al.*, 2024; Dobešová Cakirpaloglu *et al.*, 2024; Badriyah *et al.*, 2025). Addressing these psychological and professional impacts is crucial to fostering a resilient and sustainable healthcare workforce.

Mindfulness-based interventions (MBIs) have emerged as promising strategies to mitigate burnout (Salvado *et al.*, 2021; Luangapichart, Saisavoey and Viravan, 2022). However, traditional in-person MBIs face significant implementation barriers in high-stress clinical environments, including severe time constraints imposed by demanding shift work, difficulty coordinating schedules (accessibility), and the potential stigma associated with participating in mental health programs in the workplace. (Klein et al., 2020; Xu et al., 2021; Ong et al., 2024).

Digitally delivered MBIs (dMBIs), which are delivered remotely via mobile applications or web platforms, offer a potential solution by providing flexible, accessible, and scalable alternatives (Salvado *et al.*, 2021; Luangapichart, Saisavoey and Viravan, 2022; Garg and James, 2025). While diverse in structure, dMBIs typically incorporate core components, such as guided meditation practice, alongside features intended to enhance engagement, such as cognitive-behavioral elements and adaptive feedback mechanisms (Xu *et al.*, 2021). They aimed to cultivate present-moment awareness, emotional regulation, and self-compassion (van der Meulen *et al.*, 2021; Xie *et al.*, 2021; Li *et al.*, 2025). Improvements in key mindfulness skills, such as acting with awareness, non-reactivity, and nonjudging, may mediate reductions in stress, burnout, and depression (Zheng *et al.*, 2022; Cui *et al.*, 2024; Li *et al.*, 2025).

Existing evidence indicates that MBIs are effective in reducing stress and achieving short-term reduction in burnout symptoms (Salvado *et al.*, 2021; Ong *et al.*, 2024). Crucially, dMBIs have demonstrated consistent efficacy in reducing depression and anxiety symptoms among healthcare professionals (Fiol-DeRoque *et al.*, 2021; Taylor *et al.*, 2022; Pratt *et al.*, 2023). They also showed a significant increase mindfulness skills (Keng *et al.*, 2022; Monfries, Sandhu and Millar, 2023). Moreover, previous systematic reviews have generally synthesized mindfulness-based interventions as a broad category and have frequently combined digitally delivered programs with face-to-face or mixed-delivery formats, making it difficult to isolate the effect attributable to digital delivery alone among healthcare workers. In addition, prior reviews have often emphasized overall well-being or stress outcomes, with less consistent quantitative synthesis across the three burnout dimensions and related outcomes commonly assessed alongside burnout, such as depressive symptoms and trait mindfulness (Salvado *et al.*, 2021; Ong *et al.*, 2024). Therefore, an updated synthesis restricted to randomized controlled trials (RCTs) of dMBIs is needed to clarify the magnitude of their effects on burnout and key co-occurring psychological outcomes. Accordingly, this study systematically reviews and meta-analyses RCTs on dMBIs to evaluate their effects on burnout (emotional exhaustion, depersonalization, and personal accomplishment) and related outcomes (depression and mindfulness) among healthcare workers.

Materials and Methods

Protocol and Registration

This systematic review and meta-analysis followed the PRISMA 2020 guidelines (Page *et al.*, 2021)and was conducted in accordance with a pre-registered protocol in PROSPERO (Registration ID: CRD420251053146). This review aimed to evaluate the effectiveness of digitally delivered mindfulness-based interventions or dMBIs delivered via mobile applications, web-based platforms, or videoconferencing in reducing burnout symptoms among healthcare professionals.

Eligibility Criteria

Eligible studies were randomized controlled trials (RCTs) evaluating digitally delivered mindfulness-based interventions (dMBIs) for burnout among health care professionals. In this review, dMBIs were operationally defined as interventions in which mindfulness content was delivered primarily through a digital platform, including mobile applications, web-based platforms, or videoconferencing, and included core mindfulness practices (e.g., guided meditation, body scan, or breathing exercises), with or without additional supportive features (e.g., reminders, psychoeducation, or adaptive feedback). Studies were included if they

recruited healthcare professionals, such as physicians, nurses, midwives, pharmacists, psychologists, and allied health workers who were actively engaged in clinical or healthcare-related environments. Eligible studies were required to assess burnout as either a primary or secondary outcome using validated measurement tools, including the Maslach Burnout Inventory (MBI), Copenhagen Burnout Inventory (CBI), and Oldenburg Burnout Inventory (OLBI). Interventions could be self-guided or supported provided that the primary delivery of mindfulness content was digital. Studies were excluded if they focused exclusively on conditions other than burnout (e.g., anxiety or depression as the sole target without burnout measurement), involved non-healthcare populations, lacked a clearly defined comparator, or used co-interventions that prevented the isolation of the mindfulness component.

Comparators included usual care, waitlists, no intervention, or active controls such as in-person mindfulness programs or digitalized interventions that did not include mindfulness content. Studies without clearly defined comparators or those involving co-interventions that prevented the isolation of mindfulness effects were excluded. We also excluded studies published in non-peer-reviewed journals, conference papers, or non-English publications.

Information Sources and Search Strategy

A comprehensive search was conducted in six databases, from inception to June 25, 2025 (PubMed, Embase, CINAHL-Ultimate, Cochrane Library, Web of Science, and Scopus). The strategy combined four concept blocks: healthcare personnel, digital delivery (mobile or web-based applications), burnout, and randomized controlled trials (full strategies in Supplementary Table 1). The gray literature was screened using Google Scholar. Additional sources included backward reference screening, citation search, and consultation with domain experts. No protocol deviations occurred after the PROSPERO registration.

Study Selection

All retrieved records were managed and screened using EndNote software. Two independent reviewers conducted title/abstract and full-text screening based on the predefined inclusion and exclusion criteria. Discrepancies between the reviewers were resolved through discussion or, when necessary, consultation with a third reviewer.

Data Extraction and Management

Two reviewers independently extracted data from the included studies using a standardized piloted form. The extracted variables included study characteristics (authors, publication year, country, setting), participant characteristics (sample size, profession, sex), intervention details (app name, duration, mindfulness components), and outcome measures. When multiple post-randomization assessment time points were available, we extracted the first post-intervention time point closest to intervention completion for the meta-analysis. Disagreements were resolved through discussion or by a third reviewer. When the data were incomplete or unclear, the authors were contacted for clarification.

Risk of Bias Assessment

The risk of bias for the included RCTs was assessed using the Cochrane Risk of Bias tool (RoB 2.0). Two reviewers independently evaluated each study across five domains: the randomization process, deviations from intended interventions, missing outcome data, measurement of the outcome, and selection of the reported result. Discrepancies were resolved through discussion, and when consensus could not be reached, a third reviewer was adjudicated (Flemyng *et al.*, 2020).

Data Analysis

All statistical analyses were conducted using the Comprehensive Meta-Analysis software (version 4.0; Biostat Inc., Englewood, NJ, USA). A random-effects model using the DerSimonian and Laird method was applied to account for the clinical and methodological heterogeneity among the studies. Effect sizes were calculated as standardized mean differences (SMDs) with 95% confidence intervals (CIs), using post-intervention means and standard deviations. When multiple post-intervention time points were reported, the first assessment closest to the end of the intervention was prioritized to maintain comparability across the trials. For multi-arm trials, we avoided double counting by splitting the shared control group across eligible comparisons, when needed. The effect direction was coded such that negative SMDs indicated improvement in emotional exhaustion, depersonalization, and depressive symptoms, whereas positive SMDs indicated improvement in personal accomplishment and mindfulness. Statistical heterogeneity was evaluated using the I^2 statistic, with values exceeding 50% interpreted as substantial (Borenstein, 2024). Publication reporting bias was explored using Egger's regression test. Given that several outcomes included fewer than 10 studies, these tests were considered underpowered and interpreted cautiously as exploratory (Afonso *et al.*, 2024).

Ethical Compliance

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Results

Study Identification and Screening Process

A total of 994 records were initially retrieved from six databases and four records from Google Scholar for gray literature. After eliminating 492 duplicate entries, 502 records remained for title and abstract screenings. Of these, 478 were excluded because they did not meet the selection criteria. This left 24 studies for a full-text review, of which 15 were excluded for various reasons (Figure 1). Ultimately, 9 studies were included in this review.

Overview of Included Studies and Their Characteristics

Among the nine included studies, two were conducted in the United States (Pratt *et al.*, 2023; Jaiswal *et al.*, 2024)and one each in India (Bhardwaj *et al.*, 2023), Spain (Fiol-DeRoque *et al.*, 2021), Singapore (Keng *et al.*, 2022), South Africa (Kirykowicz *et al.*, 2023), Canada (Monfries, Sandhu and Millar, 2023), the United Kingdom (Taylor *et al.*, 2022), and Australia (Xu *et al.*, 2022). These studies have been published between 2021 and 2024. Across the nine included trials, the total randomized sample ranged from 34 to 2,182 participants, while 1,603 participants contributed analyzable post-intervention data to the meta-analyses (Table 1).

Participants were actively employed healthcare professionals, including nurses, physicians, and allied health workers, working in clinical settings, such as hospitals, emergency departments, and community-based care. The average age of the participants ranged from 28 to 42 years old. All interventions were digitally delivered and focused on mindfulness-based approaches to reduce burnout and depression, and improve mindfulness. Across trials, delivery formats included mobile applications (e.g., Headspace, Lift, PsyCovidApp), web-based platforms, and combinations of videoconferencing (Zoom platform) with Short Message Service (SMS). Where reported, interventions prescribed brief guided practices delivered primarily as audio- or app-based modules, with recommended use ranging from several sessions per week to daily practice over intervention periods of 2 weeks to 4.5 months (Table 1).

As summarized in Table 1, four studies used commercial applications, including headspaces (Keng *et al.*, 2022; Taylor *et al.*, 2022; Xu *et al.*, 2022) and lifts (Pratt *et al.*, 2023). Others have utilized customized or research-developed digital platforms, such as PsyCovidApp (Fiol-DeRoque *et al.*, 2021), WellMind (Jaiswal *et al.*, 2024), and Headversity (Monfries, Sandhu and Millar, 2023). While five interventions were fully self-directed and unguided (Fiol-DeRoque *et al.*, 2021; Keng *et al.*, 2022; Taylor *et al.*, 2022; Monfries, Sandhu and Millar, 2023; Pratt *et al.*, 2023), others incorporated structured elements, such as orientation sessions, personalized reminders, or adaptive content delivery (Xu *et al.*, 2022; Bhardwaj *et al.*, 2023; Jaiswal *et al.*, 2024).

Burnout was the primary outcome in eight studies and was predominantly measured using the MBI or its Human Services Survey version (MBI-HSS). One study used CBI as an alternative measure. Secondary outcomes included measures of depression, stress, and mindfulness, assessed using validated tools such as the Depression, Anxiety, and Stress Scale-21 (DASS-21), Patient Health Questionnaire (PHQ-9), 10 items of Center for Epidemiological Studies Depression Scale (CES-D-10), Mindful Attention Awareness Scale (MAAS), and Five Facet Mindfulness Questionnaire (FFMQ).

Risk of Bias in Studies

Among the nine studies included, one was rated as having a low risk of bias, one showed some concerns, and seven were rated as high risk. The most frequent sources of bias were deviations from intended interventions and the measurement of outcomes, largely due to unblinding and insufficient reporting of participant allocation. Reliance on self-reported measures also introduces potential subjectivity (Figure 2).

Effects of dMBIs Interventions on Burnout

Seven studies (n = 1,491) assessed burnout among healthcare workers using three MBI subscales: EE, DP, and PA. Using a random-effects model, dMBIs were associated with a reduction in EE (SMD = −0.34; 95% CI: −0.60, −0.07; p = 0.014) and DP (SMD = −0.31; 95% CI: −0.55, −0.07; p = 0.012) and an increase in PA (SMD = 0.48; 95% CI: 0.16 to 0.80; p = 0.003). Substantial heterogeneity was observed across all subscales (I^2 = 76.1% for EE, 83.6% for PA, and 69.8% for DP). Egger's test indicated no evidence of publication bias for any subscale (p > 0.05). Because the number of studies per outcome was less than 10, Egger's test was underpowered, and the results were interpreted as exploratory (Figure 3).

Effects of dMBIs on Mindfulness

Four studies (n = 213) reported outcomes related to mindfulness. The pooled standardized mean difference was 0.44 (95% CI: 0.07 to 0.82; p = 0.021) under a random-effects model. Heterogeneity was observed (I^2 = 41.3%), and Egger's test did not indicate evidence of small-study effects, although these results were underpowered and should be interpreted with caution (p = 0.358) (Figure 4).

Effects of dMBIs on Depression

Five studies (n = 1,371) assessed depressive symptoms among healthcare workers. The meta-analysis showed a pooled standardized mean difference of −0.20 (95% CI: −0.37 to −0.03; p = 0.021]. Heterogeneity was present (I^2 = 40.0%), and Egger's test did not suggest small study effects, but the small number of included trials limited its sensitivity; therefore, this finding should be interpreted cautiously (p = 0.413) (Figure 4).

Sensitivity Analysis

Sensitivity analysis, excluding trials rated as having a high risk of bias, substantially reduced the number of eligible studies. Under this restriction, only the pooled effect for PA remained statistically significant, and the

magnitude of the effect was attenuated compared to the primary analysis. A sensitivity analysis for mindfulness could not be performed because all trials reporting mindfulness outcomes had a high risk of bias (Supplementary Figure 1).

Discussions

Summary of Main Findings

This systematic review and meta-analysis indicated that dMBIs were linked to decreased emotional exhaustion and depersonalization, along with an increase in personal accomplishments among healthcare workers. In terms of secondary outcomes, the findings also indicated improvements in mindfulness and reduction in depressive symptoms.

The efficacy of the dMBIs across all three burnout subscales is clinically important. In this meta-analysis, the largest magnitude pooled effect among the burnout dimensions was observed for PA (SMD = 0.48), suggesting that dMBIs may strengthen perceived competence and achievement at work, a domain that is often considered more difficult to shift through individual-level interventions (Bhardwaj *et al.*, 2023; Jaiswal *et al.*, 2024). The positive PA findings further suggest that dMBIs may cultivate internal resources, such as mindfulness and self-compassion, that support professional efficacy and self-regulation in demanding clinical contexts (Klein *et al.*, 2020; Kim and Hunter, 2023). dMBIs were also associated with a reduction in EE (SMD = −0.34), indicating a benefit for the core symptom of feeling overwhelmed and drained, which is commonly responsive to mindfulness-based interventions (Monfries, Sandhu and Millar, 2023). The observed decrease in DP (SMD = −0.31), reflecting reduced cynicism and emotional distancing, is relevant for maintaining high-quality clinical care and sustaining empathetic patient interactions, potentially through improved emotional regulation and self-compassion (Li *et al.*, 2025). Overall, these pooled findings are consistent with prior evidence that supports the short-term effectiveness of both traditional and digitally delivered mindfulness-based interventions in mitigating burnout (Salvado *et al.*, 2021; Ong *et al.*, 2024). The utility of digital delivery may be driven by greater accessibility and flexibility, helping healthcare workers engage despite demanding schedules and shift work (Luangapichart, Saisavoey and Viravan, 2022; Makhfudli *et al.*, 2025), while also potentially reducing the stigma associated with participating in workplace mental health programs (Zheng *et al.*, 2022; Li *et al.*, 2025).

The meta-analytic finding of statistically significant increases in trait mindfulness substantiated the psychological mechanism hypothesized to underlie the efficacy of dMBIs (SMD = 0.44). The dMBIs successfully cultivated fundamental mindfulness skills in healthcare professionals. Studies have demonstrated that the most improved facets of mindfulness include nonreactivity, awareness, nonjudging, and acting with awareness (Haenen *et al.*, 2016; Spinhoven *et al.*, 2017; Cui *et al.*, 2024). These skills are essential mediators that enable greater emotional regulation and psychological flexibility, and serve as robust internal resources against occupational stressors (Zheng *et al.*, 2022). Improvements in mindfulness skills are directly linked to subsequent reductions in stress and burnout (Cui *et al.*, 2024). Furthermore, individuals who initially presented with lower baseline mindfulness levels often showed the greatest gains in trait mindfulness following the intervention (Sieder *et al.*, 2024). Consistent with the literature on digital delivery, guided digitally delivered interventions yield higher and more consistent gains in mindfulness than self-guided formats. Cultivating present-moment awareness also promotes awareness of self-care and allows professionals to recognize physical cues related to stress (Xu *et al.*, 2021).

The statistically significant reduction observed in symptoms of depression highlights the dual benefit of dMBIs in mitigating burnout while addressing broader psychological distress (SMD = −0.20), which is frequently comorbid with occupational stress in demanding healthcare settings. dMBIs consistently reduce depression and anxiety symptoms among healthcare workers (Liu *et al.*, 2023; Garg and James, 2025; Wu *et al.*, 2025). Guided interventions specifically demonstrated improved adherence and favorable outcomes for depression reduction. Reductions in depression are mediated by several psychological factors enhanced by dMBIs, including increases in self-compassion and psychological flexibility and a reduction in unhelpful coping mechanisms such as emotional suppression (Carona *et al.*, 2022). Importantly, the long-term benefits are further supported by evidence suggesting that improvements in mindfulness skills can lead to durable reductions in neuroticism, which in turn fully mediates the relationship between increased mindfulness and sustained improvements in depressive outcomes (Spinhoven *et al.*, 2017). These strong effect sizes align with previous meta-analytic findings on the effectiveness of digitally delivered interventions for reducing psychological distress in healthcare populations (Wang *et al.*, 2025).

Therefore, dMBIs may offer a practical and scalable approach to support burnout reduction in healthcare workers. The primary strength of dMBIs lies in their high scalability and cost-effectiveness compared with traditional in-person programs, making them particularly suitable for resource-limited settings or during periods of crisis, such as pandemics, when healthcare staff face intensified challenges (Luangapichart, Saisavoey and Viravan, 2022; Pratt *et al.*, 2023). Digital tools afford flexibility and accessibility, allowing healthcare workers who are typically

overburdened and challenged by shift work to engage with the intervention at their convenience, overcoming the geographic and scheduling barriers inherent to the profession (Cameron *et al.*, 2025). Therefore, dMBIs may be considered supportive components within institutional wellness initiatives. Given the heterogeneity and predominantly high risk of bias, strong practice or policy recommendations should be made cautiously until they are confirmed by higher-quality trials. Guided digital formats may support higher engagement than fully self-directed approaches; however, comparative effectiveness by guidance level could not be formally tested in this review and should be evaluated in future trials (Berardi *et al.*, 2021; Garg and James, 2025).

This review had several methodological limitations. First, restricting the inclusion to English-language publications may have introduced language bias and limited the global representativeness of the findings. Second, the meta-analyses were based on a limited number of studies, which reduced the precision of pooled estimates and prevented subgroup analysis and meta-regression from exploring sources of heterogeneity, including intervention duration, delivery features, fidelity, adherence, professional role, and timing of outcome measurement. In particular, we could not conduct subgroup analyses by digital delivery mode (mobile application, web-based platform, videoconferencing) or guidance level because the evidence base was limited and unevenly distributed across these categories, with some subgroups represented by a few trials. Variability in endpoint timing across studies may have contributed to heterogeneity, but statistical examination of this potential moderator was not feasible. Publication bias assessments, including Egger's regression test, were underpowered for outcomes with fewer than 10 studies; therefore, non-significant results should not be interpreted as evidence of no small-study effects or reporting bias. This limitation reflects the small number of eligible trials currently available, rather than the analytical approach. Third, most included trials were judged to have a high risk of bias, mainly due to lack of blinding, deviations from intended interventions, and reliance on self-reported outcomes. Our sensitivity analyses excluding high-risk studies showed attenuation of effects, with only personal accomplishment remaining statistically significant. Mindfulness could not be tested because all mindfulness trials were rated as high risk. These findings suggest that the pooled estimates, particularly for outcomes supported primarily by high-risk studies, may overestimate true intervention effects. Fourth, generalizability is potentially compromised because many study samples were disproportionately female, which may limit the transferability to male healthcare professionals or mixed-gender teams. Finally, intervention components and outcome domains were sometimes insufficiently described, which may have led to residual misclassification and reduced the accuracy of intervention characterization.

Conclusion

This systematic review and meta-analysis found that dMBIs significantly alleviated burnout symptoms among healthcare workers, with positive effects observed across emotional exhaustion, personal accomplishment, and depersonalization. Benefits were also noted for mindfulness and depression, indicating the potential of dMBIs to improve both occupational and psychological well-being. These findings suggest that digitally delivered mindfulness-based interventions may offer scalable and flexible options to support well-being in demanding health care environments. However, given the heterogeneity and predominantly high risk of bias, conclusions regarding effectiveness and implementation should be interpreted cautiously. While the current evidence base is promising, more high-quality trials with diverse participant samples would help strengthen the conclusions and guide implementation. Nevertheless, this review highlights the growing role of digital mindfulness strategies in addressing burnout and promoting well-being in health care settings.

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Availability of data and materials

Data sharing is not applicable to this article, as no new data were created or analyzed in this study.

Authors' contributions

SDMR led conceptualization, methodology, data curation, investigation, and drafting, and reviewed and edited the manuscript. MH and NAT contributed to methodology, investigation, and drafting, and reviewed and edited the manuscript. YMT contributed to data curation, investigation, and drafting, and reviewed and edited the manuscript. SIT contributed to

conceptualization, methodology, validation, visualization, supervision, and reviewed and edited the manuscript.

Declaration of Interest

The authors (s) declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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