

# Brief mindful coloring for stress reduction in nurses working in a Hong Kong hospital during COVID-19 pandemic

## A randomized controlled trial

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### Abstract

**Background:** Effective interventions to promote well-being at work are required to reduce the prevalence and consequences of stress and burnout especially during the COVID-19 pandemic. This study determined the effects of mindful coloring on perceived stress levels, mental well-being, burnout, and state and trait mindfulness levels for nurses during COVID-19.

**Methods:** This was a single-center, two-armed, parallel, superiority, blinded randomized controlled trial. Seventy-seven participants were randomly allocated (by computer-generated sequence) to either mindful coloring ( $n = 39$ ) or waitlist control groups ( $n = 38$ ). Twenty-seven nurses in the mindful coloring group and 32 in the control group were included in the full compliance per protocol analysis. The mindful coloring intervention included participants viewing a 3-minutes instructional video and coloring mandalas for at least 5 working days or 100 minutes in total during a 10-day period. Participants in both groups completed the Perceived Stress Scale (total score 0–40), short Warwick-Edinburgh Mental Well-being Scale (total score 7–35), Maslach Burnout Inventory-Human Services Survey for Medical Personnel (3 subscales), Five Facets Mindfulness Questionnaire-Short Form (total score 24–120) and Mindful Attention Awareness Scale-State version (total score 0–30) instruments. The primary outcome was the perceived stress level.

**Results:** Baseline prevalence of moderate to high perceived stress level was high (79.2%). There was a large mindful coloring effect on reducing mean perceived stress levels (Mean difference [MD] in change between groups  $-3.0$ , 95% CI:  $-5.0$  to  $-1.00$ ; Cohen's  $d = 0.80$ ). Mindful coloring may lead to a small improvement in mental well-being level ( $P = .08$ ), with an improvement found in the intervention group (MD  $0.9$ , 95% CI  $0.0$ – $1.8$ ,  $P = .04$ ) through enhanced state mindfulness ( $P < .001$ ). There were no effects on changing burnout subscales or trait mindfulness levels. No adverse reactions were reported.

**Conclusion:** Coloring mandalas may be an effective low-cost brief intervention to reduce perceived stress levels through enhancing state mindfulness and it may promote mental well-being. Hospitals may promote or provide mindful coloring as a self-care and stress-relief practice for nurses during their off hours or work breaks.

**Abbreviations:** CI = confidence interval, COVID-19 = coronavirus disease 2019, DP = depersonalization, EE = emotional exhaustion, FFMQ-SF = Five Facets Mindfulness Questionnaire-Short Form, MAAS-STATE = Mindful Attention Awareness Scale-State version, MBI = mindfulness-based intervention, MBI-HSS-MP = Maslach Burnout Inventory-Human Services Survey for Medical Personnel, MBSR = mindfulness-based stress reduction, MD = mean difference, PA = personal achievement, PSS-10 = Perceived Stress Scale-10 items, SD = standard deviation, SWEMWBS = short Warwick-Edinburgh Mental Well-being Scale.

**Keywords:** burnout, coloring, critical care, mindfulness-based intervention, nurses, stress

## 1. Introduction

The coronavirus disease 2019 (COVID-19) pandemic continues to challenge the provision of sufficient critical care resources

and healthcare providers worldwide.<sup>[1]</sup> Frontline nursing during this pandemic is more stressful than ever.<sup>[2,3]</sup> A systematic review of 40 studies,<sup>[4]</sup> involving 27,034 nurses, estimates the summary prevalence of stress to be 43% (95% CI 37–49%).

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All data generated or analyzed during this study are included in this published article [and its supplementary information files].

Ethical approval for the study was obtained from the City University of Hong Kong Department of Social and Behavioural Sciences Human Subjects Ethics Committee of the (A-5790-202011-08) and the Chinese University of Hong Kong Survey and Behavioural Research Ethics Committee (SBRE-20-162).

Trial registration: Clinicaltrials.gov, NCT04942509.

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Among critical care physician and non-physician practitioners, the prevalence of burnout is also high (56% and 50% respectively).<sup>[5]</sup> Stress and burnout predict physiological, behavioral and psychological problems including cardiovascular diseases, prolonged fatigue, headaches, early mortality, alcohol abuse, absenteeism, insomnia, and depressive symptoms.<sup>[6]</sup> In the healthcare system, nurses' stress and burnout predict lower job performance, poor patient safety and quality of patient care, as well as increased turnover intentions and medical errors.<sup>[7]</sup> Leisure activities and effective interventions to promote well-being at work are therefore required to help reduce the prevalence and consequences of stress and burnout.<sup>[5]</sup>

Mindfulness-based interventions (MBIs) have been recommended as an effective strategy to manage occupational stress and burnout among nurses.<sup>[8]</sup> Mindfulness can refer to either a momentary state or a dispositional trait.<sup>[9]</sup> When occupying a mindfulness state, an individual has a heightened awareness of the present-moment experiences including their outer surroundings and inner thoughts, feelings, and sensations while accepting these experiences in a non-judgmental way. A mindfulness state can be attained by purposefully focusing all attention on the ongoing flow of external and internal events as they arise, without suppressing, evaluating or fixating on any of them. Trait mindfulness is the general tendency to be mindful in daily living, and increasing state mindfulness over repeated practices may increase trait mindfulness.<sup>[10]</sup> MBIs integrate mindfulness training and practices into daily living to help participants develop a more mindful trait. Those with higher trait mindfulness have superior stress-coping ability as they appraise daily experiences as less stressful, exercise more self-acceptance and less self-blame, and more readily accept events that are beyond their control.<sup>[11]</sup>

The mindfulness-based stress reduction (MBSR) program is an established 8-week MBI that has demonstrated effectiveness in reducing stress, burnout, anxiety, and depression, as well as enhancing well-being and quality of life across various populations including nurses.<sup>[12]</sup> However, time commitment is a barrier for traditional MBIs, such as the MBSR, to be implemented broadly in the nursing setting due to nurses' irregular and long working hours.<sup>[13]</sup> Brief MBIs that were adapted to increase accessibility were introduced to overcome this barrier, and studies demonstrate effectiveness of these MBIs in improving psychological outcomes for healthcare providers.<sup>[13]</sup>

Most mindfulness practices studied involve focused breathing, but findings from a meta-analysis indicate that other mindfulness exercises, such as mindfulness applied to a task, might be more effective.<sup>[14]</sup> Coloring is an activity that may be easily accomplished by most people while promoting a sense of self-achievement on the completion of an art piece. Structured coloring with pre-designed, repetitive patterns (typically mandalas) is linked to mindfulness as the complexity and repetitiveness of structured coloring may facilitate focused attention and awareness of immediate experiences, inducing a meditative state.<sup>[15]</sup> A previous study on university students shows that daily coloring is associated with lower anxiety and depressive symptoms.<sup>[16]</sup> Mantzios and Giannou<sup>[17]</sup> integrated coloring into a MBI by supplementing the activity with mindfulness instructions. These instructions were adapted from traditional breathing-focused mindfulness practices and modified to focus on the coloring activity. Mindful coloring may help participants develop a habit of being mindful without imposing a heavy time load, and participants have reported reduced stress and burnout.<sup>[17]</sup> A previous study on teachers, another high-stress profession, has also shown that mindful coloring for 5 days enhances trait mindfulness, reduces stress, and burnout.<sup>[18]</sup> Other advantages of mindful coloring include easy accessibility and dissemination, low cost, and individual flexibility in where (workplace or in self-isolation settings) and when it is done. However, the effects of brief daily mindful coloring on the nursing population have not been examined.

The primary objective of this study was to determine the effect of mindful coloring on perceived stress levels in nurses. The secondary objectives were to determine the effect of mindful coloring on mental well-being, burnout, as well as the immediate state mindfulness and stable trait mindfulness levels. The hypotheses of the study were as follows: the coloring group would have larger decreases in perceived stress and burnout scores than the waitlist control group; the coloring group would have larger increases in trait mindfulness levels than the waitlist control group; and the coloring group would report increases in state mindfulness levels immediately after each mindful coloring session.

## 2. Methodology

### 2.1. Study design

We conducted a single-center, two-armed, parallel, superiority, blinded, randomized controlled trial. The International Committee of Medical Journal Editors Recommendations stated that the registration of a randomized controlled trial conducted on healthcare professionals to measure health outcomes is not required; however, we nonetheless retrospectively registered the trial on the ClinicalTrials.gov registry (NCT04942509). We performed simple randomization of participants to either a waitlist control or mindful coloring group with 1:1 allocation made according to a computer-generated sequence by a research nurse who was not involved in the screening, recruitment, or data collection. The first author was blinded to each participant's group allocation.

### 2.2. Participants and setting

After ethical approval was obtained for the study, we recruited nurses working at a university teaching hospital in Hong Kong through distributing posters and using the circulated email service of the Association of Hong Kong Nursing Staff. The study was carried out in two separate rounds with two different groups of participants; 21 to 30 December 2020 and 18 to 27 January 2021. As the study targeted nurses working in public hospitals and the intervention required participants to practice mindful coloring for 5 working days, the inclusion criteria were as follows: full-time clinical nurses working under the Hospital Authority of Hong Kong; and working for at least 5 days during either of the study periods, each of which lasted for 10 consecutive days. Nurses who did not meet the inclusion criteria were excluded from the study. There were no age, gender, years of experience, or other exclusion criteria.

### 2.3. Intervention

Participants received study instructions, their identification number, and a link to complete the baseline questionnaire hosted online at QuestionPro; the instructions were different depending on the assigned group allocation. The baseline questionnaire contained demographic questions (age range, sex, marital status, years of nursing experience, specialty, and previous history of meditation experience) and four psychological instruments: the Perceived Stress Scale-10 items (PSS-10),<sup>[19]</sup> the short version of the Warwick-Edinburgh Mental Well-being Scale (SWEMWBS),<sup>[20]</sup> the Maslach Burnout Inventory-Human Services Survey for Medical Personnel (MBI-HSS-MP),<sup>[21]</sup> and the Five Facets Mindfulness Questionnaire-Short Form (FFMQ-SF).<sup>[22]</sup> After 10 days, all participants in both groups received an email instructing them to complete the post-intervention questionnaire that contained the PSS-10, SWEMWBS, MBI-HSS-MP, and FFMQ-SF instruments.

We sent an email, which included a link to a 3-minute instructional video, to the participants randomly allocated to

the experimental (coloring) group and we instructed the group to watch the video before they started coloring. We asked the experimental group to color for at least 5 working days during the specified 10-day period. In the original protocol, we asked participants to color mandalas for at least 20 minutes each time. However, the nurses' workload increased during the study period due to the fourth wave of COVID-19 in Hong Kong; therefore, we instructed the participants to color for any length of time each day to avoid an excessive time burden. We sent a coloring set, which included coloring pencils and a coloring booklet containing different mandalas, to each of the participants in the experimental group on the first day of the 10-day period. In addition to a traditional circular mandala, flower and animal mandalas were included in the booklet to increase motivation. The first author designed some of the mandalas and others were downloaded for free from websites (<https://coloring4free.com/> and <https://www.free-mandalas.net/>). The patterns were printed and bound into the booklet.

We collected daily state mindfulness data using the Mindful Attention Awareness Scale-State version (MAAS-STATE).<sup>[9]</sup> The scale was included on the pages before and after each mandala pattern. We instructed the participants to color a different pattern every day and complete the five MASS-STATE questions before and after each coloring session to report changes in state mindfulness levels. We assessed the participation adherence data by reference to the participants' reporting on the time spent on coloring made after each session. We also asked the participants to take photographs of their colored mandalas and upload them online at the time of completing their post-intervention questionnaire. On the other hand, the waitlist control group carried out their coloring activity in a subsequent 10-day period after completing the two sets of questionnaires.

#### 2.4. Outcome measures

The primary outcome of this study was perceived stress level and it was assessed by the PSS-10.<sup>[19]</sup> Participants rate how often they appraise their lives as stressful on a 5-point Likert scale from 0 (never) to 4 (very often). Instead of asking participants to report based on their experiences "in the past month", we modified the question to "in the past 10 days" for the purpose of this study. Scores are reversed for 4 items (4, 5, 7, and 8) and the ranges of scores representing low, moderate and high stress levels are 0 to 13, 14 to 26, and 27 to 40 respectively.

The secondary outcome measures were mental well-being, burnout and trait mindfulness levels. Mental well-being was measured using the SWEMWBS.<sup>[20]</sup> This self-report scale consists of seven positively-worded items to assess both respondent's feelings and functioning based on a 5-point Likert scale from 1 (none of the time) to 5 (all of the time). Again, we modified the question from "in the past two weeks" to "in the past 10 days" to fit this study. The total score ranges from 7 to 35 under the following categories: probable depression ( $\leq 17$ ), possible depression (18–20), average mental well-being (21–27) and high mental well-being (28–35).

The 22-item MBI-HSS-MP<sup>[21]</sup> was used to measure burnout through three independent dimensions: emotional exhaustion (EE), depersonalization (DP) and personal achievement (PA). Participants rated how often they experienced feelings of burnout on a 7-point Likert scale from 0 (never) to 6 (every day). Nine items assess EE, totaling a score of 0 to 54 (low < 19, moderate 19–26, high > 26).<sup>[23]</sup> Five items assess DP, totaling a score of 0 to 30 (low < 6, moderate 6–9, high > 9).<sup>[23]</sup> Eight items assess PA, totaling a score of 0 to 48 (low < 34, moderate 34–39, high > 39).<sup>[23]</sup> High EE and DP scores, together with low PA scores, indicated high levels of burnout.

The level of trait mindfulness was measured by the FFMQ-SF scale that comprises 5 subscales: Observe, Describe, Act with Awareness, Non-judge and Non-react. It contains 24 items,

each of which rated on a 5-point Likert scale from 1 (never or very rarely true) to 5 (very often or always true). The total score ranges from 24 to 120, with a higher score indicating a higher level of stable trait mindfulness.

We used the MAAS-STATE<sup>[9]</sup> as a manipulation check to assess any changes in participant's state mindfulness levels before and after the daily coloring activity. Each of the 5 items in the MAAS-STATE is rated on a 7-point Likert scale from 0 (not at all) to 6 (very much), with a total score ranging from 0 to 30. We reversed the scores so that a higher total score represented higher state mindfulness. An increase in scores after coloring would support that the coloring intervention successfully facilitated a mindful experience for the participants.

#### 2.5. Sample size calculation

Baseline scores was assumed to be comparable due to randomization. A sample size of 27 in each group (total  $n = 54$ ) would have 80% power to detect a large effect size of 0.80 using a two-group  $t$  test with a 0.05 two-sided significance level using G\*Power.<sup>[24]</sup> A large effect size was considered to be a clinically meaningful intervention in a busy work environment. As we anticipated a 20% loss to follow-up and partial compliance to the coloring intervention, we recruited the 79 nurses who enrolled in our study.

#### 2.6. Data analyses

Values are reported as frequency (%), mean and standard deviation (SD) or median and interquartile range as appropriate after checking visually and using Shapiro–Wilk's test for normality. Both intention-to-treat and per-protocol (full compliance) analyses were conducted. For noncompliant participants in the mindful coloring group, missing data for state mindfulness was imputed with the overall before and after group mean values. A waterfall plot was drawn to illustrate the change (%) from baseline perceived stress levels for each nurse by intervention group<sup>[25]</sup> using SigmaPlot version 14.0 (Systat software Inc, San Jose, CA). The mean differences in outcomes between groups over time (interaction time\*group variable) were examined using generalized estimating equations with a Gaussian distribution, identity-link function, exchangeable correlation with robust standard errors. Although the level of significance was set at  $P < .05$ , we interpreted borderline significance using the terminology outlined by Pocock and Ware.<sup>[26]</sup> Statistical analyses were performed using SPSS version 27.0 (IBM, Armonk, NY) and Stata version 16.0 (StataCorp, College Station, TX).

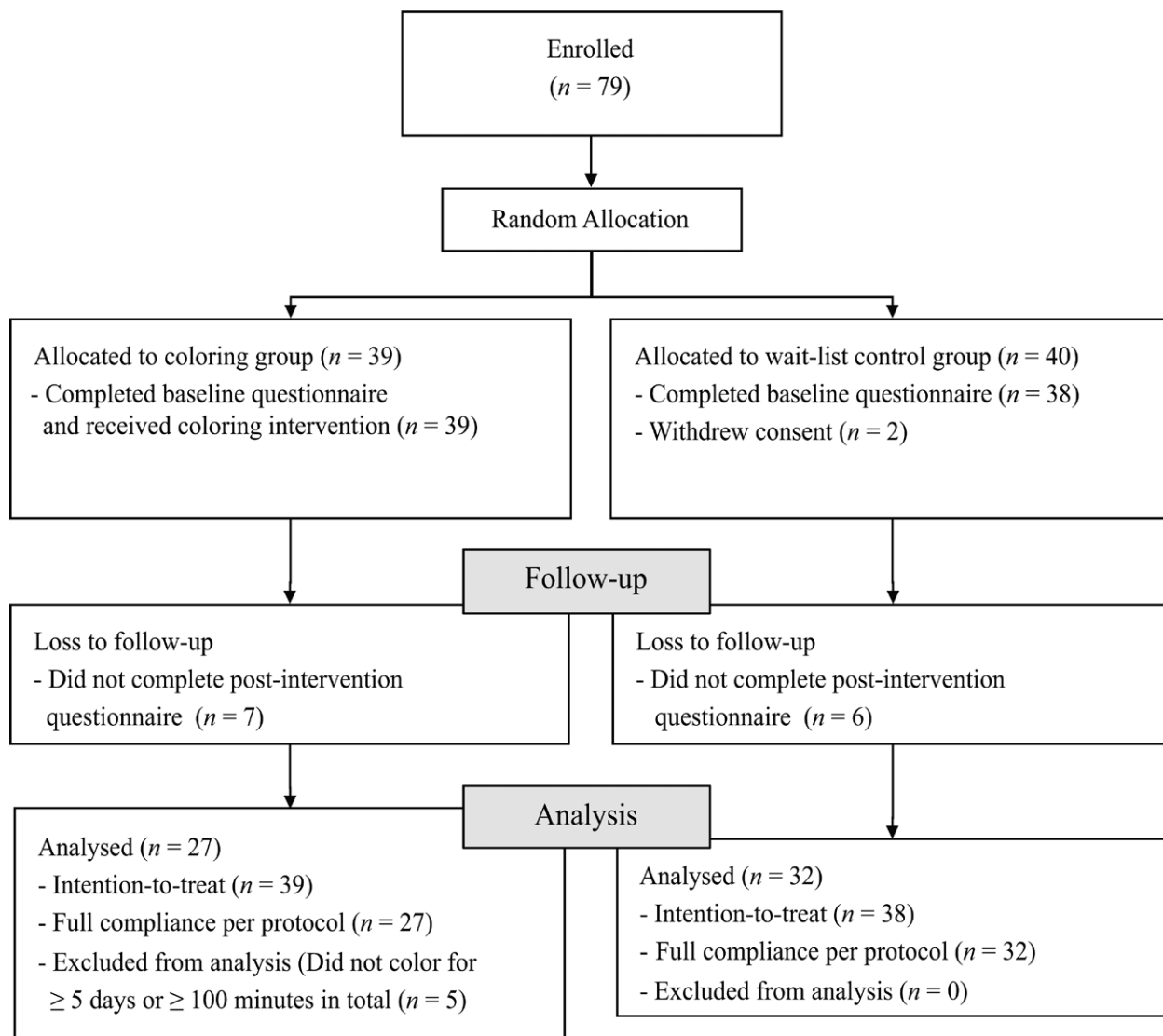
### 3. Results

#### 3.1. Participants

Of the 79 nurses working in critical care (the intensive care unit, operating suites, and the neonatal intensive care unit) and in pediatric, medical, and surgical wards, two withdrew their consent after randomization (Fig. 1). Seventy-seven (5 males and 74 females) completed the baseline questionnaire. Thirty-nine participants were allocated to the mindful coloring group and 38 in the waitlist control group. The baseline demographic characteristics are shown in Table 1.

#### 3.2. Internal consistency of questionnaires

In this study, all questionnaires showed high internal consistency. The PSS-10 scale's internal consistency at baseline ( $n = 77$ ) and post-intervention ( $n = 64$ ) were 0.84 and 0.75 respectively. The SWEMWBS Cronbach's  $\alpha$  were 0.82 at baseline



**Figure 1.** Participants flow diagram for the randomized controlled trial.

and 0.81 post-intervention. The internal consistency of the three MBI-HSS-MP subscales (EE, DP, and PA) at baseline were  $\alpha_{EE} = 0.88$ ,  $\alpha_{DP} = 0.74$ ,  $\alpha_{PA} = 0.78$  respectively; at post-intervention, Cronbach's  $\alpha$  for the subscales were  $\alpha_{EE} = 0.89$ ,  $\alpha_{DP} = 0.81$ , and  $\alpha_{PA} = 0.79$  respectively. The FFMQ-SF Cronbach's  $\alpha$  at baseline and post-intervention were 0.81 and 0.85 respectively. The before and after coloring MAAS-STATE Cronbach's  $\alpha$  were 0.93 and 0.83 respectively.

### 3.3. Adherence to coloring intervention

Sixty-four participants (32 mindful coloring and 32 wait-listed) completed the post-intervention questionnaire (response rate = 83%). Mindful coloring for at least 1 day during the 10-day period was reported in 29 (74%) participants. Twenty-three (59%) participants colored for at least 5 days, with an average coloring time of 36 minutes per day. Overall, 27 (69%) participants colored for at least 5 days or 100 minutes in total during the 10-day period, with an average coloring time of 43 minutes per day.

### 3.4. Effect of mindful coloring intervention

Both the intention-to-treat and per-protocol analyses showed increased state mindfulness immediately after mindful coloring

(Tables 2 and 3). Of the 77 participants, there were 16 (20.8%), 56 (72.7%), and 5 (6.5%) with low, moderate and high baseline perceived stress levels respectively. In the intention-to-treat analysis, the mindful coloring group may have had lower perceived stress levels than the waitlist controls, with a mean difference (MD) of  $-1.7$  (95% CI:  $-3.6$  to  $0.2$ ;  $P = .076$ ) (Table 2). Furthermore, when restricting the analysis to nurses who were fully compliant with coloring requirements, the mindful coloring intervention was effective in reducing the perceived stress levels (MD  $-3.0$ , 95% CI:  $-5.0$  to  $-1.0$ ;  $P = .003$ , Table 3). The mean (SD) percentage change from baseline PSS-10 scores in mindful coloring and waitlist control groups were  $-14.8\%$  (19.5) and  $2.2\%$  (22.6) respectively (MD  $-17.0\%$ , 95% CI:  $-5.9\%$  to  $-28.2\%$ ,  $P = .003$ ) (Fig. 2). This was equivalent to a large mindful coloring effect on reducing mean perceived stress levels (Cohen's  $d = 0.80$ , 95% CI:  $0.27$ – $1.33$ ).

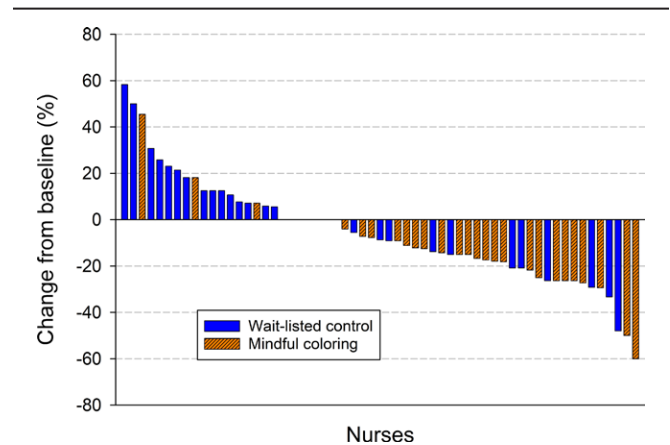
The majority of participants (62.3%) had average baseline mental well-being levels but there were 6 (7.8%) and 21 (27.3%) who had probable or possible baseline depression respectively. The baseline prevalence of moderate and high emotion exhaustion levels were 23 (29.9%) and 22 (28.6%) respectively. Similarly, the baseline prevalence of moderate and high DP were 25 (32.5%) and 18 (23.4%) respectively. Most participants (61.0%) had low baseline PA levels but moderate and high levels were reported in 22 (28.6%) and 8 (10.4%) respectively.

**Table 1**  
Baseline characteristics of participants.

Characteristic	Mindful coloring	Waitlist control
<b>Nurses</b>	<b>n = 39</b>	<b>n = 38</b>
Age (yr), n (%) <sup>*</sup>		
21–30	14 (36.8)	10 (26.3)
31–40	12 (31.6)	15 (39.5)
41–50	7 (18.4)	9 (23.7)
>50	5 (13.2)	4 (10.5)
Sex, n (%)		
Male	3 (7.7)	2 (5.3)
Female	36 (92.3)	36 (94.7)
Marital status, n (%)		
Not married	18 (46.2)	15 (39.5)
Married without children	9 (23.1)	5 (13.2)
Married with child(ren)	12 (30.8)	17 (44.7)
Other	0 (0.0)	1 (2.6)
Specialty, n (%)		
Intensive care	5 (12.8)	6 (15.8)
Operating theatre	14 (35.9)	14 (36.8)
Pediatric	16 (41.0)	15 (39.5)
Other	4 (10.3)	3 (7.9)
Nursing experience (yr), n (%)		
1–5	8 (20.5)	9 (23.7)
6–10	11 (28.2)	10 (26.3)
11–15	4 (10.3)	5 (13.2)
16–20	4 (10.3)	4 (10.5)
>20	12 (30.8)	10 (26.3)
Meditation experience (yr), n (%)		
Nil	29 (74.4)	29 (76.3)
0–1	7 (17.9)	2 (5.3)
1–5	0 (0.0)	2 (5.3)
6–10	2 (5.1)	3 (7.9)
>10	1 (2.6)	2 (5.3)

<sup>\*</sup>1 missing in mindful coloring group.

The mindful coloring intervention was not associated with changes in mental well-being, burnout subscales and trait mindfulness levels in the intention-to-treat analyses (Table 2). However, there may be a small improvement in the mental well-being in the per-protocol analysis (MD 1.0, 95% CI: -0.1 to 2.1; *P* = .075), with an improvement found after mindful coloring (*P* = .043) as shown in Table 3. Otherwise, mindful coloring was not associated with changes in burnout and trait mindfulness levels in the per-protocol analyses that included only participants fully adhering to the intervention (Table 3). No participants reported adverse reactions to the mindful coloring intervention.



**Figure 2.** Waterfall plot showing change (%) in perceived stress level within nurses by intervention groups using results from the per protocol analysis. Orange bars represent the mindful coloring group (n = 27) and blue bars represent the waitlist control group (n = 32).

**Table 2**  
Mean (95% CI) baseline values and changes over time by outcome using an intention-to-treat analysis.

Outcome	Coloring intervention (n = 39)		Control (n = 38)		Between group difference in change	<i>P</i> value
	Baseline	Change	Baseline	Change		
Perceived stress	17.6 (15.9–19.2)	-2.2 (-3.6 to -0.8)	18.6 (17.0–20.3)	-0.5 (-1.8 to 0.9)	-1.7 (-3.6 to 0.2)	.076
Mental well-being	22.4 (21.5–23.3)	0.3 (-0.5 to 1.2)	21.3 (20.3–22.2)	0 (-0.7 to 0.6)	0.4 (-0.7 to 1.4)	.497
Burnout emotional exhaustion	21.9 (19.1–24.7)	-1.1 (-3.3 to 1.1)	22.7 (19.1–26.2)	-0.3 (-2.3 to 1.6)	-0.8 (-3.8 to 2.2)	.611
Burnout depersonalization	7.1 (5.7–8.5)	0.8 (-0.4 to 2.1)	7.1 (5.4–8.8)	-0.1 (-1.2 to 1.0)	0.9 (-0.7 to 2.6)	.276
Burnout personal achievement	30.6 (28.4–32.8)	0.6 (-1.5 to 2.7)	29.8 (27.2–32.4)	-1.4 (-3.2 to 0.4)	2.0 (-0.8 to 4.7)	.159
Trait mindfulness	80.3 (77.6–83.1)	1.1 (-1.0 to 3.3)	77.7 (74.7–80.6)	-0.5 (-2.0 to 1.1)	1.6 (-1.1 to 4.3)	.242
State mindfulness	3.5 (3.3–3.8) <sup>*</sup>	0.9 (0.7–1.1) <sup>*</sup>				<.001

CI = confidence interval.

<sup>\*</sup>Mean substituted missing data in 10 participants who did not color at least 5 days or 100 minutes in total during the 10-day period.

**Table 3**  
Mean (95% CI) baseline values and changes over time by outcome using per protocol analysis.

Outcome	Coloring intervention (n = 27)		Control (n = 32)		Between group difference in change	<i>P</i> value
	Baseline	Change	Baseline	Change		
Perceived stress	18.4 (16.5–20.3)	-3.3 (-4.7 to -1.8)	18.2 (16.5–20.0)	-0.3 (-1.6 to 1.1)	-3.0 (-5.0 to -1.0)	.003
Mental well-being	21.9 (20.8–22.9)	0.9 (0.0–1.8)	21.5 (20.4–22.6)	-0.1 (-0.8 to 0.6)	1.0 (-0.1 to 2.1)	.075
Burnout emotional exhaustion	21.3 (17.8–24.7)	-1.6 (-4.2 to 1.1)	23.4 (19.5–27.3)	-0.5 (-2.5 to 1.5)	-1.1 (-4.4 to 2.2)	.510
Burnout depersonalization	6.4 (4.8–7.9)	0.9 (-0.5 to 2.2)	7.7 (5.7–9.6)	-0.2 (-1.3 to 0.9)	1.0 (-0.7 to 2.8)	.238
Burnout personal achievement	30.1 (27.4–32.9)	0.5 (-2.0 to 3.0)	30.3 (27.6–33.0)	-1.6 (-3.3 to 0.2)	2.1 (-1.0 to 5.1)	.184
Trait mindfulness	79.7 (76.1–83.3)	1.6 (-0.9 to 4.1)	78.4 (75.1–81.6)	-0.6 (-2.1 to 1.0)	2.2 (-0.8 to 5.1)	.146
State mindfulness	3.5 (3.2–3.9)	0.9 (0.6–1.1)				<.001

CI = confidence interval.

## 4. Discussion

### 4.1. Key findings

This randomized controlled trial showed concerning baseline prevalence rates of moderate to high level of perceived stress (79.2%), moderate to high level of EE (58.4%), moderate to high level of DP (55.8%), low level of PA (61.0%) and low level of mental well-being (35.1%). There was a large effect on reducing the perceived stress levels when approximately 70% of nurses colored mandalas for at least 5 days or 100 minutes in total during a 10-day period. The MAAS-STATE results showed that the coloring activity was effective in enhancing participants' state mindfulness immediately after coloring. Compared to waitlist controls, mindful coloring may improve mental well-being levels but there were no effect on burnout or stable trait mindfulness levels.

### 4.2. Comparison with other studies

There were small differences in perceived stress and mental well-being levels between the intention-to-treat analyses and per-protocol analyses. This suggests that there may be an intervention compliance confounding effect that would overestimate the beneficial effects associated with mindful coloring. Our non-compliance rate of about 30% was within other reported attrition rates of 0% to 44% from seven smaller studies on different MBIs for healthcare workers included in a systematic review.<sup>[27]</sup> Nevertheless, our self-guided MBI is highly feasible to implement since the participation rate for at least one session was higher than an onsite mental health team-led mindful practices (5–10 minutes) for healthcare workers (74% vs 61%).<sup>[28]</sup> The mindful coloring intervention required few time demands and training resources, and was executed independently and remotely, making it highly accessible and adaptable for nurses included in this study. These features are likely to make the intervention suitable for other healthcare workers during the current pandemic when face-to-face interactions are limited.

The reduction in perceived stress levels associated with a brief mindful coloring intervention was consistent with findings from pre-post studies in nurses attending a 4-hour mindfulness workshop<sup>[29]</sup> or daily 5-minute mindfulness practice over a month.<sup>[30]</sup> Mindfulness states interrupt habitual responses to stress by facilitating decentering from stress appraisal and freeing up cognitive resources for the adaptive reinterpretation stressful events, yielding alternative responses and perceptions.<sup>[31]</sup> While we found a large effect size on perceived stress levels in the per-protocol analysis, a meta-analysis of 7 randomized controlled trials (n = 188 participants) on workplace mindfulness training, including both self-guided and face-to-face training lasting for up to 12 weeks, showed a medium effect size on stress levels.<sup>[27]</sup> In a post hoc analysis, higher baseline perceived stress scores were moderately correlated with lower subjective well-being scores in our study ( $\rho = -0.54, P < .001$ ) which was consistent with results reported in primary healthcare workers ( $\rho = -0.57, P < .001$ ).<sup>[32]</sup> However, this study did not support the reducing stress level from mindful coloring through enhancing participants' trait mindfulness. This is contrary to findings from another study which showed that teachers' stress levels lowered and trait mindfulness improved after coloring mindfully for 5 working days.<sup>[18]</sup> This may be due to the fact that teachers from the other study colored for 5 consecutive days while nurses in our study colored less regularly due to their irregular work shifts. Our results suggest that nurses may need more mindful practices to develop mindfulness as a habit.

The baseline prevalence of moderate to high EE and DP levels were similar to those reported in non-physician critical care members<sup>[5]</sup> and pediatric nurses.<sup>[33]</sup> However, the baseline prevalence of low PA (61%) was higher than in previous studies.<sup>[5,33]</sup> The null intervention effect on burnout in this study may be due to the short duration or time gap between baseline and post-intervention assessments for the reduced stress levels to cause a

change in burnout levels. Despite lacking a control group, a 4-hour mindfulness workshop was effective in decreasing EE at 1-month and 6-months post-intervention while personal accomplishment only significantly improved after 6 months.<sup>[29]</sup>

### 4.3. Implications

The potential applicability of our results is high, especially when many healthcare systems worldwide continue to be stressed from managing COVID-19 patients. This study found that a 10-day brief mindful coloring intervention reduced stress and improved mental well-being for nurses and could be implemented in the healthcare setting to address the high prevalence of nurses' occupational stress. The short online instruction video and coloring practice are particularly suitable for an intervention targeting nurses and healthcare workers who work long, irregular hours. Online-guided mindful coloring is available during social distancing or quarantine, and can serve as a self-help tool for mental well-being even when nurses are on sick leave or in isolation.

Mandala coloring is inexpensive, simple for most to do, and engaging enough to facilitate focused attention, making it an ideal modality to introduce nurses to mindfulness. We recommend that coloring materials be provided in nurses' lounges to give nurses on-the-job stress relief. Engaging in short, mindfulness practices during the work day (e.g., during breaks) can focus nurses to the present to reduce stress responses. Also, keeping the coloring materials in common areas hence providing access to mindfulness practices over time can help create an environment that supports mindfulness without creating of sense of coercion or force. We also suggest that training be provided from time to time to deepen the understanding of mindfulness principles, augmenting mindful awareness during practices. Training and consistent practices work complementarily to cultivate mindfulness as a habit, and help nurses become more mindful in everyday lives.

### 4.4. Limitations and further research

There were several limitations to this randomized controlled trial. As we included predominately females, with most (91%) participants working in high risk areas, generalizability of the study results to broader nursing populations is limited. Future studies can explore recruitment methods and extend recruitment periods to include more nurses from different hospitals, or different departments within a hospital. Second, measurement bias may be present in using self-reported outcome measures, especially when there is also large heterogeneity in thresholds used in the BMI-HSS-MP instrument to classifying various burnout levels.<sup>[23]</sup> Finally, the long-term mindful coloring effects on outcomes beyond the 10-day period are unknown. Future studies may consider extending the duration of a mindful coloring intervention to nurses who have irregular working schedules hence maybe short on continuity in their practices than other professions. Further studies should also include follow-up assessments to test long-term effects, especially the more chronic or stable outcomes such as burnout and trait mindfulness. Notably, follow-up should be carefully planned due to the high dropout rates at follow-up found in previous MBSR studies.<sup>[12]</sup> In addition, conducting mediation analyses would be helpful to test if enhancing trait mindfulness would explain the mechanism behind reducing perceived stress and improving psychological well-being.

## 5. Conclusions

The baseline prevalence rates of moderate to high levels of perceived stress and burnout were concerning. The findings of this study support that mindful coloring may be an effective brief intervention to reduce perceived stress levels and

may promote mental well-being for nurses. Mindful coloring enhances momentary mindfulness, which predicts stress reductions despite the lack of change in trait mindfulness. We suggest that coloring materials be provided in nurses' lounge to give nurses access to on-the-job mindfulness practices and stress relief. However, there were no intervention effects on reducing burnout and enhancing trait mindfulness levels during the short period of this randomized controlled trial. Future studies should include follow-up assessments to test the intervention's effects on burnout and trait mindfulness, as well as its sustained effects on stress and mental well-being.

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