Longitudinal increases in mindfulness practice quality are associated with changes in psychological outcomes and not vice versa – a brief report

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Declarations

Trial Registration

The initial study (Strohmaier et al., 2021) was pre-registered on ClinicalTrials.gov (pre-registration identifier: NCT03797599), however, the current further analyses were not preregistered.

Conflicts of interest

There are no conflicts of interest.

Informed Consent

All participants who took part in this study gave informed consent.

Ethics approval

The study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

Author contributions

All authors contributed to the study design. Material preparation, data collection and analysis were performed by SS. The first draft of the manuscript was written by SS and all authors

commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Abstract

With research on mindfulness increasing exponentially, it is important to clarify factors that may influence the success of this approach. We examined the construct of mindfulness meditation practice quality using longitudinal data drawn from a randomized controlled trial testing low-dose mindfulness practices with novice mindfulness practitioners from the general population ($N = 48$). Results suggest that increases in mindfulness practice quality over time are associated with improvements in psychological outcomes (anxiety, stress, and mindfulness), but not vice versa. Findings join previous research supporting the notion that mindfulness practice quality is an important element of mindfulness training in higher-dose programs as well as low-dose and self-help mindfulness programs and practices. Therefore, this research contributes to finding further support of the importance of mindfulness practice quality as a cause of improvement in psychological distress. This needs to be explored further in future research.

Keywords: mindfulness; mindfulness practice; practice quality; psychological distress

Introduction

There has been an exponential increase of scientific interest with different doses of mindfulness practices and programs in recent years (Strohmaier, 2020), especially considering the importance of post-pandemic mental health in the general population (Cavalera et al., 2023; Sun et al., 2023). Along with attempts to clarify the necessary dose of practice (Berghoff et a., 2017; Strohmaier et al., 2021; Strohmaier et al., 2022), it is important to understand intervention mechanisms, such as mindfulness practice quality (Goldberg, 2022; Hassed et al., 2021). According to Ericsson's (1994) theory of deliberate practice, the nature of one's practice impacts the development of expertise. Research by Ribeiro et al. (2018) with novice practitioners found that practice quality rather than time spent practicing was considered more important in a mindfulness-based program (MBP). Similarly, recent research from a larger dose study of mindfulness-based stress reduction (MBSR) found that greater practice quality mediated the association between practice dose and changes in outcomes (Goldberg et al., 2020).

However, no study to date has investigated the possibility of reverse causation, whereby increase in practice quality emerge as a result rather than cause of changes in outcomes. Although not sufficient to establish causality, demonstrating temporal precedence is an important aspect of a causal relationship (Kazdin, 2007). Moreover, practice quality has not been examined in a lower dose program containing briefer practices isolated from group discussions. Therefore, this brief report seeks to further examine the association between changes in mindfulness practice quality over time and how this relates to change in both, psychological distress, and mindfulness.

Methods

Participants and Procedure

Participants were largely white British or European, female adult novice mindfulness practitioners recruited from the general UK population. In this single-blind study, 71 participants were randomly assigned to one of three groups, namely i) four shorter (5-minute) mindfulness of the breath meditation practices (n = 24), ii) four longer (20-minute) mindfulness practices (n = 24), or iii) an active audiobook (25-minute) control group (n = 23), each taking place twice a week over two weeks. To reduce bias, mindfulness groups also listened to audiobook excerpts so that all participants received 25-minutes of audio content in each session. Participants were asked not to engage in formal mindfulness practice outside of sessions to control the dose of practice.

Measures

Participants were asked to complete the following self-report measures at each session (one to four). Trait measures were also administered one week after session four.

Depression, Anxiety, Stress Scale (DASS-21; Henry & Crawford, 2005)

The DASS-21 (α = .82; depression: α = .78.; anxiety: α = .75; stress: α = .74) is divided into three 7-item subscales of trait depression, anxiety, and stress with higher scores indicating greater symptomatology.

Five Facet Mindfulness Questionnaire (FFMQ-15; Baer et al., 2006)

Trait mindfulness was measured with the FFMQ-15 (α = .84), with three items for each of its five facets observe, describe, act aware, non-judging, and non-reactivity. Greater scores on the FFMQ-15 indicates greater trait mindfulness.

Toronto Mindfulness Scale (TMS; Lau et al., 2006)

The 13-item TMS (α = .94) measures state mindfulness and includes the subscales curiosity and decentering. Greater TMS scores are indicative of greater state mindfulness.

Practice Quality-Mindfulness (PQ-M; Del Re et al., 2013)

The PQ-M (α = .68) is a visual analogue scale where participants are asked to rate six items in terms of practice quality, with greater practice quality represented by higher scores.

Data analysis

Since this report focuses on the results of the PQ-M, only the mindfulness practice groups, but not the control, are included in the analysis. Descriptive statistics and analysis of assumptions were completed first (see XX (*removed for blinding*)).

We conducted a series of multilevel models to examine whether longitudinal change in PQ-M scores were associated with pre-post improvements in psychological distress and mindfulness.

$$Y_{ij} = B_{oo}(Intercept) + B_{10}(Time) + B_{01}(Pre - Post\ Change\ Score) + B_{02}(Time * Pre - Post\ Change\ Score) + [U_{0j} + e_{ij}], \quad \text{(Equation 1)}$$

where Y_{ij} reflects PQ-M scores at timepoint i for participant j, B_{00} is the fixed intercept, B_{10} is the fixed slope for time, B_{01} is the fixed slope for pre-post change score (e.g., pre-post change in psychological distress), B_{02} is the fixed slope for the cross-level interaction between time and pre-post change score, U_{0j} is the random participant-level intercept, and e_{ij} is the error term.

A parallel set of models examined whether longitudinal changes in psychological distress and mindfulness scores were associated with pre-post improvements in PQ-M (i.e., same as Equation 1 but with psychological distress or mindfulness scores as Y_{ij} and pre-post change in PQ-M as a predictor). Analyses were conducted in R using the 'lme4' package (Bates et al., 2015).

We provide further analysis of data from a previously published study; for more details, including a priori G*Power analysis, see XX (removed for blinding).

Results

Table 1 depicts descriptive statistics of outcomes at each timepoint. See Table SI.1 in the supplementary Online Resources for demographic information.

Table 1

Descriptive statistics

Outcome	**Time 1** **M (SD)** **N=48**	**Time 2** **M (SD)** **N=48**	**Time 3** **M (SD)** **N=48**	**Time 4** **M (SD)** **N=48**
FFMQ-15	34.9 (7.3)	43.9 (5)	45.4 (5.4)	47.8 (5.4)
TMS	25.9 (7.6)	30.5 (6.3)	35.2 (7.2)	39 (7.7)
DASS-21 Depression	8 (5.9)	5 (4.1)	4.1 (4.1)	2.5 (3.1)
DASS-21 Anxiety	5.1 (5.4)	3.9 (4.4)	3 (3.4)	2.3 (2.9)
DASS-21 Stress	11.8 (6.6)	8.5 (5.2)	7 (4.4)	5.5 (3.3)
PQ-M	78.7 (9.1)	80.2 (9)	82.3 (9.9)	84.7 (11.4)

M=Mean; *SD*=Standard Deviation; *FFMQ-15*=Five Facet Mindfulness Questionnaire; *Dass-21*=Depression Anxiety Stress Scale; *TMS*=Toronto Mindfulness Scale; *PQ-M*=Practice Quality – Mindfulness

Multilevel models

Significant time X pre-post change score interactions were detected in multilevel models. These effects indicated that improvements in PQ-M were steepest for participants who showed the largest reductions in anxiety and stress (but not depression) and the largest increases in trait and state mindfulness (Table 2). In contrast, time X pre-post change score interactions were not detected when modeling pre-post changes in PQ-M as a predictor of longitudinal changes in measures of psychological distress and mindfulness (see Table SI.2 in supplementary Online Resources). No difference in results was found when considering age, gender, and mindfulness teacher's years of experience.

Table 2

Multilevel model of longitudinal mindfulness practice quality change and its association with pre-post change in psychological outcomes over time

Outcome	Time			Pre-post change			Time x pre-post change		
	b	**SE**	**t**	**b**	**SE**	**t**	**b**	**SE**	**t**
Trait mindfulness	0.07	0.05	1.31	-0.05	0.11	-0.49	.14	.05	2.9**
State mindfulness	-0.07	0.05	-1.33	0.22	0.12	1.82	.14	.05	2.9**
Depression	0.1	0.05	2.18*	-0.14	0.1	-1.39	-.06	.04	-1.34
Anxiety	0.13	0.04	3.2**	-0.07	0.1	-0.67	-.1	.04	-2.13*
Stress	0.09	0.16	1.93	-0.04	0.1	-0.38	-.11	.05	-2.3*

SE=Standard Error; *=p<.05; **=p<.01; ***=p<.001

Discussion

The current analyses showed that changes in practice quality over time were moderated by pre-post change in distress and mindfulness. This finding coincides with previous research of higher-dose programs demonstrating that longitudinal changes in practice quality are associated with pre-post changes in psychological outcomes (Del Re et al., 2013; Goldberg et al., 2014, 2020). This is consistent with the theory of deliberate practice, where the nature of one's practice impacts the development of expertise (Ericsson, 1994). It also further adds to the argument that quality may be an important factor for producing beneficial effects of mindfulness training (Ribeiro et al., 2018). This may especially apply to novice practitioners where practice is isolated (Strohmaier et al., 2021) and for different clinical populations (Campbell & Pakenham, 2022). Although the current design cannot establish practice quality as a causal factor (Kazdin, 2007), it did provide evidence suggesting that trajectories of

change in practice quality are associated with pre-post changes in outcomes while trajectories of change in outcomes were not associated with pre-post changes in practice quality.

Limitations and Future Research

Firstly, one limitation relates to internal consistency of the PQ-M measure, which is below the generally acceptable threshold in this sample (Cronbach's $\alpha = 0.68$), which may be due to the nature of this study not having included a qualified mindfulness teacher and discussions with peers (for more detail, see XX (*removed for blinding*)). However, arguably, lower reliability in this measure would make a significant finding less likely given it introduces measurement error, rather than artificially producing associations which are not there (Cohen et al., 2003). Secondly, the relatively small sample size and thirdly, fairly demographically homogeneous sample need to be noted as limitations. However, a priori power analysis suggested that the sample size was sufficient (see XX (*removed for blinding*)) and future research should repeat the analysis with a more demographically diverse sample.

Future research should further examine the role of mindfulness practice quality and steps towards increasing quality in both higher- and lower-dose MBPs (Strohmaier, 2020), such as ensuring guidance is given by experienced and qualified practitioners and practices being evidence-based following validated protocols (Crane et al., 2017). It will be important to understand practice quality across diverse populations (e.g., based on race/ethnicity, socioeconomic status, clinical condition; Pagnini et al., 2019).

In conclusion, results support the importance of practice quality as a potential cause – rather than effect – of improvements in psychological outcomes in MBPs. Therefore, studying the possibility of reverse causation is an important next step in establishing practice quality as a causal mechanism within MBPs. Future research experimentally manipulating practice quality should confirm this possibility.

Data availability statement

The datasets generated during and/or analyzed during the current study are not publicly available since participants' permission to make the raw data from their scores publicly available was not sought and therefore this cannot be made available in this case.

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Supplementary Information Online Resources

Table SI.1

Demographic information

N	Age M (SD)	Gender (% female)	Ethnicity *N* (%)	Occupation *N* (%)
48	38.9 (13.4)	77.1%	White: 38 (79.2%)	Student: 20 (41.7%)
			Black: 2 (4.2%)	Lecturer: 12 (25%)
			Asian: 2 (4.2%)	Administrator: 8 (16.7%)
			Other: 2 (4.2%)	Librarian: 3 (6.3%)
			Unknown 4 (8.3%)	Other: 5 (10.4%)

Table SI.2

Multilevel model of longitudinal psychological outcome change and its association with pre-post change in mindfulness practice quality over time

Outcome	**Time**			**Pre-post change**			**Time x pre-post change**		
	b	**SE**	**t**	**b**	**SE**	**t**	**b**	**SE**	**t**
Trait mindfulness	0.48	0.05	10.3***	0.21	0.14	1.5	0.02	0.05	0.72
State mindfulness	0.43	0.03	12.75***	0.3	0.11	2.79**	0.03	0.03	1
Depression	-0.3	0.04	-6.86***	-0.27	0.14	-1.88	0.001	0.04	0.02
Anxiety	-0.18	0.04	-5***	-0.16	0.12	-1.31	-0.01	0.04	-0.23
Stress	-0.31	0.04	-7.07***	-0.46	0.14	-3.2**	0.07	0.04	1.54

SE=Standard Error; *=p<.05; **=p<.01; ***=p<.001