



Effectiveness of an online short-term audio-based mindfulness program on negative emotions during the COVID-19 pandemic: Latent growth curve analyses of anxiety and moderated mediation effects of anxiety between mindfulness and negative affect

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Abstract

This pilot study aims to explore the effects and mechanisms of a mindfulness-based intervention on negative emotions in community settings during the COVID-19 pandemic. Participants ($N = 100$) were randomized into an intervention group ($n = 50$) and a waitlist control group ($n = 50$). Participants in the mindfulness group underwent 3 weeks (21 sessions) of an online audio-based mindfulness-based intervention program and completed the online measures four times whereas those in the waitlist control group needed to complete the measures twice. Participants completed measures of the Hospital Anxiety and Depression Scale and Positive and Negative Affect Schedule. The results of the measures of the two groups were compared. Moderated mediation analysis was used to analyze intervention outcomes on negative affect through anxiety. Unconditional quadratic latent growth analysis was used to test the growth trajectories of anxiety. The results showed that this intervention program was effective at improving positive affect and at reducing depression, anxiety, and negative affect. The baseline anxiety moderator was found to be significant, and indirect effects of anxiety post-intervention were found between the mindfulness-based intervention and negative affect. Anxiety levels of participants were not at the same starting point and had similar but non-quadratic growth trajectories. The mindfulness-based intervention program was effective at promoting mental wellbeing and reducing mental problems in community settings in China. Mindfulness practices were beneficial to people with different anxiety levels but had more obvious benefits on anxiety and a negative affect for participants with low anxiety levels. Clinical trial registration: ISRCTN16205138 on 26/02/2021.

Keywords Mindfulness · Audio-based · Community settings · COVID-19 · Anxiety · Negative affect

Introduction

Benefits of online mindfulness for negative emotions

According to the World Health Organization report, from March 31 to May 2, 2021, the total number of confirmed cases of COVID-19 increased from 102,333 to 103,649 and the total number of deaths increased from 4,849 to 4,858 in China (World Health Organization, 2021), where the prevalence of depression, anxiety, and stress-related symptoms during the outbreak of COVID-19 has been reported to be 26.9%, 21.8%, and 48.1% respectively (Bareeqa et al., 2021). During the COVID-19 pandemic, depressive, stress, and anxiety symptoms increased (Leong Bin Abdullah et al., 2021). China implemented aggressive containment measures. Despite the small number of new cases, the Chinese government acted decisively

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to lock down the city to curb the spread of the contagious virus to other areas, including school closure, work suspension, and production stoppage, and community containment (Wang et al., 2021), so that face-to-face mental health treatment was largely halted in order to control virus transmission (Liu et al., 2020). Online psychological services and self-help mental health kits become essential in China. As one of the common mental health intervention approaches, mindfulness-based interventions (MBIs) help to cultivate consciousness in the current moment with non-judgement and intention (Kabat-Zinn, 2013). Individuals who perceive lower levels of depression, anxiety, and stress about COVID-19 have higher levels of mindfulness (Yalçın et al., 2022), indicating that mindfulness is a protective factor during the pandemic. Four to eight weeks of online home-based audio guided MBI is effective for adults' anxiety, depression, and stress in different countries (Hall et al., 2018; Lahtinen et al., 2021; Si et al., 2021; Simonsson et al., 2021). A sample of communities trained in mindfulness practices has demonstrated a significant increase in positive affect (Garland et al., 2015). However, the effectiveness of 10–20-min online short-term (less than four weeks) audio-based mindfulness (SAM) programs on negative emotions and positive affect in community settings in China during the epidemic has not been tested. Therefore, the first contribution of this pilot study is to provide empirical evidence for the effects of a specific MBI.

Potential mechanisms of anxiety between mindfulness and negative affect

MBIs can reduce the negative emotions of adults, especially anxiety and negative affect (Sears & Kraus, 2009), and mindfulness can significantly predict lower levels of anxiety (de Abreu Costa et al., 2019) and negative affect (Raes et al., 2013). Mindfulness is negatively related to negative emotions as conscious actions or consideration promote self-regulation of thoughts and emotions (Gautam et al., 2019). Mindfulness is associated with less anxiety and depressive symptoms, as more mindful individuals have greater awareness and acceptance of negative emotions, less difficulty with impulse control, and more efficient use of emotion regulation strategies (Cheung & Ng, 2019). Negative affect is positively related to anxiety levels (Hughes & Kendall, 2009; Sauer-Zavala et al., 2012). The effects of anxiety symptoms can cause people to automatically pay attention to negative information that matches their negative emotions, and it is difficult not to pay attention to negative information, leading to a vicious cycle that exacerbates negative emotions (McKee et al., 2007). However, few empirical research studies have tested whether anxiety can positively predict negative affect. Therefore, the second contribution of this pilot study is to provide empirical evidence of the relationship between anxiety and negative affect. This pilot study proposes the hypothesis that mindfulness will mitigate negative affect via changes of anxiety based on previous research and will fill

the research gap. Additionally, one study found no significant linear relationship between anxiety levels at baseline and the effect of MBI, but the curve estimates displayed an inverted U-shaped approximation. The study proposed that individuals with moderate anxiety received the most benefits from MBIs compared with those having low or high levels of anxiety. For individuals with high levels of anxiety, medical intervention is superior to psychotherapy (Chen et al., 2013). Thus, the baseline anxiety may influence the effectiveness of MBIs on negative affect and this study will further examine this. Thus the third contribution of this pilot study is to provide some empirical evidence support for the mechanisms and theories of MBIs' impact on negative affect.

Differences in the effect of MBIs on anxiety of individuals

The wide use of MBIs needs careful and rigorous consideration. Most researchers suggest the application of MBIs to different samples, but they assume that the MBIs' effectiveness for each individual is homogeneous based on the group average outcomes (Tang & Braver, 2020). However, empirical research demonstrates the existence of individual differences when receiving the same psychotherapies (Caspi & Bell, 2004; Gully et al., 2002). Without attention to individual differences, MBIs may not achieve the desired effects, and individual differences may make the results of empirical studies irreproducible (MacCoon et al., 2014; Rosenkranz et al., 2013) because samples have characteristics that may make them more responsive to treatment (Tang & Braver, 2020). The differences in the efficacy of MBI may be due to various reasons, including personality traits (Uher, 2011), participants' age (Halladay et al., 2019), or education levels (Akase et al., 2020) and so on. These individual differences, which can lead to receiving the same MBI but having different outcomes, are particularly relevant for anxiety (Fumero et al., 2020), because compared with other psychiatric disorders, MBIs have the greatest impact on anxiety disorders (Khoury et al., 2013). From a practical standpoint, consideration of individual differences in treatment response is important for the popularity of MBIs in different settings, as this will allow for a better understanding of specific subgroups that are most or least likely to effectively achieve desired outcomes (Tang & Braver, 2020). Therefore, this pilot study will explore the individual differences in anxiety of participants after MBIs to observe whether they can achieve valuable results. So, the fourth contribution is to determine which anxiety subgroups MBIs are more effective for, and to provide a reference for future mindfulness training.

Objectives

1. To test the effects of the SAM on negative emotions (e.g., negative affect, anxiety, and depression) and posi-

tive affect between the mindfulness group and the waitlist control group.

2. To test the mediation and moderation effects of anxiety between SAM and negative affect after a three-week intervention.
3. To explore individual differences and weekly change patterns of mindfulness treatment effects on anxiety.

Hypotheses

1. SAM would influence negative affect, anxiety, depression, and positive affect.
2. Anxiety at post-intervention would mediate the relationship between SAM and negative affect at post-intervention.
3. Baseline anxiety would moderate the mediation relationship between SAM and negative affect at post-intervention.
4. There would be individual differences in the effects of weekly SAM on anxiety.

Methods

Participants

Sample size estimation using G*Power for repeated-measures analysis of variance (ANOVA) with two groups (mindfulness group and waitlist control group) and four phases (baseline and at 1, 2, and 3 weeks) implied that 74 participants are required to test a small to medium effect size ($f = 0.25$), with $\alpha = 0.05$, and $\text{power} = 0.95$. The small to medium effect size is in line with previous studies (Mak et al., 2018). Due to withdrawal, dropout, technical failure, and data loss, the attrition rate is estimated as 30% (Torous et al., 2020). The pilot study therefore needs to recruit at least 97 participants.

The researchers disseminated recruitment information to online community groups and recruited participants from various community settings in China via the Internet or by phone. Inclusion criteria consist of those who were over 18 years old, lived in community settings, could understand and read Mandarin, had consistent Internet access, could receive audio every day, and had spare time to listen to the training audio for 10–20 min every day for 21 consecutive days. Exclusion criteria include those who had practiced mindfulness meditation before, were currently receiving any medication or psychotherapies, or had been diagnosed with depression, anxiety, or other mental illness.

Participants were assigned to two groups in an expected 1:1 allocation ratio (intervention group, $n = 50$; waitlist control group, $n = 50$) using a computer-generated random number. Each participant was assigned a number code matched with their online assessment forms to ensure that personal identities cannot be ascertained from the questionnaires. In

terms of the blinding setting, the trial is open label, so both the researchers and participants know which intervention groups the participants are assigned to.

Intervention

In the SAM group, participants received one 10–20-min audio consisting of mindfulness practices every day via social media, such as WeChat or QQ, for a period of 21 days. Participants confirmed whether they had completed the practice each day by answering a question about the audio content and how they felt about the audio sent via a group sending function of chat tools on the following day before noon. If a participant missed an audio session, he/she could make up for it in the next training session and catch up by listening to the audios he/she had missed. If participants did not reply to the message, researchers reminded them again before sending another new audio. Participants were deemed to automatically drop out if they did not respond to messages for more than 3 days or did not complete the scales during the intervention. Researchers kept a record of attendance or missed sessions for the participants every day.

The 21-session mindfulness program is adapted from an online mindfulness-based model developed in a previous study (Harnett et al., 2010), including typical and traditional mindfulness practices. The order of mindfulness practice in the audio in the first week included 10-min mindful sitting, 20-min body scan, 15-min mindful breathing, 20-min mindful eating, 15-min mindful walking, 3-min breathing space plus 15-min mindful yoga, as well as 15-min flashlight mindfulness. The 7 audio files were recorded by the third author who spoke fluent Mandarin and has practiced mindfulness meditation for three years and were reviewed by a qualified mindfulness instructor. The content of mindfulness practice in the first week was repeated in the second and third weeks.

In the waitlist control group, participants only needed to complete the scales and follow their usual routine. Participants of both groups started and ended the practices on the same dates. Participants who completed the intervention and all measures received an exquisite gift that was selected by them, not limited to dolls, small fans, water cups, notebooks, umbrellas, clothes, or coupons and they could also receive free counseling sessions from qualified counselors.

Measures

All participants provided demographics and background information, such as phone number, age, gender, education level, and marital status. Participants in the SAM group filled in online measures at baseline, 7-days, 14-days and 21-days of mindfulness practice while those in the control group filled in scales at baseline and 21-days.

Depression & anxiety

The Chinese Hospital Anxiety and Depression Scale is a 4-point Likert scale from 0 to 3 and has 7-item depression (DEP) and 7-item anxiety (ANX) subscales (Leung et al., 1993). The reliability for the anxiety subscale was 0.82 and that for the depression subscale was 0.71 (Spinhoven et al., 1997). In this study, the alpha coefficient of reliability for the anxiety subscale was 0.76 at baseline, 0.73 at 1-week, 0.78 at 2-weeks, and 0.75 at 3-weeks respectively while that for the depression subscale was 0.72 at baseline, 0.74 at 1-week, 0.76 at 2-weeks, and 0.78 at 3-weeks respectively.

Positive affect & negative affect

The Five-point Likert Positive and Negative Affect Schedule measures mood status, involving a 10-item positive affect (PA) subscale and a 10-item negative affect (NA) subscale (Watson et al., 1988). This scale was validated in for the Chinese population including teenagers and young adults (Huang et al., 2003). In this study, the alpha coefficient of internal consistency for the PA subscale was 0.89 at baseline, 0.88 at 1-week, 0.90 at 2-weeks, and 0.91 at 3-weeks respectively, while that for the NA subscale was 0.92 at baseline, 0.91 at 1-weeks, 0.94 at 2-weeks, and 0.96 at 3-weeks respectively.

Statistical analysis

The study used the IBM SPSS version 25.0. Baseline characteristics of the two groups were analyzed via independent t-tests and chi-square tests. In the two groups, within-group effects were analyzed via paired sample t-test and between-group effects via independent sample t-test. The effect sizes of 0.2, 0.5, and 0.8 were denoted by Cohen's *d* (*d*) as small, medium, and large effect sizes (Cohen, 2013). A repeated-measure ANOVA was used to test data changes over time and partial eta-squared (η^2) was used as the effect size in the SAM group.

The moderated mediation model was tested by using PROCESS SPSS computational tool (Hayes, 2013). Bootstrapping procedures were set to 5,000 samples to test the estimated indirect effect, that was, a 95% confidence interval of indirect effect did not include zero. Simple slope test by the pick-a-point approach and the Johnson-Neyman approach was used to further explore moderation effects. The processes of the pick-a-point approach included selecting the values of the moderator, calculating conditional effects of independent variables on dependent variables on those values, and generating confidence intervals (Hayes & Matthes, 2009). In the moderated mediation model (Fig. 1), the binary independent variable was Group (1 = SAM, 0 = Control) and Time 3 negative affect (T3NA) was the

dependent variable. Anxiety at baseline (T0ANX) was set as the moderator while anxiety at Time 3 (T3ANX) was set as the mediator. T0ANX was not related to the intervention because of randomization, so it fulfilled the requirement of moderator according to Kraemer et al. (Chmura Kraemer et al., 2008). Group*T0ANX was the product of Group and mean-centered T0ANX to explore the interaction effects. Age, gender, education, and marital status were regarded as control variables in the model. Conditional effects through plots and tests of simple effects to interaction effects (Mean-1SD, Mean, Mean + 1SD) across levels of T0ANX were explored and observed (Preacher et al., 2007).

The unconditional quadratic latent growth model (LGM), which allowed non-linear growth on variable, explored the trajectories of anxiety and interpersonal differences in anxiety changes in the intervention group (Duncan & Duncan, 2004) in Mplus 8.0 under the robust maximum likelihood estimator (Muthen & Muthen, 2017). In LGM, latent intercept represented the initial level of anxiety trajectory while the slope was the speed of change of anxiety trajectory. Quadratic growth factors were added into the model to examine whether it had a better model fitting the trajectory shape. The Chi-square (χ^2), degree of freedom (df), comparative fit index (CFI), root mean squared error of approximation (RMSEA) and standardized root mean square residual (SRMR) were used to measure model fits (Hu & Bentler, 1999).

Results

Demographic information

A total of 120 participants were recruited. However, 8 participants were ineligible, 4 participants declined to participate, and 8 participants did not sign the consent form, producing a total of 100 samples. Then 50 samples were randomized to the intervention group and 50 samples were randomized to the control group. All participants finished the trial without dropout during the study (Fig. 2). Table 1 displays the demographic information of the samples in the

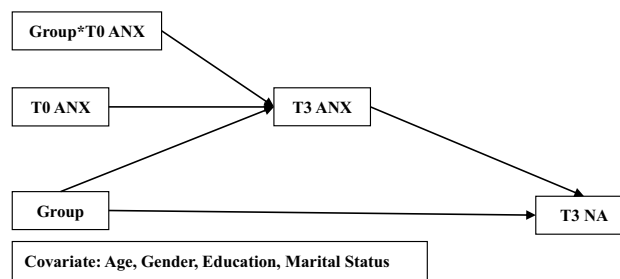


Fig. 1 Moderated mediation model

two groups. In the intervention group, the mean age of samples was 37.9 years (SD=8.16, Min=23, Max=55). 48% of the people were males and 52% females. Most samples had high school or college education (60%) and were married (84%). The demographic variables of the two groups did not show a significant difference at T0 ($p > 0.05$).

Intervention outcomes

Table 2 presents the results of within-group and between-group effects. Compared with those in the control group, participants in the intervention group showed significantly improved positive affect ($F = 10.75, p < 0.001, d = 0.18$), reduced anxiety ($F = 41.41, p < 0.001, d = 0.46$), depression ($F = 66.93, p < 0.001, d = 0.58$), and NA ($F = 7.66, p < 0.001, d = 0.14$) after 3-weeks SAM. As for the control group, there was no significant difference in participants' mental health data during the intervention period. There was no significant difference between the two groups at T0, but there was a significant difference in all scale scores at T3. The scores of PA ($t = 2.46, p < 0.05, d = 0.49$) in the SAM group were significantly higher than those in the control group at T3. Moreover, the scores of NA ($t = -2.14, p < 0.05, d = 0.43$), ANX ($t = -7.12, p < 0.001, d = 0.81$), and DEP ($t = -8.07, p < 0.001, d = 0.62$) in the SAM group were significantly lower than those in the control group at T3.

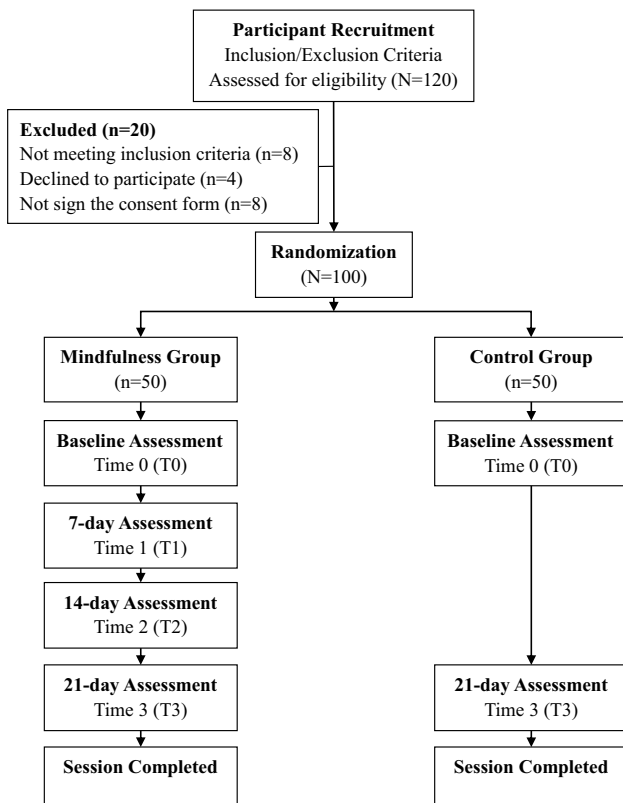


Fig. 2 Flow diagram of randomized controlled trial

Conditional mediation model

Table 3 shows regression estimates in the mediation model, moderated mediation model, and conditional effects. As for the mediation model, there was a negative and significant total effect between Group and T3NA ($\beta = -2.43, p < 0.05$). T3ANX partially mediated the relationship between Group and T3NA (Indirect effect: $\beta = 4.09, CI = 2.20$ to 6.23 ; Direct effect: $\beta = -6.52, p < 0.001$). Controlling for the auto-regressive effect of demographic variables, mediation analysis revealed that Group was significantly negatively related to T3ANX ($\beta = -3.48, p < 0.001$) and T3NA ($\beta = -6.52, p < 0.001$). Higher T3ANX predicted flatter T3NA ($\beta = -1.18, p < 0.001$). The mediation model explained

Table 1 Demographic and profiles of participants in two groups

Demographic		SAM (n = 50)		Control (n = 50)		p
		Mean (Min)	SD (Max)	Mean (Min)	SD (Max)	
Age (Years)		37.90 (23)	8.16 (55)	36.02 (23)	7.83 (55)	.24
		Frequency	Percent	Frequency	Percent	
Gender	Male	24	48	23	46	.84
	Female	26	52	27	54	
Education	Junior secondary and below	1	2	6	12	.19
	High School or college degree	30	60	28	56	
	Bachelor degree	18	36	16	32	
	Master degree and above	1	2	0	0	
Marital Status	Unmarried	7	14	13	26	.21
	Married	42	84	37	74	
	Divorced	1	2	0	0	
	Widowed	0	0	0	0	

SD = Standard deviation, Min = Minimum, Max = Maximum, p = Significant level

Table 2 Results of within-group and between-group outcomes

Within-group effects								
Group	Variable	Mean	SD	Lower Bound	Upper Bound	<i>F/t</i> -test	$\eta p^2/d$	
SAM	PA					10.75***	.18	
	T0	29.30	5.34	27.78	30.82			
	T1	30.88	5.55	29.30	32.46			
	T2	32.14	5.92	30.46	33.82			
	T3	32.80	6.41	30.98	34.62			
	NA					7.66***	.14	
	T0	20.98	6.52	19.13	22.83			
	T1	19.28	5.44	17.73	20.83			
	T2	18.60	4.62	17.29	19.91			
	T3	18.06	5.08	16.62	19.50			
	ANX					41.41***	.46	
	T0	15.10	2.25	14.46	15.74			
	T1	12.68	1.99	12.11	13.25			
	T2	12.78	2.05	11.20	13.36			
	T3	12.36	2.36	10.69	13.03			
Control	DEP					66.93***	.58	
	T0	12.60	1.77	12.10	13.10			
	T1	9.56	1.88	9.03	10.09			
	T2	9.38	1.82	8.86	9.90			
	T3	8.96	1.97	8.40	9.52			
	PA					.03	.00	
	T0	29.48	6.13	27.87	31.09			
	T3	29.46	7.14	26.56	31.37			
	NA					.38	.05	
	T0	20.74	6.22	18.95	22.53			
	T3	20.42	5.94	18.87	21.97			
	ANX					.18	.03	
	T0	15.84	2.88	15.11	16.57			
	T3	15.76	2.41	15.09	16.43			
	DEP					-1.43	.13	
T0	12.28	2.15	11.73	12.83				
T3	12.32	2.19	11.74	12.90				
Between-group effects								
Time	Scale	Group	Mean	SD	Lower Bound	Upper Bound	<i>t</i>	<i>d</i>
T0	PA	SAM	29.30	5.34	-2.46	2.10	-1.16	.03
		Control	29.48	5.34				
	NA	SAM	20.98	6.52	-2.29	2.77	.19	.03
		Control	20.74	6.22				
	ANX	SAM	15.10	2.25	-1.77	.29	-1.43	.09
		Control	15.84	2.88				
DEP	SAM	12.60	1.77	-.46	1.10	.81	.16	
	Control	12.28	2.15					
T3	PA	SAM	32.80	6.41	.65	6.03	2.46*	.49
		Control	29.46	7.14				
	NA	SAM	18.06	5.08	-4.55	-.17	-2.14*	.43
		Control	20.42	5.94				
	ANX	SAM	12.36	2.36	-4.35	-2.45	-7.12***	.81
		Control	15.76	2.41				
DEP	SAM	8.96	1.97	-4.19	-2.53	-8.07***	.62	
	Control	12.32	2.19					

* $p < .05$, ** $p < .01$, *** $p < .001$. SD = Standard deviation

Table 3 Regression estimates in mediation model, moderated mediation model and conditional effects

Results of mediation analysis								
DV	IV	β	SE	<i>t</i>	LLCI	ULCI	<i>F</i>	<i>R</i> ²
T3ANX	Constant	14.72***	1.86	7.90	11.02	18.42	11.90***	.39
	Group	-3.48***	.49	-7.16	-4.44	-2.51		
	Age	.08*	.03	2.25	.01	.14		
	Gender	-.56	.48	-1.16	-1.52	.40		
	Education	.02	.40	.05	-.77	.81		
	Marital Status	-.49	.60	-.82	-1.68	.70		
T3NA	Constant	40.05***	4.91	8.15	30.29	49.80	7.15***	.32
	Group	-6.52***	1.23	-5.29	-8.97	-4.07		
	T3ANX	-1.18***	.21	-5.58	-1.59	-.76		
	Age	-.06	.07	-.92	-.20	.07		
	Gender	-1.07	.99	-1.08	-3.04	.90		
	Education	.22	.82	.26	-1.40	1.84		
	Marital Status	1.39	1.23	1.14	-1.04	3.83		
Total effect		-2.43*	1.14	-2.13	-4.69	-.17		
Direct effect		-6.52***	1.23	-5.29	-8.97	-4.07		
Indirect effect		4.09	1.03		2.20	6.23		
Results of moderated mediation analysis								
T3ANX	Constant	16.14***	1.69	9.58	12.79	19.49	15.25***	.54
	Group	-3.06***	.43	-7.05	-3.92	-2.20		
	T0ANX	.27*	.11	2.45	.05	.48		
	Group*T0ANX	.38*	.18	2.13	.03	.73		
	Age	.06	.03	1.92	.00	.12		
	Gender	-.73	.43	-1.70	-1.58	.12		
	Education	-.07	.37	-.19	-.81	.66		
	Marital Status	-.73	.53	-1.38	-1.79	.32		
T3NA	Constant	40.05***	4.91	8.15	30.29	49.80	7.39***	.32
	Group	-6.52***	1.23	-5.29	-8.97	-4.07		
	T3ANX	-1.18***	.21	-5.58	-1.60	-.76		
	Age	-.07	.07	-.92	-.20	.08		
	Gender	-1.07	.99	-1.08	-3.04	.90		
	Education	.22	.82	.26	-1.41	1.84		
	Marital Status	1.39	1.23	1.14	-1.04	3.83		
Results of conditional effects								
Label			T0ANX	Effect	<i>t</i>	SE	LLCI	ULCI
Direct effect			-	-.52***	-5.29	1.23	-8.97	-4.07
Conditional effects of Group on T3ANX		-2.60		-4.04***	-6.70	.60	-5.24	-2.85
		.00		-3.06***	-7.05	.43	-3.92	-2.20
		2.60		-2.07***	-3.11	.67	-3.39	-.75
Conditional indirect effects of Group on T3NA		-2.60		4.76	-	1.18	2.53	7.14
		.00		3.60	-	.93	1.92	5.57
		2.60		2.44	-	.97	.80	4.60

p* < .05, *p* < .01, *** *p* < .001. DV = Dependent variable, IV = Independent variable, β = Unstandardized estimates, SE = Standard error, LLCI = Lower limit confidence interval, ULCI = Upper limit confidence interval

around 39% of the total T3ANX ($F = 11.90, p < 0.001$) variance and 32% of the total T3NA ($F = 7.15, p < 0.001$). Moderated mediation analysis implied that indirect effects of SAM on T3NA through T3ANX were significantly moderated by T0ANX, and there was a positive and significant

effect of the interaction term on T3ANX ($\beta = 0.38, p < 0.05$). The moderated mediation model explained around 54% of the total T3ANX variance ($F = 15.25, p < 0.001$) and 32% of the total T3NA ($F = 7.39, p < 0.001$). These results indicate that people’s NA can be effectively reduced through

lower anxiety via three-week SAM and different levels of baseline anxiety of participants can influence the mediation relationship.

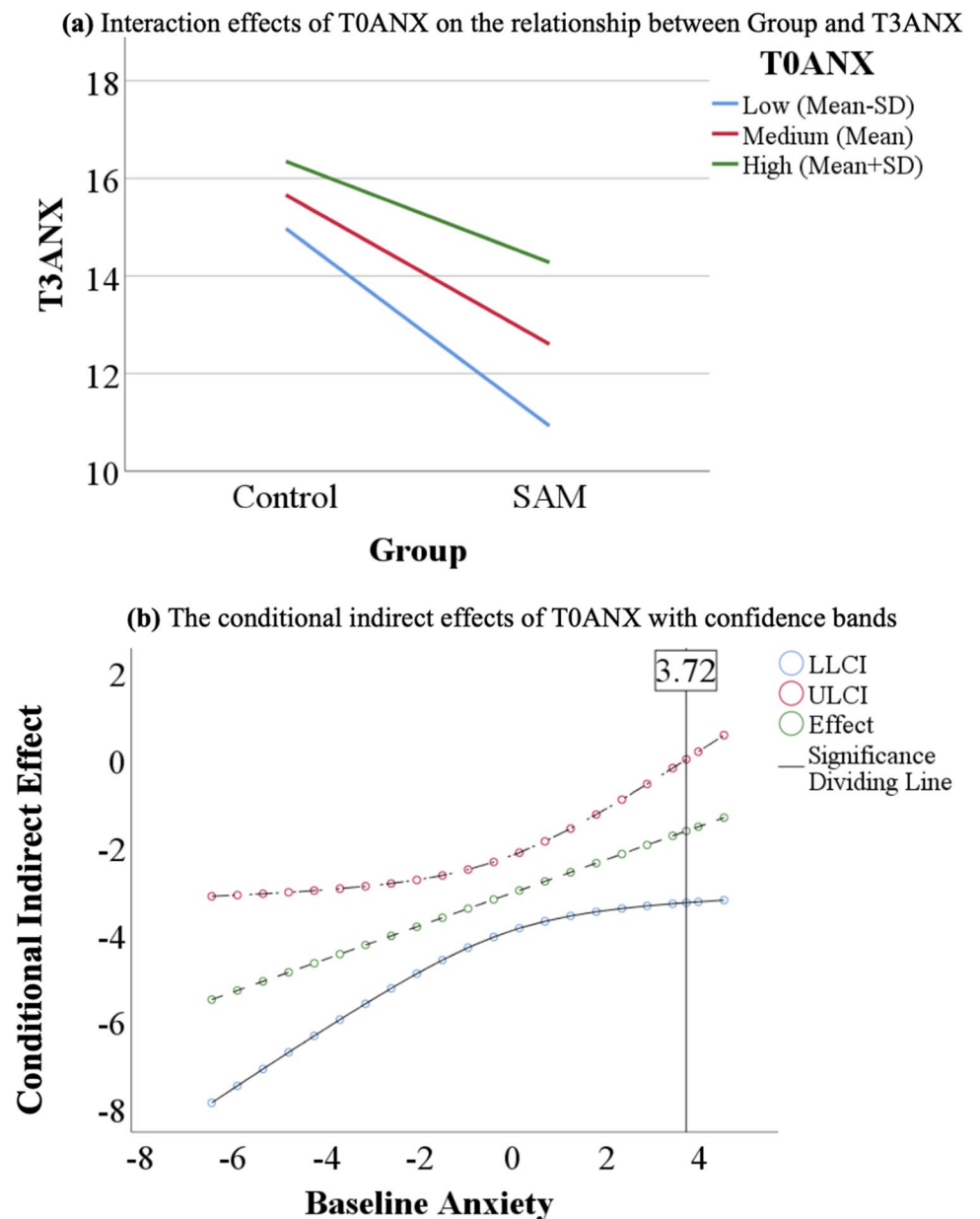
Figure 3a shows the interaction effect of T0ANX on the relationship between Group and T3ANX. Participants with high levels of T0ANX had less reduction in T3ANX in the SAM group than participants with moderate and low baseline anxiety levels. Apart from the moderation effect mentioned above, the Johnson-Neyman approach was used to examine when the effects took place. Figure 3b describes the conditional indirect effects of T0ANX with confidence bands. The results of the Johnson-Neyman approach showed when the effects of SAM on T3ANX were significant across the levels of T0ANX. The conditional indirect effect was

statistically significant with the 95% CI when T0ANX was less than 3.72. The results indicate that participants whose baseline anxiety level was lower than 3.72 can effectively reduce their NA through the lower anxiety via three-week SAM.

Unconditional quadratic latent growth model

Table 4 presents the coefficients information of quadratic unconditional LGM. Model fit of quadratic LGM ($\chi^2=13.85, df=5, p<0.05, CFI=0.90, RMSEA=0.19,$ and $SRMR=0.05$) was acceptable and better than linear LGM ($\chi^2=38.03, df=13, p<0.001, CFI=0.7, RMSEA=0.20,$ and $SRMR=0.12$). Therefore, this study just showed the results

Fig. 3 Interaction effect and conditional indirect effect with confidence bands



of quadratic LGM. The intercepts of age ($B = 0.32, p < 0.05$) and of education ($B = 0.26, p < 0.05$) were significant, indicating that participants had significant differences in age and education regarding their initial levels of anxiety. The means of intercept, slope, and quadratic were $6.92 (p < 0.01)$, $-1.19 (p > 0.05)$, and $-0.36 (p > 0.05)$, demonstrating that participants' anxiety levels were not at the same starting point and that they had similar decreased but insignificant and nonquadratic growth trajectories. The variances of intercept, slope, and quadratic were not significant ($p > 0.05$), which indicates the homogeneity of the individuals' starting levels, and the different rates of anxiety levels did not show obvious inter-individual differences. The correlation between slope and intercept was not significant ($\beta = -2.21, p > 0.05$), indicating that higher baseline anxiety levels did not predict more obvious reduction in anxiety after participants receiving MBI. The relationship coefficients between quadratic factor and intercept and slope were $0.60 (p > 0.05)$ and $-0.02 (p > 0.05)$, implying that both intercept and slope were not related to quadratic factor. Figure 4a displays the unconditional quadratic LGM of anxiety with standardized coefficient and Fig. 4b shows developmental trajectories of the mean of anxiety over time. The levels of anxiety decreased obviously in the first week, then rebounded slightly, and finally dropped slightly. The results indicate that there were individual differences in baseline anxiety, which may be affected by their education or age. After three weeks SAM, the individuals' anxiety development trends were similar. All of them decreased in the first week, rebounded in the second, and continued to reduce in the third week.

Table 4 Coefficients information of unconditional quadratic LGM

Items		Estimate	SE	Est/SE
Mean	Intercept	6.92**	2.41	2.87
	Slope	-1.19	2.61	.46
	Quadratic	-.36	.88	-.41
Variance	Intercept	4.03	2.60	1.55
	Slope	.89	2.92	.31
	Quadratic	-.11	.25	-.43
Covariance	Slope with Intercept	-2.21	3.00	-.74
	Quadratic with Intercept	.60	.77	.78
	Quadratic with Slope	-.02	.72	-.03
Intercept on	Age	.32*	.13	2.85
	Gender	.23	.14	1.70
	Education	.26*	.11	2.60
	Marital Status	.09	.10	.93
Slope on	Age	-.19	.35	-.65
	Gender	-.05	.23	-.22
	Education	-.57	.63	-2.40
	Marital Status	.06	.18	.32

* $p < .05$, ** $p < .01$, *** $p < .001$. SE = Standard error, Est/SE = Estimate divided by SE

Discussion

Intervention effects for negative emotions

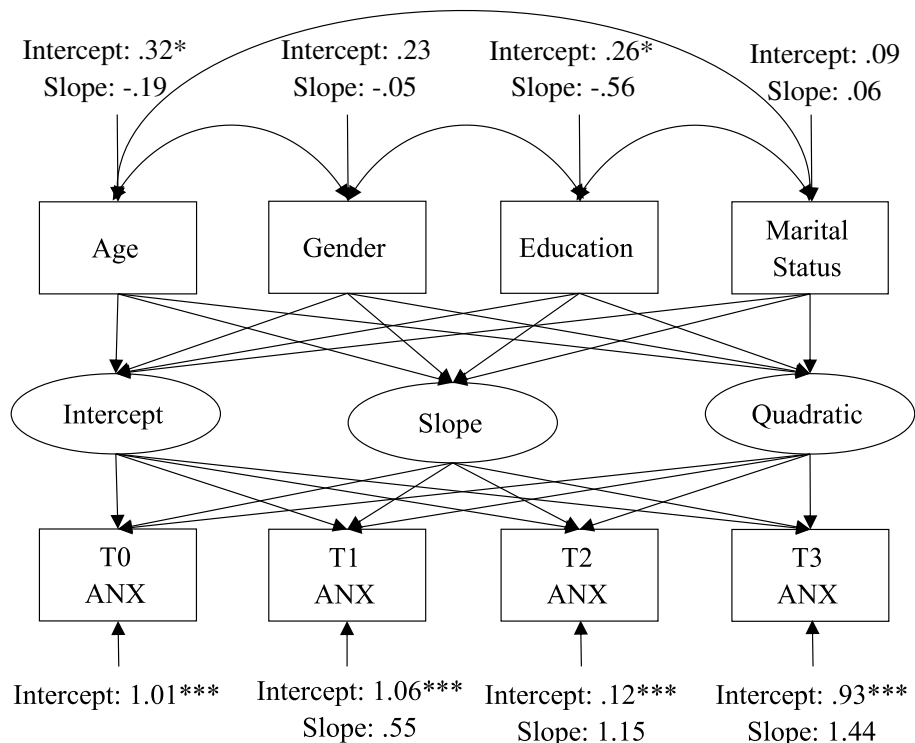
SAM can improve PA and reduce NA, anxiety, and depression in 3 weeks. The results were consistent with previous studies that SAM can be beneficial for individuals in the community (Mak et al., 2018). Apart from the effectiveness of the program, an expected finding of this pilot study is the different timing of changes of variables during the intervention period. Participants' anxiety and depression reduced remarkably in the first week of MBI. A possible mechanism for these quick and effective outcomes is that the benefit of mindfulness meditation could be the state relaxation effect mediated by the activation of parasympathetic functions when participants try to develop their awareness of breathing sensations and accept pressure sources (e.g. worried thoughts, negative moods, and suffering) (Harrison et al., 2017; Jerath et al., 2015). The 10-min audio-instructed mindfulness meditation condition can elevate heart rate variability (Azam et al., 2019), which is an index of continuous and real-time changes in parasympathetic function at rest and under specific conditions (Allen et al., 2007).

The role of anxiety in the intervention effects and the trajectories of anxiety

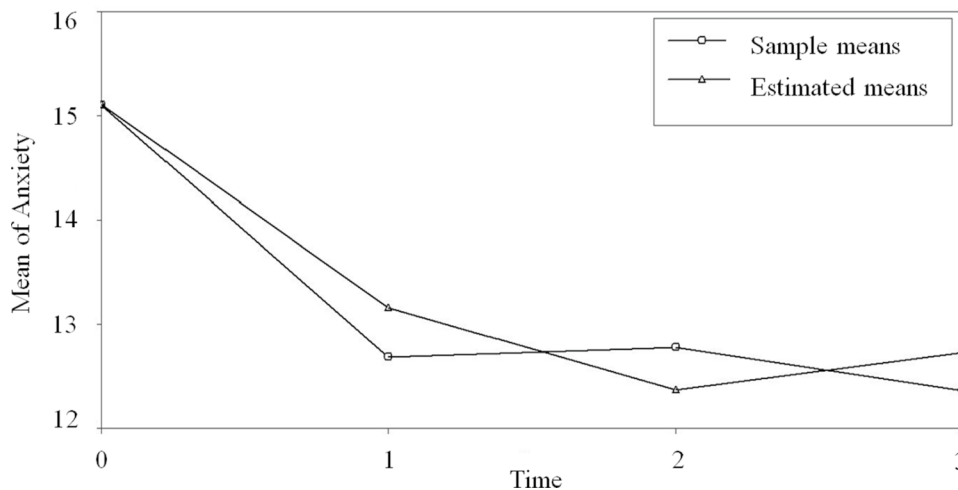
A new contribution of this pilot study is the discovery of how anxiety directly mediated the relationship between SAM and NA. Previous studies using community samples (Chen et al., 2013; Schumer et al., 2018) found that brief MBI directly predicted not only reduced NA, but also decreased anxiety, and identified a correlation between anxiety and NA. In this study, anxiety was proven to be the mediator between SAM and NA. Moreover, baseline anxiety moderated the relationship between SAM and post-intervention NA through post-intervention anxiety. More specifically, the indirect effects of the SAM on post-intervention NA through post-intervention anxiety were weakened in participants with higher levels of anxiety. These findings are consistent with a previous study that reported that the sensitivity of higher levels of anxiety was significantly related to lower levels of awareness and acceptance of mindfulness skills (McKee et al., 2007). People who readily experience negative moods, such as sadness, anxiety, and anger, may not focus on current activities or the present moment in the short term; similarly, those with restricted abilities to focus on their current states without judging themselves (or others) are more likely to experience NA (McKee et al., 2007). Studies showed that standardized MBIs have large effect sizes on reducing anxiety and depression symptoms (Snippe et al., 2017). One mindfulness session or ultra-short mindfulness practice, on the other hand, such as a 5-min lesson

Fig. 4 The unconditional quadratic LGM and developmental trajectories of anxiety

(a) The unconditional quadratic LGM of anxiety with standardized coefficient



(b) Developmental trajectories of mean of anxiety over time



or 10 min of practice every day for 2 weeks, has a small effect size on decreasing anxious symptoms and NA (Schumer et al., 2018). Therefore, people with higher levels of anxiety may need more frequent and longer MBIs. SAM may be more suitable to a low-anxiety level or non-clinical population looking for stress-reduction interventions, and the potential of online and self-help interventions for promoting community mindfulness practices is proved (Cavanagh et al., 2018).

This pilot study found that SAM has similar effects on people of different backgrounds, but at different levels. The

initial levels of anxiety of the participants were different, but their anxiety reduction trends were similar during and after intervention, which means SAM is suitable for people with different anxiety levels. This differs from the study by Kim et al. (2020), in which the trend of anxiety levels showed individual differences. This may be because they did not include the covariates in the model, which may influence the model fit and final results. The reasons for the non-significant slope of anxiety in the present study may be that the intervention and measurement time were too short, so the anxiety of most

participants in the short-term (3 weeks) intervention had similar trajectories. They might show different trajectories if the practice time became longer. Therefore, the anxiety trajectories for longer practice time need to be further explored in future studies.

Limitations and future directions

The first limitation of this pilot study is that it did not provide any information on the enduring effects of SAM. Further research with a follow-up study is required to confirm whether there is maintenance of observed effects or increasing effects for individuals who begin to practice mindfulness regularly. The second limitation is that there was no active control group in this study. Although only pre- and post-tests are sufficient to draw conclusions (Zhang & Zhang, 2021), in the absence of an active control intervention, any observed group differences may simply be due to nonspecific treatment effects (i.e., placebo effects). In the future, when resources and funds are sufficient, the number of measurements in the control group could be made the same as that in the intervention group. The third limitation is that the current recruitment procedure may potentially lead to a selection bias. The use of online platforms as a primary source of recruitment may result in the exclusion of older populations, as there may be an age divide in the use of new information and communication technologies by the elderly (Nimrod, 2017). If targeting community-dwelling elderly, future efforts in the field of online therapy should broadly address this issue (Fischer et al., 2014).

Conclusion

This pilot study may offer a promising line of future research, indicating that SAM may be a meaningful route into mindfulness practice for some people to reduce negative emotions, especially low-anxiety levels of a non-clinical population.

Author contribution Man Ying KANG: Conceptualization, methodology, formal analysis and investigation, writing-original draft preparation. Dr. Joshua NAN: Writing-review and editing, supervision. Yue YUAN: Resources preparation and production.

Data availability The datasets generated during and/or analysed during the current study are available in the [Open Science Framework] repository, [https://osf.io/49kmf/?view_only=99251a147dda481a9a36b7f1cadf560e].

Declarations

Ethics approval The study was approved by the Research Ethics Committee of the Hong Kong Baptist University (REC/20–21/0270). The procedures used in this study adhere to the tenets of the Declaration of Helsinki.

Informed consent Informed consent was obtained from all individual participants included in the study.

Conflict of interest The authors have no competing interests to declare that are relevant to the content of this article.

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