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App-based mindfulness training supported eudaimonic wellbeing during the COVID19 pandemic

Agnieszka Golec de Zavala[1] | **Oliver Keenan**[1] | **Matthias Ziegler**[2] | **Pawel Ciesielski**[3] | **Julia E. Wahl**[4] | **Magdalena Mazurkiewicz**[5]

[1]Goldsmiths, University of London, London, UK

[2]Humboldt-Universität zu Berlin, Berlin, Germany

[3]Adam Mickiewicz University, Poznań, Poland

[4]SWPS University of Social Sciences and Humanities, Poznań, Poland

[5]SWPS University of Social Sciences and Humanities, Warsaw, Poland

Correspondence
Agnieszka Golec de Zavala, Goldsmiths, University of London, London, UK.
Email: agnieszka.golec@gmail.com

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Abstract

A randomized-controlled-trial study ($N = 219$) tested two pre-registered hypotheses that mobile-phone app-based mindfulness training improves wellbeing and increases self-transcendent emotions: gratitude, self-compassion, and awe. Latent change score modeling with a robust maximum likelihood estimator was used to test how those changes are associated in the training versus the waiting-list group. The training increased wellbeing and all self-transcendent emotions regardless of interindividual variance in the changes across time. Changes in all self-transcendent emotions were positively associated with changes in wellbeing. The strength of those associations was comparable in the waiting-list group and the training group. More studies are needed to test whether the effects of mindfulness practice on wellbeing are driven by increases in self-transcendent emotions. The study was conducted over 6 weeks during the COVID19 pandemic. The results indicate that the mindfulness training can be an easily accessible effective intervention supporting eudaimonic wellbeing in face of adversity.

KEYWORDS

app-supported mindfulness training, COVID19, latent change modeling, self-transcendent emotions, wellbeing

INTRODUCTION

The latest Gallup Report has indicated a sharp rise in global unhappiness in the last 5 years (The Gallup Organization, 2022). The American Psychological Association has warned about an impending global mental health crisis propelled by the COVID19 pandemic (Gruber et al., 2021). Cultivating mindfulness has been proposed as an effective way to help manage the mental health crisis (Kabat-Zinn, 2019). Mindfulness-based interventions, especially meditation based Mindfulness-Based Stress Reduction (MBSR) training (Kabat-Zinn, 2003) and Mindfulness-Based Cognitive Therapy (MBCT; Segal et al., 2013), effectively reduce mental health problems (for a recent review, see Goldberg et al., 2022). They also support and sustain eudaimonic wellbeing—non-contingent happiness in face of adversity (Garland & Fredrickson, 2019).

Eudaimonic wellbeing stems from savoring positive aspects of experience, self-value, and positive social connection. However, the role of self-transcendent emotions that link us to someone and something beyond the self (e.g. gratitude, compassion, or awe; Stellar et al., 2017) in mindfulness-supported wellbeing is yet to be clarified by evidence (Ivtzan et al., 2016; Verhaeghen, 2019). We tested whether a mindfulness meditation training - increased self-transcendent emotions and improved wellbeing in a community sample of Polish adults during the COVID19 pandemic. The recent increases in stress and unhappiness in Poland are among the highest in developed countries (The Gallup Organization, 2022). Poland also underperforms on indices of life satisfaction (OECD, 2020) that further decreased during the pandemic (Gawrych, 2020). The training was developed as a mobile phone application. It was based on the MBSR and MBCT with sensitivity to cultural and linguistic patterns of the addressed population (Loucks et al., 2022; van Dam et al., 2018).

Mindful reappraisal and positive wellbeing

Mindfulness is commonly defined as "the awareness that emerges through paying attention on purpose, in the present moment, and nonjudgmentally to the unfolding of experience moment by moment" (Kabat-Zinn, 2003, p. 144). Mindfulness can be trained and practiced. Mindfulness-based interventions are trainings that include the cultivation of a focus on the present moment during sustained meditation practice (Crane et al., 2017). MBSR is the prototypical mindfulness-based intervention, whereas MBCT, while derived from MBSR, was developed specifically to treat depression (Segal et al., 2013). Both interventions are effective in improving wellbeing in clinical and non-clinical populations (for recent reviews, see, e.g. Goldberg et al., 2022; Kuyken et al., 2015, 2016; Querstret et al., 2020). While improved attention focus, breadth, and flexibility result in decreased negative affect, it is the nonjudgmental and accepting attitude towards the experience that increases positive affect (Chin et al., 2019; Lindsay et al., 2018; Verhaeghen, 2019). Thus, mindful positive reappraisal has been proposed as a

mechanism driving the positive effect of mindfulness practice on positive wellbeing (Garland et al., 2017; Hanley et al., 2021; Lindsay et al., 2018).

The mindfulness-to-meaning model (Garland et al., 2015; Garland & Fredrickson, 2019), inspired by the S-ART framework (self-awareness, self-regulation, and self-transcendence; Vago & Silbersweig, 2012), postulates causal links between the psychological processes instigated by mindfulness practice. According to this model, practicing mindfulness increases attentional focus, broadness, and flexibility. Improved qualities of attention foster the ability to postpone immediate judgment and emotional reactions to experience. Thus, mindfulness practice develops the ability to take an observer or a third-person perspective towards one's own experience (e.g. Bernstein et al., 2015; Dahl et al., 2015). This ability elicits insights into maladaptive reaction patterns (Kropp & Sedlmeier, 2019) and facilitates constructive reappraisal of experience in an adaptive way.

The mindfulness-to-meaning model proposes that the new, positive perspective on experience produces a sense of self-transcendence (a selfless state in which the division between subject and the object of cognition are surpassed; Garland et al., 2015; Garland & Fredrickson, 2019) that leads to eudaimonic happiness. Within this framework, wellbeing and happiness are understood as resulting not from obtaining pleasure and avoiding pain (like in hedonism), but from "savoring" meaningful and positive aspects of existence even in the face of adversity (Garland et al., 2015). Indeed, mindfulness practice develops the allocentric (other-centered) frame of reference (Hanley & Garland, 2019) and a sense of awareness extending beyond one's physical body and mental states (e.g. Hanley et al., 2020). Since self-transcendence assumes fading boundaries between the self and non-self, it may promote a sense of connection between the self and non-self. Thus, experiencing self-transcendent emotions may be one of the consequences of fading barriers between the self and non-self. However, the role of self-transcendence in wellbeing has yet to be clarified.

Mindfulness and self-transcending emotions

Self-transcendent emotions, such as gratitude (i.e. feeling thankful for all aspects of experience; Wood et al., 2010), compassion (i.e. a commitment to alleviate suffering in the self and others; Gilbert, 2014; Neff & Germer, 2013), or awe (i.e. perception of vastness induced by factors experienced as greater than the self; Keltner & Haidt, 2003), allow us to recognize and feel connected to something beyond the self and greater than the self. Those emotions link us to others, inspire our propensity towards their needs, and minimize self-absorption (Stellar et al., 2017). They may drive the positive effects of mindfulness interventions on the sense of connection to and responsibility for the world outside the self (Donald et al., 2019; van Doesum et al., 2020; for review, see Creswell, 2017; for theoretical integration, see Garland & Fredrickson, 2019).

Indeed, mindfulness practice increases prosocial beliefs, features, and behaviors (Berry et al., 2018; Donald et al., 2019; van Doesum et al., 2020, cf. Poulin et al., 2021), gratitude (Ivtzan et al., 2016), and compassion and self-compassion (Wasson et al., 2020). Studies also specify that the interventions involving mindful practice of self-transcendent emotions such as gratitude, loving-kindness, compassion or self-compassion—compared to interventions focused solely on experience monitoring or on perspective taking—increase self-transcendent emotions, and altruistic behavior (Hildebrandt et al., 2017, 2019; Singer & Engert, 2019). While some authors interpret self-transcendent emotions such as gratitude or self-compassion as an aspect

of eudaimonic wellbeing (Ivtzan et al., 2016), others suggest that self-transcendent emotions pertain to a distinct variable, and when increased by mindfulness practice, they may mediate its effects on eudaimonic wellbeing (Verhaeghen, 2019). However, the later proposition is supported only by correlational data linking dispositional mindfulness to self-transcendent emotions. We used an experimental design to test the effect of mindfulness training on self-transcendent emotions and their role in inspiring wellbeing. Specifically, based on the mindfulness-to-meaning model and MBSR and MBCT interventions, we designed a mobile-app supported, mindfulness-based intervention to improve attention and emotional management (details in the supporting information). We expected that the intervention should increase self-transcendent emotions of gratitude, awe, and self-compassion as well as psychological wellbeing operationalized as positive mood, low stress, high satisfaction with life, and positive self-esteem.

Overview

We tested two pre-registered hypotheses that the mindfulness training should increase positive wellbeing (H1) and self-transcendent emotions (H2). In addition, to test whether self-transcendent emotions are a mechanism of wellbeing, we explored how self-transcendent emotions and positive wellbeing are related among participants who took part in the mindful-gratitude training and the control, waiting-list group. We expected that the stronger association in the training versus the control group would support the proposition that self-transcendent emotions drive the effect of mindfulness practice on wellbeing. It is important to note though that given the study's design, we could not conclusively test a mediation hypothesis.

We followed JARS (Kazak, 2018). The study was approved by the university's ethics committee (decision 02/P/04/2020). Participants signed informed consent. The pre-registered hypotheses are available online (at https://osf.io/a4jx6/?view_only=e761c7b8d127423392b1671c54733899). Data and codes are available online (at https://osf.io/8p7au/?view_only=9223f6a5b32a4ac68bfed6907747b653). The same study also tested different hypotheses pertaining to the effect of the present training on general prejudice (Golec de Zavala, Ziegler, et al., 2023) and explored trajectories of daily mood improvements among participants (Golec de Zavala, Foerster, et al., 2023).

METHOD

Participants

Participants were 219 Polish adults, 168 women and 48 men (3 participants preferred not to disclose gender). Their age ranged between 18 and 62 ($M = 28.15$, $SD = 8.15$). They were recruited via social media and university mailing lists during the COVID19 pandemic between December 2020 and June 2021. Sample size estimation and detailed information about recruitment, the CONSORT diagram, and exclusion criteria are in the supporting information. Out of 322 participants initially recruited during the screening process, 244 responded to the baseline questionnaires, and another 18 dropped out during the study. Data from further seven participants were excluded from analyses based on pre-registered

criteria: Two participants failed to participate in more than eight training session, and five participants made more than one mistake in questions controlling whether participants listened to the recorded session.

Design and procedure

The study had a randomized controlled trial, mixed design with a two-level within factor (pretest vs. posttest measurements) and a two-level between factor (mindfulness condition: waiting list vs. training). We used one control group due to the funding constraints. We used a passive control group, as this was the first study to test the feasibility of a novel intervention adapted for an understudied population (i.e. Polish participants). Passive control groups allow us to estimate effectiveness of an intervention relative to the passage of time or related potential confounds (e.g. regression to the mean and normal fluctuations). Active control groups estimate effectiveness of interventions beyond non-specific treatment ingredients (e.g. wellbeing improving interventions without a meditative aspect). They are suitable in studies aiming to discern which aspect of the intervention works. Nevertheless, the results of mindfulness interventions on wellbeing and prosociality follow the same pattern in studies with passive and active controls, with the former showing larger effect sizes than the latter (Goldberg et al., 2022). We used passive control because we tested hypotheses derived from a specific theoretical model with measures that did not assess researched constructs in a face valid way to limit demand characteristic.

During the pretest only, we collected demographic data and information about participants' previous experience with mindfulness or contemplative practices. We selected participants who had no previous experience with those practices (we pre-registered the criteria of no longer than 3 months total, at least a year before the training, but the initial screening indicated none of the participants had previous mindfulness experience). After they completed the pretest measurements, participants were randomly allocated to the training ($n = 103$) versus waiting-list group ($n = 116$). Participants in both groups were contacted by a monitoring experimenter (blind to the hypotheses) for an online information session.

Participants in the waiting-list group were informed they will be invited to continue the study in 6 weeks. They were instructed not to engage in any meditation or contemplative practice during this period, as they were to participate in the mindfulness training in 6 weeks after the first group finishes the training. Participants in the training group were instructed on the installation and usage of a *6-week mindfulness practice* mobile application. Participants downloaded the mobile application supporting the training and learned how to use it. Participants were instructed to practice daily, if possible at the same time every morning, in a quiet place where they can sit and remain undisturbed for half an hour. To practice, they logged into the mobile app, read the short introduction describing the skills to be practiced during the session, and followed recorded guidance to practice those skills. We took several quality control measures to ensure participants engaged in the daily practice. The mobile app reminded participants about each session in the evening prior and in the morning of the day of the session. It allowed experimenters to monitor participants' daily progress, checking whether they logged into the app, how long they spent using it, and whether they answered the control questions correctly. Participants could see and answer the control question regarding the content of the session only after the session finished (e.g. 'Choose the correct way to finish the sentence: Rhythmic breathing (1) improves resilience; (2) increases craving;

(3) should be practiced in the evening'). Experimenters contacted participants who missed a session or provided a wrong answer and reminded them about the rules of their participation explained and agreed at the beginning of the study. According to those rules, participants' payment depended on their participation in the training. Participants were rewarded daily, for each correct answer by a small amount of money that incrementally increased until the end of the study when the whole sum was paid. Missed sessions or wrong answers were penalized by deduction of money from this sum. The app allowed participants to monitor how much money they earned each day of the training and how much more money they could gain continuing to participate (detailed information about the training is in the supporting information).

After 6 weeks, all participants were invited to take part in posttest measurements. In pretest and posttest measurements, the order of measures and each of their items were randomized for each participant. In the end, participants were probed for guessing the hypotheses of the study (nobody guessed) and were remunerated. Participants were fully debriefed after data collection was completed.

Analytical strategy

To test H1 and H2, we used a latent-change-score approach (McArdle, 2001, 2009). This approach overcomes two common problems with assessing change in similarly designed studies: uncertain baseline equivalence and the measurement error (Loevinger, 1954; Lord, 1956). Testing for temporal invariance in the randomized trial design allows us to ascertain that the same constructs have been measured over time in the same scale. Strong factorial invariance is required to indicate that the latent change variable is meaningful, i.e. that the units of change are equivalent (Castro-Schilo & Grimm, 2018; Putnick & Bornstein, 2016; Vandenberg & Lance, 2000).

We combined path analyses with a robust maximum likelihood estimator. While the design renders some of the path models just identified yielding no model fit information, this is compensated by analyses that require fewer assumptions and allow using the full information maximum likelihood approach. Those analyses have more statistical power than regression, ANOVA, or *t*-test analyses typically used for similar designs, which make a number of strict assumptions and provide limited possibilities to deal with missing data.

First, we constructed a latent variable for the indices of wellbeing. The average scores for each indicator—perceived stress (reverse coded), positive affect, negative affect (reverse coded), life-satisfaction, and self-esteem—served as parcels to reduce the number of measured variables and improve model fit (Little et al., 2002). Each measure loaded strongly on to the latent wellbeing factor in T0 and T1. As gratitude, self-compassion, and awe were not predicted by a single latent factor, separate latent variables for each emotion were created. Items of the measures loaded strongly on the latent factors corresponding to each emotion at T0 and T1.

Next, we adopted the procedure of invariance testing suggested by Beaujean (2014). Longitudinal invariance first requires adequate levels of fit for each model at each time point. In a second step, a combined model is tested in which increasingly stricter restrictions (configural, weak, and strong factorial invariance) were imposed. We used the criteria of $\Delta CFI < .01$ (Cheung & Rensvold, 2002) to judge whether those models were invariant. First, analyses of configural invariance checked the overall measurement model at different times.

Next, for weak invariance, the equivalence of the factor loadings of each indicator of the latent construct was tested. Finally, for strong invariance, the equivalence of factor loadings and intercepts for each indicator of the latent construct was examined (Hirschfeld & von Brachel, 2014). All tests were conducted using robust maximum likelihood estimation and robust Huber–White standard errors. Results supported the assumption of strong factorial (scalar) invariance.

In order to evaluate model fit, we used the common cutoffs suggested by Hu and Bentler (1998): confirmatory fit index (CFI) around .95, root mean error square of approximation (RMSEA) < .08, and standardized root mean square residual (SRMR) < .08. In case of model misfit, we followed the guidelines by Heene et al. (2011) and Greiff and Heene (2017) and identified potential sources of misfit. All latent factors showed good fit and strong (scalar) invariance. Details of those analyses are in the supporting information.

To test H1 and H2, we first specified a model (Model 1) in which latent variables for wellbeing and self-transcendent emotions at T1 were regressed on the same variables at T0. The regression weight is fixed to one and the residual to zero. In addition, a further latent variable, the change score variable, is specified in a way that allows capturing all differences between T0 and T1. This variable contains the error free change. In a second model (Model 2), we regressed the change score onto the training group variable (0, waiting-list; 1, training). We report the variance for the latent change score for Model 1 (capturing change from T0 to T1) to underscore the existence of interindividual differences in change. We report R^2 from Model 2 (including the training as the predictor of change) to show how much these differences are explained by differences between the training and the waiting-list groups. For Model 2, we also report β coefficients and p values to indicate the significance and direction of change due to training. The positive sign of the regression weight indicates increases in wellbeing and self-transcendent emotions.

Measurements

Unless otherwise indicated, participants provided responses using a 1 (*definitely disagree*) to 7 (*definitely agree*) rating scale. The items were coded so that higher scores reflect higher levels of each variable. For negative affect and stress, the responses were reversed and averaged so that higher scores indicate less negative affect and less stress. For all measures without Polish translations, the items were translated and independently back-translated by two bilingual scholars.

Dispositional mindfulness

This variable was assessed to validate the training: to test whether it worked as expected to increase mindfulness (Quaglia et al., 2016; van Dam et al., 2018). We used the Five Facet Mindfulness Questionnaire (FFMQ; Bohlmeijer et al., 2011, used in previous studies in Poland, Radoń & Rydzewska, 2018) assessing five aspects of dispositional mindfulness divided into attention aspects: observing (e.g. 'I pay attention to physical experiences, such as the wind in my hair or sun on my face') and describing (e.g. 'I'm good at finding words to describe my feelings') as well as attitudinal aspects: acting with awareness (e.g. 'I find it difficult to stay focused on what's happening in the present moment'); non-judging (e.g. 'I tell myself I

shouldn't be feeling the way I'm feeling'); non-reacting (e.g. 'I watch my feelings without getting carried away by them'). All items were averaged so that higher scores express higher levels of dispositional mindfulness. Four facets of the five facet measure mindfulness were used as indicators of a latent dispositional mindfulness factor. The observing facet was dropped because it loaded poorly (details in the supporting information). It is not uncommon for mindfulness-based intervention to affect different aspects of dispositional mindfulness and, at the same time, have a positive impact on mental health and wellbeing (Prieto-Fidalgo et al., 2022; Quaglia et al., 2016).

Indices of positive wellbeing

Satisfaction with life was measured by a five-item Satisfaction with Life Scale (Diener et al., 1985, used in previous studies in Poland, Jankowski, 2015, e.g. 'In most ways my life is close to my ideal'). *Self-esteem* was measured using a 10-item Self-Esteem Scale (Rosenberg et al., 1995 in Polish adaptation by Laguna et al., 2007, e.g. 'I feel that I am a person of worth, at least on an equal plane with others'). *Positive* and *negative affect* were measured using Positive Affect Negative Affect Scale (Watson et al., 1988). Participants responded to the instruction: "To what extent in the past two weeks did you feel...", assessing each affect using a 1 (*Not at all or barely at all*) to 5 (*Very strongly*) scale.[1] *Stress* was measured using Perceived Stress Scale (Cohen et al., 1983, e.g. 'In the last month, how often have you been upset because of something that happened unexpectedly').

Self-transcendent emotions

Gratitude was measured by three items of the GQ-6 scale (McCullough et al., 2002): 'I am grateful to a wide variety of people'; 'I have so much in life to be thankful for'; and 'If I had to list everything that I felt grateful for, it would be a very long list'. *Self-compassion* was measured by the Self-Compassion Scale (Raes et al., 2011, e.g. 'I try to be understanding and patient towards those aspects of my personality I don't like'). *Awe* was measured using the awe subscale of the dispositional positive emotion scales (Shiota et al., 2006, used in the Polish version also in, e.g. Razavi et al., 2016, e.g. 'I see beauty all around me').

RESULTS

Detailed information about reliability estimates, correlations, and mean differences between conditions is in the supporting information. Participants in the control and training group did not differ in terms of age, gender, or previous experiences with mindfulness interventions ($ps >= .67$) or with respect to any of the assessed variables ($ps >= .52$, supporting information). All measured variables were positively intercorrelated at pretest and posttest.

[1]This was rescaled to 1 to 7 for construction of the latent factor.

The effect of mindfulness training on dispositional mindfulness

First, to assess the effectiveness of the training, we specified a latent change score model capturing the change in dispositional mindfulness from T0 to T1 (Model 1). The model had acceptable fit, $\chi 2\ (21) = 40.585$, $p = .006$, $CFI = .971$, $RMSEA = .070$, $SRMR = .051$. Variance for the change score was significant ($p < .001$), indicating a valid latent change score. The amount of variance in change explained by the baseline was 5.3%. This indicates that, overall, the change in dispositional mindfulness over time was only slightly affected by its baseline level. However, adding the training group as a predictor of the latent change score for dispositional mindfulness (Model 2) improved the model fit, $\chi 2\ (28) = 48.151$, $p = .010$, $CFI = .973$, $RMSEA = .060$, $SRMR = .050$. The regression weight for the group was significant, indicating that there was more change in the experimental versus the control group ($p < .001$). The sign of the regression weight indicates that dispositional mindfulness increased in the experimental group over time more than in the control group ($\beta = .567$). The amount of variance explained in the latent change score for dispositional mindfulness increased to 36.7% reflecting the impact of training on dispositional mindfulness ($\Delta R^2 = 31.4\%$).

The effect of mindfulness training on wellbeing

In order to test H1, we specified a latent change score model capturing the change in positive wellbeing from T0 to T1 (Model 1). The model demonstrated good fit: $\chi 2\ (21) = 25.145$, $p = .241$, $CFI = .996$, $RMSEA = .031$, $SRMR = .044$. Variance for the change score was significant ($p < .001$). The baseline explained 17.3% of the variance in change. The association was negative ($\beta = -.417$), suggesting that participants with higher initial wellbeing demonstrated smaller change in wellbeing at post-intervention measurement. In the next step, we added the training group as a predictor of this change (Model 2). The fit of the model improved, $\chi 2(28) = 31.118$, $p = .312$, $CFI = .997$, $RMSEA = .023$, $SRMR = .046$. The regression weight for the group was significant ($p < .001$) and indicated that the experimental group changed more on average from T0 to T1. The sign of the regression weight indicates that wellbeing increased as a function of the training ($\beta = .378$). The amount of variance explained increased to over 30.5% reflecting the positive impact of training on wellbeing over and above the baseline of wellbeing ($\Delta R^2 = 13.5\%$).

The effect of mindfulness training on self-transcendent emotions

The latent change score model capturing the change between *self-compassion* from T0 to T1 (Model 1) demonstrated sufficient fit: $\chi 2(37) = 74.701$, $p < .001$, $CFI = .973$, $RMSEA = .070$, $SRMR = .049$. Variance for the change score was significant ($p < .001$). The baseline explained 28.1% variance in change. Again, participants with high levels of self-compassion at the baseline showed smaller change in compassion in post-intervention assessment ($\beta = -.467$). The fit of Model 2 that tested H2 improved, $\chi 2(46) = 83.868$, $p = .001$, $CFI = .973$, $RMSEA = .063$, $SRMR = .048$. The regression weight for the group was significant ($p < .001$), and the sign indicated that self-compassion increased as a function of the training ($\beta = .367$). The amount of variance explained increased to 34.3%, reflecting the impact of training on the increase in self-compassion ($\Delta R^2 = 6.2\%$).

The latent change score model capturing the change between *gratitude* from T0 to T1 (Model 1) demonstrated good fit, $\chi 2\ (9) = 10.139$, $p = .339$, CFI = .997, RMSEA = .032, SRMR = .082. Variance for the change score was significant ($p < .001$). The baseline explained 26.9% of the variance in change ($\beta = -.518$), again indicating that participants with higher levels of gratitude at the baseline showed less increase in gratitude after the training. The fit of Model 2 that tested H2 improved, $\chi 2\ (14) = 13.121$, $p = .517$, CFI = 1.000, RMSEA = .000, SRMR = .076. The regression weight for the group was significant ($p = .002$). The sign indicates that gratitude increased as a function of the training ($\beta = .215$). The amount of variance explained by in gratitude Model 2 increased to 32.7% ($\Delta R^2 = 5.8\%$).

The latent change score model capturing the change between *awe* from T0 to T1 (Model 1) demonstrated sufficiently good fit, $\chi 2\ (21) = 30.067$, $p = .091$, CFI = .988, RMSEA = .046, SRMR = .045. Variance for the change score was significant ($p < .001$). The baseline explained 7.2% of the variance in change ($\beta = -.268$), indicating a similar pattern as the other self-transcendent emotions assessed in our study. The fit of the Model 2 that tested H2 improved, $\chi 2\ (28) = 33.872$, $p = .205$, CFI = .993, RMSEA = .032, SRMR = .047. The regression weight for the training group was significant ($p = .002$). The sign indicates that wellbeing increased as a function of the training ($\beta = .242$). The amount of variance explained by the model increased to 14% ($\Delta R^2 = 6.8\%$).

The association between changes in self-transcendent emotions and wellbeing

The mindfulness-to-meaning theory (Garland et al., 2015; Garland & Fredrickson, 2019) suggests the positive reciprocal loop between positive wellbeing and self-transcendent emotions. We explored the covariance of the changes in wellbeing and self-transcendent emotions in the waiting-list and the training groups. If their association is stronger in the training group than in the control group, this may suggest that the training impacted wellbeing by increasing this association. Given the experimental design and the randomized allocation of participants, differences between the groups are likely to be caused by the mindfulness intervention. However, if the covariance of the changes is not equivalent in both groups, this would suggest that the mean shifts in wellbeing and self-transcendent emotions, although both being due to the training, are likely driven by different processes.

We specified the covariance of the latent change score for wellbeing and each self-transcendent emotion allowing the covariances to vary between groups. Next, we compared the covariance between groups for equivalence using a Wald test. Results in Table 1 indicate that the changes in each self-transcendent emotion were positively associated with the change in wellbeing and those associations were equivalent in the training group and the waiting-list group.

DISCUSSION

The present study tested whether mobile-app mindfulness training increases wellbeing and self-transcendent emotions in a non-clinical adult population in Poland during the COVID19 pandemic. The results of the randomized-trial study obtained through path analyses and latent change score modeling indicate that (1) the training worked as intended to increase

TABLE 1 Latent change covariance of wellbeing and each self-transcendent emotion in the control and the training group and their equivalence tests.

Groups	Cov (SE)	*p*	*r*	Equivalence tests	
		Self-compassion		$\chi 2$ (1)	*p*
Control	0.12 (.04)	.002	.64		
Training	0.19 (.05)	<.001	.66	1.360	.244
		Gratitude		$\chi 2$ (1)	*p*
Control	0.067 (.03)	.020	.35		
Training	0.12 (.05)	.027	.47	0.697	.404
		Awe		$\chi 2$ (1)	*p*
Control	0.12 (.05)	.012	.53		
Training	0.15 (.04)	<.001	.78	0.336	.562

dispositional mindfulness and (2), on average, positive wellbeing and self-transcendent emotions (gratitude, self-compassion, and awe) increased in the training group more than in the control group. In both groups, the variances of the change scores were significant. This means that there were interindividual differences in the ways wellbeing and all self-transcendent emotions changed over time. They increased among some people and decreased among others due to external life events. Nevertheless, those fluctuations were independent of the increases caused by the training.

In addition, we examined the possibility that mindfulness training increases wellbeing because it increases self-transcendent emotions as suggested by the mindfulness-to-meaning model (Garland et al., 2015; Garland & Fredrickson, 2019) and previous studies (Verhaeghen, 2019). The changes in self-transcendent emotions and wellbeing were indeed positively associated. However, the strength of their association did not differ between the control and the training groups. All associations were stronger in the training than the control group. However, the difference was not large enough to reach the conventional level of statistical significance. Thus, the associations between the increases in self-transcendent emotions and wellbeing due to the mindfulness practice may be independent rather than sequentially ordered. Future experimental studies should utilize larger samples to revisit the causal link between self-transcendent emotions and wellbeing.

The present results are in line with previous findings indicating beneficial consequences of mindfulness practice (also online and mobile app-supported; Huberty et al., 2019) in nonclinical populations (Ivtzan et al., 2016; Visted et al., 2015). They indicate that mobile app-based, easily accessible and cost-effective mindfulness training supports wellbeing and increases self-transcendent emotions in times of adversity such as the pandemic. Those results partially align with the mindfulness-to-meaning theory (Garland & Fredrickson, 2019; Ivtzan et al., 2016; Verhaeghen, 2019). The increases in all self-transcendent emotions due to the training support the proposition that the mindfulness practice enhances not only wellbeing but also the allocentric framework of reference. The present results suggest that the fading of the boundaries between the self and non-self during mindfulness practice (Hanley & Garland, 2019; Hanley et al., 2020) may result in the sense of connection between the self, non-self, and others indicated by the increase in self-transcendent emotions.

Extending previous research (Ivtzan et al., 2016), and in line with previous findings (Verhaeghen, 2019), the present results suggest that self-transcendent emotions are separate variables and they are different than other aspect of positive wellbeing. While the five indices of positive wellbeing loaded on the same temporally invariant latent factor, the self-transcendent emotions did not, and each represented a separate temporally invariant latent variable. This suggests that the assessed self-transcendent emotions are distinct, though positively related (Reed & Haugan, 2021; Stellar et al., 2017). Moreover, each of them positively covaries with wellbeing. Further studies are required to test whether experiencing self-transcendent emotions may be a mechanism driving eudaimonic wellbeing.

Although it was not the focus of our investigation, the supplemental results shed some light on the aspects of mindfulness sensitive to mindfulness trainings that may drive the effects on wellbeing (Quaglia et al., 2016). The present training increased the describing, acting with awareness, non-reacting, and non-judging aspects of dispositional mindfulness (we were not able to reliably assess the observation aspect). Changes in all four aspects of mindfulness correlated positively with the changes in wellbeing and each self-transcendent emotion. This suggests that developing observing aspect of attention management may not be as crucial as other aspects for mindfulness to improve on self-transcendent emotions and positive wellbeing. This finding is in line with results of recent meta-analytical summaries (Prieto-Fidalgo et al., 2022) and findings suggesting that attitudinal aspect of mindfulness is more important in eliciting positive change in wellbeing than the attention aspect (Lindsay et al., 2018; Verhaeghen, 2019). Moreover, those findings are in line with analyses indicating that unlike other aspects of dispositional mindfulness, the observing aspect may be not associated with positive outcomes of mindfulness interventions (e.g. Carpenter et al., 2019; or even predict negative outcomes, Royuela-Colomer & Calvete, 2016).

Limitations

The present study is not without limitations. First, the study used a passive control group. While this is less rigorous than an active control group, the present results are in line with multiple findings specific to the effects of mindfulness-based interventions on wellbeing and self-transcendence; therefore, it is unlikely that the results were produced by a placebo effect or participants engaging in any activity (vs. not engaging in any activity, especially during the pandemic) as opposed to being specifically attributable to the mindfulness training. Moreover, meta-analytical summaries show that mindfulness-based intervention studies with passive and active control groups similarly point to beneficial effects of such interventions, although the effect sizes are larger in studies with passive control groups, which should be taken into account when interpreting the present results (Goldberg et al., 2022). Future studies would do well replicating the present results using an active control group.

Second, the present study used a convenience sample that was imbalanced in terms of gender and was predominantly female. We included gender as a covariate in supplemental analyses and showed that it did not affect the results (see the supporting information). Moreover, meta-analytical summary has shown that the effects of mindfulness-based interventions are typically smaller among women than among men (Goldberg et al., 2022). This would suggest that our study provides a conservative test of our hypotheses.

Another limitation is that the present study offers insights only to the immediate changes after the training. Future studies would do well assessing the impact of this intervention after

longer periods to evaluate how long the effects last. Additionally, we relied on self-report measures. It is unlikely that this accounts for the results; nevertheless, future studies would do well using more objective measures of wellbeing such as physiological and behavioral assessments of mental health and self-transcendence. Finally, the study was designed to address the Polish non-clinical population during the COVID19 pandemic. The fact that the population and time period were specific may limit generalizability of our findings. While future studies would do well assessing their generalizability, it is worth noting that the present findings are in line with many previous findings in the mindfulness literature conducted on other populations and outside of the period of the pandemic. This increases our trust in the reliability of our findings.

Practical application

The present results have an applied value. They indicate that the beneficial effects of mindfulness training on eudaimonic wellbeing (e.g. Garland et al., 2017; Ivtzan et al., 2016) generalize to the Polish non-clinical population and the training supported by a phone app rather than in person. Previous studies showed that in-person mindfulness-based interventions reduced the mental health problems in the Polish population (Holas et al., 2020; Szumska et al., 2021). However, to the best of our knowledge, there have been no benefits-focused studies to demonstrate that mindfulness-based interventions increase positive wellbeing and self-transcendent emotions in this population.

The app-supported training had a very small attrition rate (8%) and was positively evaluated in the pilot focus group study. The use of the mobile application to support the mindful-gratitude practice addresses the need for a flexible and cost-effective delivery of the wellbeing supporting interventions. It can benefit a large number of people accessing also vulnerable and underserved populations. The mindfulness training has proven feasible, engaging, and effective and could be use independently to support eudaimonic wellbeing and as a support for other mental health improving interventions.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Data and analyses codes and study materials are available in open access (at https://osf.io/8p7au/?view_only=9223f6a5b32a4ac68bfed6907747b653).

ETHICS STATEMENT

The study was approved by the SWPS University's ethics committee (decision 02/P/04/2020).

ORCID

Agnieszka Golec de Zavala https://orcid.org/0000-0002-7631-9486
Oliver Keenan https://orcid.org/0000-0002-1783-6651
Matthias Ziegler https://orcid.org/0000-0003-4994-9519
Pawel Ciesielski https://orcid.org/0000-0002-2022-2706
Julia E. Wahl https://orcid.org/0000-0002-6388-3395
Magdalena Mazurkiewicz https://orcid.org/0000-0001-8149-7087

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