nature portfolio

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Reporting Summary

Nature Portfolio wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Portfolio policies, see our Editorial Policies and the Editorial Policy Checklist.

Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a	Confirmed
☐	☒ The exact sample size (*n*) for each experimental group/condition, given as a discrete number and unit of measurement
☐	☒ A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
☐	☒ The statistical test(s) used AND whether they are one- or two-sided *Only common tests should be described solely by name; describe more complex techniques in the Methods section.*
☐	☒ A description of all covariates tested
☐	☒ A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
☐	☒ A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
☐	☒ For null hypothesis testing, the test statistic (e.g. *F*, *t*, *r*) with confidence intervals, effect sizes, degrees of freedom and *P* value noted *Give P values as exact values whenever suitable.*
☒	☐ For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
☐	☒ For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
☐	☒ Estimates of effect sizes (e.g. Cohen's *d*, Pearson's *r*), indicating how they were calculated

Our web collection on statistics for biologists contains articles on many of the points above.

Software and code

Policy information about availability of computer code

Data collection	The Resilience Training App (Version 2.1)
Data analysis	R (Version 4.3.1), mmrm (Version 0.3.11), emmeans (Version 1.9.0) R code files used in the statistical analyses are available on GitHub at https://github.com/nomahi/RESiLIENT.

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Portfolio guidelines for submitting code & software for further information.

Data

Policy information about availability of data

All manuscripts must include a data availability statement. This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our policy

Data availability
De-identified individual participant data and data dictionary will be made available 24 months after publication on UMIN-ICDR, an individual case data repository managed by the Japanese University hospital Medical Information Network (UMIN) Center (https://www.umin.ac.jp/icdr/index.html). Proposals with specific aims

and an analysis plan should be directed to the corresponding author, Toshi Furukawa (furukawa@kuhp.kyoto-u.ac.jp). The decision will be made within a month.

Research involving human participants, their data, or biological material

Policy information about studies with human participants or human data. See also policy information about sex, gender (identity/presentation), and sexual orientation and race, ethnicity and racism.

Reporting on sex and gender	Gender was self-reported. There were 51% males, 29% females, and 0.5% others in the study cohort. Gender was entered as a covariate in the main analyses.
Reporting on race, ethnicity, or other socially relevant groupings	We did not ask participants questions regarding race, ethnicity or other socially relevant groupings.
Population characteristics	Table 1 presents the baseline characteristics of the participants.
Recruitment	Participants were recruited in the following four fields. The potential participants accessed the internet web page for the trial to apply for the study, received the explanations about the study from the trial coordinators online remotely, and provided their informed consent by electronic signature. 1. Health insurance societies: There are several types of public health insurance schemes together constituting the universal healthcare in Japan. We collaborated with two large associations, namely, National Federation of Health Insurance Societies covering employees and their families in large corporations (ca 30 million insured), and Japan Health Insurance Association covering employees and their families of small-to-middle-sized corporations (ca 35 million insured). 2. Business companies and corporations 3. Community and local governments 4. Direct-to-consumer advertisements We asked interested, potential participants to log onto the web specifically prepared for the trial and fill in the screening questionnaire. Once we ascertained the minimum eligibility criteria (age, possession of smartphone, not receiving treatment from mental health professionals), we invited them to the online informed consent session on Zoom in which we explained all the details of the study and its procedures. Once individuals have agreed and signed their digital consent forms, we provided the ID and password for the smartphone app to be downloaded either from App Store or from Google Play. Thus the participants were self-selected. This does not affect the internal validity of the study findings because all the comparisons were randomised. However, this may affect the external validity of the study findings. Thus in the limitations section of the main text, we discussed "Lastly, it is unclear whether our findings about the five skills are limited to our smartphone app only for adults with subthreshold depression and may not be generalisable to similarly administered CBT skills by other apps or by human therapists, extrapolate to the school setting, to elderly people or to people with comorbidities, apply to populations other than Japanese, or extrapolate to major depressive disorder. These are all empirical questions that require further research."
Ethics oversight	The study was approved by Kyoto University Ethics Committee (C1556) on 3 March 2022.

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☐ Life sciences ☒ Behavioural & social sciences ☐ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see nature.com/documents/nr-reporting-summary-flat.pdf

Behavioural & social sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	The RESiLIENT (Resilience Enhancement with Smartphone in Living ENvironemTs) trial is a master protocol trial involving four 2x2 factorial trials. This is a quantitative study.
Research sample	Participants were recruited in the following four fields across Japan. The potential participants accessed the internet web page for the trial to apply for the study, received the explanations about the study from the trial coordinators online remotely, and provided their informed consent by electronic signature. 1. Health insurance societies: There are several types of public health insurance schemes together constituting the universal healthcare in Japan. We collaborated with two large associations, namely, National Federation of Health Insurance Societies covering employees and their families in large corporations (ca 30 million insured), and Japan Health Insurance Association covering employees and their families of small-to-middle-sized corporations (ca 35 million insured). 2. Business companies and corporations 3. Community and local governments 4. Direct-to-consumer advertisements

	The participants were mainly in their 30s, 40s and 50s; 51% were men; most were married and employed. Their mean baseline PHQ-9 score was 8.1 (SD: 2.7); 17% had suspected problematic alcohol use, 29% had treatment history for mental health, and 33% had some physical comorbidities. (More details available in Table 1 of the main text.) They were intended to represent the general population in Japan as we used various access routes that we could think of to have access to as many people across Japan as possible. However, there is no guarantee that they are representative of the whole Japanese population.
Sampling strategy	The RESiLIENT trial was powered for each factorial trial for its primary outcome of the PHQ-9 at week 6 among those with the baseline PHQ-9 scores of 5 or more. The Fun the Learn, Act and Think through Technology trial (Mantani 2017) has shown a standardised mean difference of 0.3–0.4 for the earlier version of the Resilience Training App using the combination of BA+CR over the waiting list control among patients with drug-refractory depression. In order to detect a standardised mean difference of 0.2 at alpha=0.05 and beta=0.10, each factorial trial in the current master protocol would need in total 1053 participants (FactorialPowerPlan, http://methodology.psu.edu), hence 264 in each arm. Altogether the RESiLIENT trial will require 264×12=3168 participants with baseline PHQ-9 scores of 5 or more. The Healthy Campus Trial (HCT) had 5% dropout rates for its eighth week outcome. We may expect somewhat higher dropout rates in the RESiLIENT trial, which targets the general adult population in the community. Assuming a 10% dropout rate, the required sample size was set to be 3520.
Data collection	All the data were collected on the smartphone app developed for this study, The Resilience Training App (Version 2.1). The participants filled in the questionnaires on their own, with no researcher present either at the place or remotely. The research staff at the central office were not blind to the experimental condition or the study hypothesis.
Timing	Of 34123 adults assessed for eligibility, 5364 were judged eligible and provided informed consent, and were randomised to one of the 12 intervention or control arms between September 2022 and February 2024.
Data exclusions	Two later withdrew their consent, and 1426 had baseline PHQ-9 scores of 4 or less.
Non-participation	Across interventions, between 64% and 92% of the participants, or 78% on average, completed all the intervention programs within eight weeks, which was the time limit for the week 6 assessment. The proportions of the participants completing the assessments were 95.3% (3751/3936) at week 3 and 97.2% (3824/3936) at week 6 (Extended Data. Table 3.)
Randomization	After the participants completed all the questionnaires, the app automatically randomised the participants to one of the 12 intervention or control arms according to their employment status (yes vs no) using the pre-installed permuted block randomisation sequence, prepared by an independent statistician. The block size was known only to the statistician and allocation was concealed from any study personnel involved in participant recruitment.

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☒	☐ Palaeontology and archaeology
☒	☐ Animals and other organisms
☐	☒ Clinical data
☒	☐ Dual use research of concern
☒	☐ Plants

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging

Clinical data

Policy information about clinical studies

All manuscripts should comply with the ICMJE guidelines for publication of clinical research and a completed CONSORT checklist must be included with all submissions.

Clinical trial registration	UMIN Clinical Trials Registry (UMIN000047124) on 1 Aug, 2022
Study protocol	Furukawa TA, Tajika A, Sakata M, Luo Y, Toyomoto R, Horikoshi M, Akechi T, Kawakami N, Nakayama T, Kondo N, Fukuma S, Noma H, Christensen H, Kessler RC, Cuijpers P & Wason JMS (2023) Four 2x2 factorial trials of smartphone CBT to reduce subthreshold depression and to prevent new depressive episodes among adults in the community-RESiLIENT trial (Resilience Enhancement with Smartphone in LIving ENvironmenTs): a master protocol. BMJ Open, 13, e067850. 10.1136/bmjopen-2022-067850
Data collection	The recruitment of participants took place between 5 September 2022 and 21 February 2024. The date of the last-participant-out for the week 6 data was 19 April 2024, that for the week 26 data was 3 September 2024. The participants filled in the questionnaires

within the app (The Resilience Training App, Version 2.1) using their own smartphone, with no researcher present either at the place or remotely.

Outcomes

Primary outcome
The primary outcome is the change in the PHQ-9 from baseline to week 6.

Secondary outcome
The secondary outcomes include:
1. Changes in PHQ-9 from baseline to weeks 1, 2, 3, 4, and 5.
2. Changes in the GAD-7 51 from baseline to weeks 3 and 6.
3. Changes in the ISI 63 from baseline to weeks 3 and 6.
4. Changes in the SWEMWBS 62 from baseline to weeks 3 and 6.
Anxiety usually coexists with depression and we aimed to examine what effects the intervention components, while mainly targeting depression, may have on anxiety. We also aimed to monitor broad psychopathology of common mental disorders encompassing depression, anxiety and insomnia as well as positive mental health which are deteriorated in common mental disorders.

Post-hoc additional analyses
We added two post-hoc analyses up to week 26 to inform and facilitate the interpretations of the primary analysis results.

All the outcomes were collected via Resilience Training App.

Plants

Seed stocks

Report on the source of all seed stocks or other plant material used. If applicable, state the seed stock centre and catalogue number. If plant specimens were collected from the field, describe the collection location, date and sampling procedures.

Novel plant genotypes

Describe the methods by which all novel plant genotypes were produced. This includes those generated by transgenic approaches, gene editing, chemical/radiation-based mutagenesis and hybridization. For transgenic lines, describe the transformation method, the number of independent lines analyzed and the generation upon which experiments were performed. For gene-edited lines, describe the editor used, the endogenous sequence targeted for editing, the targeting guide RNA sequence (if applicable) and how the editor was applied.

Authentication

Describe any authentication procedures for each seed stock used or novel genotype generated. Describe any experiments used to assess the effect of a mutation and, where applicable, how potential secondary effects (e.g. second site T-DNA insertions, mosiacism, off-target gene editing) were examined.