Efficacy of the mHealth app syd on mental health and quality of life in UK healthcare workers: randomized controlled trial

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Declarations

Funding
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Conflicts of Interest
All authors have completed the ICMJE uniform disclosure form at http://www.icmje.org/disclosure-of-interest/ and declare: PH is a full-time employee and had financial support from iamYiam Limited for the submitted work; no other relationships or activities that could appear to have influenced the submitted work. The views expressed are those of the authors and not necessarily those of the NHS, NIHR, iamYiam or the Academic institutions.

Availability of data and material
Anonymised participant-level data are available on reasonable request from the corresponding author after approval by the trial steering committee and the ethics committee.

Code availability
Southern Health NHS Foundation Trust and iamYiam entered a collaboration agreement, where both parties have Data Controller responsibilities. Data will not be shared with anyone outside the Sponsor and iamYiam research teams, unless needed to independently verify results at the request of regulators.

Author contributions

AB, PH, LS developed the syd intervention; PH, AB, PP, LS and SR drafted the first manuscript; PH and AB conducted the analysis; and all authors revised and approved the final manuscript for publication.

Ethics approval

The study received Health Research Authority (HRA) and Health and Care Research Wales (HCRW) approval. REC Reference: 21/HRA/0308. IRAS number: 294071.

Consent to participate

Eligible participants were invited to complete an informed consent form prior to engaging in the study.

Consent for publication

Prior to signing the informed consent form, participants were made aware that their data will be shared between Southern Health NHS Foundation Trust and iamYam. Their data will also be analysed and used to produce findings which will be reported in a journal article.

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ABSTRACT

Objective: To evaluate the impact of the mHealth smartphone application See Yourself Differently (syd) on quality of life, anxiety, depression and stress in United Kingdom's (UK) National Health Service (NHS) staff suffering from anxiety or depression

Design: Randomised controlled trial with crossover of control participants at 3 months from inclusion in the study with follow-up at 6 months.

Setting: 82 National health service (NHS) trusts in the United Kingdom

Participants: 595 NHS staff with at least mild anxiety and/or depression.

Intervention: Participants in the Intervention Group were invited to install and interact with the syd mHealth app (Months 0-3). syd focuses on improving quality of life through research-backed personalized lifestyle recommendations in multiple domains with summarized as well as in-depth informative content.

Primary and secondary outcome measures: The primary outcome measures were Quality of life (QoL, WHOQOL-BREF) and Health-related quality of life (HRQoL, EQ-5D-5L) changes after 3 months of engagement with syd. Secondary outcome measures were anxiety (HADS-A), depression (HADS-D) and stress (PSS-4) scores to 3 months.

Results: 595 eligible participants were randomly assigned to the syd app intervention (n=298) or wait-list control group (n=297). Data from the control group would also form a before and after study.

Intention-to-treat (ITT) analysis at the primary endpoint showed that the syd app had a significant effect in improving QoL in the psychological domain (β=0.91 [0.06, 0.77], P=0.035), however, modelling with additional covariates didn't confirm these results, warranting further investigation. Additionally, anxiety (β=-0.30 [-0.50, -0.10], P=0.003), depression (β=-0.23 [-0.43, -0.03], P=0.027) and stress (β=-0.21 [-0.37, -0.05], P=0.010) were significantly reduced.

Pre-post comparison of the crossed-over control group to the intervention arm during the 3-6 months period showed improved QoL in the social relationships domain (β= 14.53 [4.78, 24.28], P=0.004) and reduced HRQoL in the self-care (β=-0.17 [-0.31, -0.03], P=0.02), usual activities (β= -0.56 [-0.94, -0.18], P=0.004) and visual analogue scale (β=-8.65 [-16.57, -0.73], P=0.032) domains, as well as reduced anxiety (β=-2.28 [-4.01, -0.54], P=0.01).

Usage level of syd was associated with increased QoL in the general QoL (β=0.05 [0.01 to 0.09], P=0.016), general health (β=0.06 [0.00 to 0.11], P=0.037) and physical health (β=1.33 [0.61 to 2.04], P<0.001) domains, as well as HRQoL in the usual activities (β=0.07 [0.03 to 0.10], P<0.001) and anxiety/depression (β=0.06 [0.01 to 0.10], P=0.012) domains.

Conclusions: This trial demonstrates that the syd app is effective in reducing anxiety, depression and stress, and gives suggestive evidence that it may improve quality of life in healthcare workers suffering from anxiety or depression. Additional mental health research growth is needed to confirm these findings and translate this work more widely.

Trial registration number: ISRCTN41061413

Keywords: Healthcare workers, NHS, Mental health, Quality of life, RCT, syd

INTRODUCTION

Mental health disorders are a leading contribution to the global burden of disease, affecting nearly 1 billion people worldwide and having increased almost 50% since 1990 [1]. Anxiety and depressive disorders are the two most prevalent conditions, accounting for 31% and 29% of cases and ranked 8th and 2nd as leading causes of years lived with disability (YLDs) [1]. These figures point to an increasingly pressing need for delivering effective prevention and treatment programs to individuals with or at risk of developing these debilitating conditions. Healthcare workers (HCW) are faced with a high prevalence of mental health issues such as stress and burnout [2, 3], anxiety [2, 4–6], depression [2, 4–6], post-traumatic stress disorder [2, 4] and sleep disturbances [5]. In the UK, National Health Service (NHS) staff have reported increasing levels of stress (46.8% in 2021 vs 44% in 2020), burnout (34.3% in 2021) and presenteeism (54.5% in 2021 vs 46% in 2020) [7], as well as high sickness absence rates (5.4% in 2021) of which stress, anxiety and depression are the leading cause (24.6%) [8]. The COVID-19 pandemic has further aggravated mental health conditions for HCWs. A recent study conducted in the first peak of the COVID-19 pandemic (April, 2020) found that HCWs in the UK had high levels of depression (28.1%), anxiety (33.1%) and stress (27.5%) [9], a burden especially prevalent among women, nurses and front-line HCWs in direct contact with COVID-19 patients [9, 10].

While mental health has seen an increase in attention, less focus has been put on other important factors for general health and wellbeing, or quality of life (QoL). The World Health Organization (WHO) defines QoL as *"an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns"* [11]. As such, QoL is a multi-dimensional construct that encompasses all dimensions of life, from physical and mental health, to financial, social and environmental wellbeing. While QoL-related measurements have been utilized to some extent for policy-making, particularly in healthcare (e.g., the UK's National Institute for Health and Care Excellence, NICE, uses quality-adjusted life years (QALYs) to assess the cost-effectiveness of new treatments [12]), QoL assessments are rarely measured in the context of health-related intervention studies, despite advocated as a key approach in measuring the overall health and wellbeing of individuals and populations [13]. Furthermore, most QoL instruments measure health-related quality of life (HRQoL), which primarily focuses on the physical and mental dimensions of QoL [14].

Mobile health interventions.

Despite the existence of effective evidence-based treatments for mental health conditions [15], limitations in the availability and delivery methods condition their general use and effectiveness [15–17]. Moreover, while curative interventions can help mitigate the burden of mental health conditions, such a strategy by itself is unlikely to support a sustainable solution to their increasing incidence rate. Instead, focusing on effective evidence-based preventive methods to tackle their development is key to reduce their burden [17–20]. Mobile health (mHealth) applications are seen as an effective tool in globalizing the access to mental health help while reducing the cost and delivery of treatment [21, 22]. Indeed, not only the availability of such apps has increased dramatically in the past years (>350000 in 2021), both individuals and employers are increasingly seeking to have them in their arsenal [23]. A growing number of clinical trials and meta-analysis of mHealth interventions in supporting

mental health and quality of life have been conducted in the past few years, indicating a maturation of the evidence of effectiveness behind their use [23–27]. Indeed, a recent systematic review of 145 RCTs found highly suggestive evidence of effectiveness in improving levels of anxiety, depression and stress [24], indicating an increased potential of these tools to support individuals' mental health, as well as their application in clinical practice [28].

Despite the increasing evidence for mHealth interventions in mental health, however, few studies have analysed their impact on other sub-domains of quality of life. Van Emmerik et al. tested a mindfulness-based app for 8 weeks in the general population and found evidence for improvement of QoL in the psychological (*d*=0.38) and social (*d*=0.38) domains [29]. Boettcher et al. tested a self-help app for 7 weeks in patients with social anxiety disorder and found small effects in QoL (*d*=0.33), but did not discriminate between sub-domains [30]. Bruhns et al. and Lüdtke et al. both tested self-help apps for 4 weeks, however, neither found evidence for an effect in QoL and also did not discriminate between sub-domains [31, 32]. Other studies have focused on HRQoL [33], life satisfaction [34, 35] or psychological wellbeing [36, 37], with generally positive results dependent of type of intervention and target population [38].

Few mHealth interventions have also targeted specific vulnerable groups of the general population, such as HCWs. One such study tested a resiliency-based app in HCWs with low levels of stress at a tertiary healthcare institution for 6 weeks and found improvements in psychological wellbeing [37]. The lack of rigorous mHealth trials in HCWs adds to the importance of conducting such interventions, as they might play a vital role in reducing the burden of mental health conditions and improve quality of life in HCR as well as improving healthcare systems overall [17, 20].

METHODS

Aims.

This randomized controlled trial aims to determine the effectiveness of a preventative mHealth application, *See Yourself Differently* (syd), in affecting quality of life, stress, anxiety and depression in HCWs of the UK's National health service (NHS) suffering from anxiety and/or depression. We hypothesised that syd would lead to improved QoL and decreased stress, anxiety, and to a lesser degree, depression, in HCWs, by providing evidence-based lifestyle recommendations targeted to improve QoL. The findings from this study add to the body of knowledge on the efficacy of mHealth applications in mental health and QoL, with specific impact for HCWs already suffering from significant mental health strain. This will help inform policy makers to explore QoL as an outcome and consider such interventions as part of their decision-making process.

Research design.

This study was a randomized controlled trial with a wait-list control. Assessments were conducted at baseline, month 1, month 2, month 3 and a follow-up at month 6. Participants allocated to the intervention group received access to the syd mHealth app without constraints. Participants allocated to the wait-list group received the intervention after 3 months.

Recruitment and selection.

Recruitment and baseline data collection started on June 1st, 2021. A registry of NHS staff who previously participated in a large observational study assessing the psychological impact of COVID-19 [6] and consented to be contacted for future research was used as the initial strategy to invite prospective participants to join the trial. On November 18th, 2021, participation in the trial was opened to any NHS staff that met the inclusion criteria through open advertisement by collaborating NHS Trusts across the UK. Recruitment ended on April 15th, 2022.

Interested participants were directed to the online site (via the Qualtrics platform), asked to read the participant information sheet outlining the study and, if interested in taking part in the study, provide consent to eligibility screening. Consenting participants were asked to complete the pre-screening survey including the Hospital Anxiety and Depression Scale (HADS) questionnaire.

Participants were deemed eligible for the study if they were: (1) at least 18 years old, (2) were active UK NHS staff members with a valid NHS email address, (3) owned a smart phone device, (4) had sufficient English language ability, (5) were not currently receiving a psychological intervention (e.g., counselling therapy), (6) were not receiving clinical treatment as part of another clinical trial, (7) were not considered clinically extremely vulnerable from COVID-19 by the UK government guidance at the time of recruitment, and (8) presented mild to moderate levels of anxiety and/or depression (score of >8 and <15 in either HADS anxiety or depression sub-scales).

Eligible participants were randomly assigned to the intervention or wait-list control group. Participants in both groups were sent automatic emails at each assessment time-point with the link to complete the outcomes questionnaire and 2 weekly reminder emails were sent to participants that failed to do so within 7 days.

Randomization and blinding.

Participants were randomised 1:1 automatically by the Qualtrics platform after completion of the pre-screening survey. Due to the nature of the intervention, the allocation was not masked to study participants and members of the NHS research team directly involved in participant recruitment.

Intervention.

Participants in the intervention group were sent an automatic email with their group allocation and detailing the procedures to download, install and sign-up to the *See Yourself Differently* (syd) app, including the participant-specific code that was required to enter in the sign-up form and which was used to link the participants' assessment data and syd app usage data. Sign-ups were monitored and participants that did not sign-up to the syd app were sent 2 weekly reminder emails with the procedures.

Syd is a mobile application available on both Android and iOS devices via the Google Play and Apple App stores, respectively. Screenshots of the syd app are shown in Figure 1. Syd focuses on improving quality of life through research-backed personalised lifestyle recommendations with summarised as well as in-depth informative content. It is designed to guide and support individuals to attain and maintain good lifestyle practices that are known to either prevent or delay afflictive conditions or that support improvement of current ailments. In syd, individuals can

track their progress across 9 dimensions of quality of life (Physical health, Emotional health, Brain power, Self-awareness, Purpose, Career, Financial health, Social life and Environment), which are referred to in syd as Life Quality indexes, or Lqis, by completing recommended activities, practicing audio-guided meditations, engaging in journaling and through self-assessment, all within the app. Furthermore, it provides personalised content and feedback in a goal-oriented process where individuals select a goal their trying to attain (from 15 possible goals) and are oriented towards attaining or maintaining that goal by being recommended activities that are deemed important for the selected goal.

After signing up, individuals are on-boarded by providing information related to their current lifestyle, height/weight and goal. After this process, users have access to several components in the app: **(1) Lifestyle recommendations;** Around 400 research-backed lifestyle recommendations are available through the syd app. These are categorised by type of activity: Eat, Feel, Move, Sleep, Work, Environment and Do, have detailed descriptions and are generally accompanied by longer articles with references which individuals can read and explore within the app. They can be scheduled in a calendar and a recommender system acts to prioritise and personalise recommendations and articles based on the individuals' characteristics, goals and health state with the objective to improve engagement in positive lifestyles. **(2) Meditations;** Several mindfulness audio-guided meditations are available from inside the syd app that progress from introducing mindfulness practice to cultivation of wisdom. These have short descriptions and have an average duration of 10 minutes. Meditations can also be scheduled and completion is automatically assessed. **(3) Journaling;** Individuals can write private journal entries either in free form or through predefined templates that address common journaling practices (e.g., gratitude). **(4) Goal setting;** 15 health and wellbeing goals (e.g., improving heart health, improve sleep, feel in shape) can be set, which prioritises content in the app to meet the set goal. **(5) Conversational agent;** Individuals can converse with a chatbot agent. The agent is trained to provide guidance and easy access to syd's content, as well as support for concerns across all domains of quality of life. **(6) Life Quality index (LQi) tracker;** Individuals can track their LQi progress across all 9 dimensions. To update their progress, they can provide information on dimension-related items through self-assessment or through passive input (e.g., biometrics). Each LQi dimension section provides detailed information about it, related variables that contribute to it and recommendations that can allow improvements on the respective dimension. **(7) Biometrics;** 8 biometric variables are passively or actively extracted including: Body mass index (BMI), step counts, distance walked/ran, calories burned, sleep duration, body fat percentage, blood pressure and heart rate. Daily, weekly and monthly progress can be tracked and detailed information and recommendations are offered in the app as to guide individuals to improve their values.

[Figure 1]

Participants assigned to the intervention group were asked to interact with the syd app at least once every day and undertake 3 to 4 recommendations each week, although this wasn't enforced, and participants that did not interact with the app frequently were still allowed to remain in the study. Activity data was collected directly by the app and stored in a secure database hosted in Amazon's AWS RDS service. Participants were allowed to keep access to the syd app without constrains after the end of the study.

Wait-list control.

Participants assigned to the wait-list control group were sent an automated email informing them to their group allocation and explaining that they would gain access to the syd app in 3 months' time. After 3 months participants received an email with instructions to download and access the syd app. Participants were allowed to keep access to the syd app without constrains after the end of the study.

Measures.

Quality of life.

Quality of life (QoL) was assessed through the WHOQOL-BREF instrument [11], a 26-item questionnaire that measures quality of life in 4 domains: physical health (7 items), psychological health (6 items), social relationships (3 items) and environment (8 items). Two other items measure general quality of life and general health. It has demonstrated good-excellent reliability and content validity measures across different cultures and populations [39]. Items are rated on a 5-point Likert scale and coded 1-5 where 1 is the worst and 5 the best outcome. Domain scores were constructed by averaging the score of all items in a domain, then multiplying by 4 and scaling such that each domain score ranges from 0-100. The time frame of this instrument was the previous 2 weeks.

Health-related quality of life.

Health-related quality of life (HRQoL) was assessed through the EQ-5D-5L instrument [40], a 5-item questionnaire with five dimensions: mobility, self-care, usual activities, pain/discomfort and anxiety/depression plus a visual analogue scale (VAS) that measures the individual's self-rated health [40]. It has demonstrated good reliability and content validity measures, however with some problems on item-level stability and ceiling effects [41]. Items are rated in a 5-point Likert scale and coded 1-5 where 1 is the worst and 5 the best outcome. The VAS is reported in a value 0-100 where 0 is the worst and 100 the best health. The time frame of this instrument was the day of the assessment.

Anxiety and Depression.

Anxiety and depression were assessed through the Hospital Anxiety and Depression Scale (HADS), a 14-item questionnaire with 2 sub-scales: anxiety (HADS-A, 7 items) and depression (HADS-D, 7 items) [42]. The scale has demonstrated good reliability and content validity across different populations and contexts [43]. Items are rated in a 4-point Likert scale and coded 0-3 where 0 is the best and 3 the worst outcome. Sub-scale scores were constructed by summing the scores of all items in each of the sub-scales giving a possible score range of 0-21. A cut-off score of 8 or more in either of the sub-scales has shown a good balance between sensitivity and specificity in determining presence of anxiety disorders and depression [43]. Mild, moderate or severe anxiety/depression is defined as HADS-A/D score of 8-10, 11-14 and 15-21, respectively [44]. The time frame of this instrument was the previous week.

Stress.

Stress was assessed through the Perceived Stress Scale 4 (PSS-4) instrument [45], a 4-item questionnaire rated in a 5-point Likert scale. It has demonstrated good reliability

and content validity measures [46]. Items were coded 0-4 where 0 is the best and 4 the worst outcome. Total scores were constructed by summing the scores of all items, giving a possible range of 0-16. The time frame of this instrument was the previous month.

Covariates.

Individual-level covariates were assessed at baseline. These include age group, gender, ethnicity, religion, years in the NHS, employment type, profession, work setting, COVID-19 job requirements, mobile phone usage, study cohort and previous mental health diagnosis. A full list of covariates can be seen in Table 2.

Assessment-level covariates were either calculated or cross-linked from several sources. These include season, Townsend deprivation quintile, Lower layer Super Output Area (LSOA) index of Multiple Deprivation (IMD), UK region, cohort, COVID-19 restriction index and COVID-19 hospitalization. The COVID-19 restriction index was extracted for each participant at the date they filled in each of the assessments from the Oxford COVID-19 Government Response Tracker (OxCGRT) dataset [47]. The average stringency index for the national UK region value was used. This value ranges from 0 to 100, where 0 indicates no restrictions and 100 full restrictions. COVID-19 hospitalizations were extracted for each participant at the date they filled in each of the assessments [48] using the *"total admissions"* value from the *"patients admitted to hospital"* dataset. Values were transformed to represent number per million individuals. Townsend deprivation quintile (TDI) and LSOA IMD index were extracted for each participant based on the postcode of the NHS Trust they were part of and cross-referencing the geolocation code with associated 2011 TDI score from [49] and LSOA index from [50]. Cohort was defined for each participant based on whether they were enrolled through the first registry-based (Initial) or the second open participation (Open) enrolment.

Statistical analysis.

The data was analysed using an intention-to-treat (ITT) principle. All descriptive statistics and modelling analysis were conducted in python using dedicated scripts. A p-value of < 0.05 was considered statistically significant. Comparisons of between-group differences (syd vs. wait-list) were analysed for all outcome measures using linear mixed effects (LMM) models fit with restricted maximum likelihood (REML) estimation with an interaction term of group x time, a random intercept for each participant and adjusted for gender, age and ethnicity (Model 1). To examine if professional settings were associated with outcome differences we further adjusted for profession, work setting, employment, years in the NHS, job requires shift work, job requires COVID-19 patient contact, job requires COVID-19 patient care, COVID-19 restriction index and COVID-19 hospitalizations (Model 2). All other covariates were added in a third model to account for other personal (e.g., comorbidities) or circumstantial (e.g., season) differences between the participants in each group (Model 3). Time was defined as month from baseline assessment. Model fit statistics are presented with AIC, conditional R^2 [51], RMSE and Intraclass Correlation Coefficient (ICC).

Participant-level activity with the syd app was measured with regards to number of weekly sessions, number of recommendations scheduled and number of meditations listened to. A session was defined as opening the app. A recommendation scheduled was defined as a recommendation that was added to the app calendar. A meditation listened was defined as a meditation track that was played in the app. Activity levels of each participant for all 3 app interactions were assessed for each month from the date of the baseline assessment. 4 categories (None, Low, Medium, High) were constructed for each type of interaction by log-transforming all activity levels for the 1st month of the study and calculating the 25th and 75th percentiles of the distribution of these values. Linear mixed effects models were used to test the association of activity category for each type of activity and outcome scores. Each model contained an interaction term of time x activity category at month 1, a random intercept for each participant and were adjusted for all covariates. Only participants of the syd group in the first 3 months (primary endpoint) were included in this analysis.

RESULTS

The study CONSORT flow diagram of the study is shown in Figure 2. Of the 1076 individuals who expressed interest in participating in the study, 964 (90%) provided informed consent to be included in the study. Of these, 595 (62%) passed the eligibility criteria and were included in the study. 298 (50%) were randomised to the syd intervention group and 297 (50%) to the wait-list control group. Attrition rates were high in the intervention group compared to the wait-list group (M1: 51% vs. 13%; M2: 61% vs. 19%; M3: 71% vs. 26%; M6: 78% vs. 59%). All participants were included in the primary and secondary endpoint analysis in accordance to intention-to-treat principle.

[Figure 2]

Participant's characteristics.

Detailed description of participants' demographics is shown in Table 1. The participants' age was relatively uniform across all age groups but with a higher representation of respondents aged 45 to 54 years old (32%). The majority identified as female (90%), of white British ethnicity (92%) and of no religion (56%) or Christian (40%). These figures are in general agreement with the national statistics of the NHS [7], although we note an over-representation of females (vs. 76% national) and under-representation of ethnic minority groups (e.g., Asian (<1%) and African or Black (1%) ethnicities) in this cohort. Most of the participants were from the South East (32%), Yorkshire and The Humber (20%), East Midlands (14%) and the South West (14%) of England. Regarding profession, the majority of participants were administrative staff (31%), nurses (29%) or other allied health professional (17%), worked in hospitals (37%), mental health clinics (24%) or community settings (24%) or and were employed full-time (71%).

[Table 1]

In terms of their mental health, at baseline, 45%, 40% and 9% of participants presented HADS scores that indicated mild, moderate or severe anxiety, and 34%, 17% and 1% indicating mild, moderate or severe depression (Supplementary figure 1). Also, 38% of participants reported having been previously diagnosed with a mental health condition, with special prevalence of depression (29%) and anxiety (29%). Comorbidity was also

prevalent, with 75% of individuals who reported being diagnosed with anxiety also reporting being diagnosed with depression (73% in the inverse relationship).

Changes in study outcomes.

[Table 2]

Quality of Life.

Quality of life, as measured through the WHOQOL-BREF instrument, increased in the first 3 months of the trial for both groups in the general QoL (β=0.032, p=0.018) and general health (β=0.046, p=0.006) domains (Figure 3).

There was an effect of time x group after adjusting for demographic in the psychological domain (β=0.91, p=0.035; Model 1), but not after adjusting for work settings and all other covariates (Table 2).

In the follow-up period, the wait-list group increased QoL in the general QoL (β =0.068, p=0.002), general health (β= 0.085, p=0.008), psychological (β= 1.265, p=0.018) and social relationships (β= 1.569, p=0.011) domains.

These results suggest that syd may increase QoL, with a more pronounced effect in the psychological domain. Other covariates like work setting might influence this effect, prompting further investigation.

[Figure 3]

Health-related Quality of Life.

Health-related quality of life (HRQoL), as measured through the EQ-5D-5L instrument, decreased in the first 3 months of the trial for both groups in the mobility (β=-0.046, p<0.001), self-care (β=-0.017, p=0.008), usual activities (β=-0.030, p=0.023) and pain/discomfort (β=-0.060, p<0.001) domains (Figure 4).

There was a negative effect of time x group in the usual activities domain after adjusting for demographics (β=-0.05, p=0.045; Model 1), work settings (β=-0.05, p=0.039; Model 2) and all other covariates (β=-0.05, p=0.033; Model 3).

In the follow-up period, the wait-list group increased HRQoL in the VAS domain after adjusting for demographic variables (β= 1.199, p=0.029; Model 1), however, the effect was negative when accounting for all covariates (β=-8.65, p=0.032; Model 3), warranting further investigation of these findings. There was also a negative effect in the self-care (β=-0.17, p=0.002; Model 3) and usual activities (β=-0.56, p=0.004; Model 3) domains after accounting for all covariates.
These results indicate that syd was not effective in improving HRQoL.

[Figure 4]

Anxiety.

Anxiety scores decreased in the first 3 months in both groups (β=-0.157, p=0.007).

There was a significant effect of time x group after adjusting for demographic (β=0.314, p=0.002; Model 1), work settings (β=-0.299, p=0.003; Model 2) and all other covariates (β=-0.297, p=0.003; Model 3).

In the follow-up period, anxiety scores decreased in the wait-list group after accounting for demographics (β=-0.295, p=0.021; Model 1) and all other covariates (β=-2.276, p=0.010; Model 3).

These results indicate that syd is effective in reducing levels of anxiety.

Depression.

Depression scores decreased in the syd group while remaining relatively unchanged in the wait-list group for the first 3 months (Figure 5), as observed in a significant time x group effect adjusting for demographic (β=-0.241, p=0.020; Model 1), work settings (β=-0.221, p=0.033; Model 2) and other covariates (β=-0.228, p=0.027; Model 3).

In the follow-up period, depression scores decreased in the wait-list group after accounting for demographics (β=-0.349, p=0.004; Model 1) and work setting (β=-0.724, p=0.044; Model 2) covariates, but not in the full covariate model (β=-0.545, p=0.546; Model 3).

These results indicate that syd is effective in reducing levels of depression.

Stress.

Stress scores decreased in the first 3 months in both groups (β=-0.117, p=0.017; Figure 5).

There was a significant effect of time x group after adjusting for demographic (β=-0.231, p=0.005; Model 1), work settings (β=-0.212, p=0.010; Model 2) and all other covariates (β=-0.211, p=0.010; Model 3).

In the follow-up period, stress scores decreased in the wait-list group after accounting for demographics (β=-0.252, p=0.004; Model 1), but not work settings (β=-0.402, p=0.135; Model 2) and all other covariates (β=-0.278, p=0.729; Model 3).

These results indicate that syd is effective in reducing levels of stress.

[Figure 4]

Determinants of mental health and quality of life.

Examination of the estimated linear mixed models' coefficients (Model 3) revealed several socio-demographic factors associated with the outcome measures of this study. Here we present results relevant for the current population and discussion points. Full results can be found in Figure 6 and Supplementary Table 3.

In relation to demographic variables, age was negatively associated with QoL in the general QoL (β=-0.012, p<0.001), general health (β=-0.012, p=0.002), physical health (β=-0.239, p<0.001) and social relationships (β= -0.240, p=0.003) domains, as well as HRQoL in the Mobility (β=-0.012, p<0.001) and Pain/discomfort (β=-0.015, p<0.001) domains, and positively associated with depression scores (β=0.036, p=0.009). Furthermore, males were negatively associated with QoL in the social relationships (β=-6.947, p=0.006) and environment (β=-4.415, p=0.026) domains, and positively associated with HRQoL in the usual activities domain (β=0.253, p=0.004), as well as depression (β=0.887, p=0.038).

Regarding work-related variables, working part-time was negatively associated with depression (β=-0.696, p=0.017), and being a nurse was positively associated with HRQoL in the self-care (β=0.096, p=0.035) and usual activities (β=0.164, p=0.035) domains. Working from home was positively associated with QoL in the general QoL (β=0.402, p=0.027), psychological (β=9.526, p=0.013) and environment (β=8.743, p=0.022) domains, while working at an office was positively associated with QoL in the social relationships domain (β=8.899, p=0.049), but negatively in the general health domain (β=-0.551, p=0.014). Shift work was negatively associated with QoL in the psychological (β=-3.603, p=0.047), social relationships (β=-4.549, p=0.046) and environment (β=-4.335, p=0.015) domains, as well as positively associated with depression (β=1.081, p=0.005) and stress (β=0.598, p=0.038).

Baseline anxiety/depression-mediated changes

To understand if syd differentially impacted individuals with different baseline anxiety and depression categories, we included the baseline anxiety and depression level (Low, Mild, Moderate or Severe) as an interaction term with time (month), adjusting for the full set of covariates (Table 3).

Surprisingly, anxiety scores showed a negative effect in individuals with moderate (β=-0.47, p=0.008) or severe (β=-0.47, p=0.032) anxiety at baseline, but not mild (β=-0.13, p=0.485), compared to low scored individuals.

Similarly, individuals with severe depression at baseline showed a greater effect in depression scores (β=-2.68, p<0.001) than those with moderate (β=-0.53, p<0.001) or mild (β=-0.41, p<0.001) depression, as well as decreased anxiety (β=-1.63, p<0.001), stress (β=-0.60, p=0.036), increased QoL in the psychological (β=3.85, p=0.011) and social relationships (β=7.09, p<0.001) domains, and HRQoL in the anxiety/depression domain (β=0.21, p=0.015).

These results indicate that individuals with moderate or severe levels of anxiety and depression may benefit more from syd than those with lower scores.

[Table 3]

Activity-mediated changes.

Because mobile interventions can be significantly impacted by adherence of individuals to the intervention, we next analysed if changes in the outcome measures were affected by different activity and adherence patterns within the syd app.

syd has several components with which individuals could interact with. However, we postulated that 3 main components might have impact in the outcomes measured in this study: (1) number of sessions; (2) number of completed meditations; and (3) recommendations scheduled. Because the wait-list group only received access to syd in the follow-up period (months 3-6), this analysis was done only for the syd group in the first 3 months of the trial.

For this analysis, we first calculated the average number of weekly sessions, meditations and recommendations for each participant by accessing syd's internal activity logs. As the distribution of all activity metrics was negatively skewed (Supplementary Figure 1), we log-transformed these values and identified 4 categories of activity by calculating the 25^{th} and 75^{th} percentile of the log-transformed values in the 1^{st} month of the intervention (None: no activity, Low: $<25^{th}$, Medium: $>=25^{th}$ and $<75^{th}$, High: $>=75^{th}$). These categories were then applied to activity values from months 2 and 3. Means and number of individuals in each activity category are shown in Supplementary Table 1. Linear mixed effects models with full set of covariates were used to determine the association in activity category and outcome measures for each of syd's components (Table 4).

Weekly sessions were positively associated with QoL in the general QoL (β=0.05, p=0.016), general health (β=0.06, p=0.037) and physical health (β=1.33, p<0.001) domains, as well as HRQoL in the usual activities domain (β=0.07, p<0.001). Completed meditations was positively associated with QoL in the general health (β=0.07, p=0.018) and physical health (β=1.05, β=0.013) domains, as well as HRQoL in the anxiety/depression domain (β=0.07, p=0.005). Scheduling recommendations was negatively associated with depression (β=-0.15, p=0.049).

These results strongly indicate that actively engaging with syd positively influences quality of life across several domains.

[Table 4]

DISCUSSION

Principal findings.

This randomized controlled trial tested the efficacy of the mobile health (mHealth) app *See Yourself Differently* (syd) in improving quality of life (QoL) and reducing scores of anxiety, depression and stress in a population of healthcare workers (HCWs) in the UK's National Health Service (NHS) that suffered from mild to moderate levels of anxiety and/or depression. The trial lasted for 6 months and the primary endpoint was

at 3 months. In the follow-up period (3 to 6 months), participants in the wait-list group were also given access to the syd app, which enabled to infer if syd had similar effects relative to the syd group at the primary endpoint.

Our findings suggest that syd may improve QoL, especially in the psychological domain, and finds strong evidence that it is effective in reducing levels of anxiety, depression and stress in 3 months. These effects also seem to be specially pronounced in individuals suffering from moderate or severe anxiety or depression. Additionally, we find evidence that activity level and activity type within the syd app may work to improve several domains of QoL and HRQoL, warranting a more in-depth study of these effects.

This is one of the first studies to examine the effects of a mHealth intervention in HCWs on mental health and quality of life outcomes, significantly adding to the body of work of evidence for effective interventions to support HCWs' wellbeing.

Quality of life and Health-related quality of life.

In this study, we didn't find convincing evidence that syd has an effect on QoL as measured by the WHOQOL-BREF instrument. However, we found suggestive evidence for an effect on the psychological domain when only accounting for demographic covariates. This is in line with our findings that syd has an effect in reducing levels of anxiety and stress, as these outcomes are highly correlated (Supplementary Figure 4). Moreover, we find that positive effects on other dimensions of QoL might be dependent on activity levels within the syd app (Table 4), with higher number of weekly sessions improving general QoL, general health and physical health QoL scores, and meditations also seemingly having a positive effect on general health and physical health QoL (Table 4). Despite this, we approach these findings with caution and warrant a more in-depth analysis accounting for other covariates as well as a larger sample size a more diverse population.

Surprisingly, we found that HRQoL scores consistently decreased in both groups in the mobility, self-care and pain/discomfort domains, as well a significant effect that syd negatively impacts the usual activities domain when compared to the wait-list group (Table 2). This contrasts with changes in QoL domains, which generally increased in this study. This is not entirely surprising, as HRQoL as measured through the EQ-5D-5L is likely to be better suited to measure physical health aspects in individuals living with higher physical impairments than the population included in our study [41]. Indeed, the vast majority of participants reported having *No problems* in the mobility, self-care and usual activities domains (Supplementary Figure 2).

Hierarchical clustering of the correlation between all outcomes measured further reveals that HRQoL measures only the physical aspect of QoL (Supplementary figure 2). Indeed, HRQoL domains apart from anxiety/depression and VAS form a separate cluster and are highly correlated amongst themselves and physical health QoL. The same analysis of HRQoL domains with facet-level scores in the WHOQOL-BREF instrument also reveals that these are, not surprisingly, clustered and highly correlated with the *Dependence on medication or health care*, *Pain and discomfort* and *Mobility* facets (Supplementary Figure 5), while only weekly correlated with most other facets.

While we cannot at this point rule out that the syd app has a detrimental effect on how HCWs engage in their usual activities, it seems unlikely that an mHealth intervention like syd would do so. Rather, we postulate that an imbalance of the conditions affecting both groups could have occurred during the period of the intervention.

It's possible that with the observed increase in COVID-19 hospitalisations in the first 3 months of the trial, increased work-related physical strain may have impacted these 3 aspects of physical health in HCWs across both groups. Indeed, full-time equivalent (FTE) days lost due to back-related or other musculoskeletal problems across all NHS staff increased from an average of 93771 at baseline to 101953 at month 3 of this trial [8], suggesting that NHS staff were under increased physical strain during this period.

Nevertheless, this is one of the first studies to address the impacts of a mHealth intervention in QoL in HCWs. Mistretta et al. tested the effects of a resiliency-based app in HCWs with low levels of stress at a tertiary healthcare institution for 6 weeks [37] and found significant improvements in wellbeing, but not in stress and emotional burnout. There are several differences with this study such as the type of intervention, the instruments used (WHO-5 for mental wellbeing [55] and DASS-21 for stress, anxiety and depression [56]), the use of an active control group and a relatively small number of participants, thus direct comparisons with this study are not possible.

A recent meta-analysis comparing several types of mHealth interventions on mental wellbeing found that mindfulness-based and multi-component positive psychological interventions (PPI) demonstrated the greatest efficacy in clinical and non-clinical populations, while singular PPI, cognitive and behavioural therapy (CBT), acceptance and commitment therapy (ACT), and reminiscence interventions were also impactful [38]. syd could be categorized as a multi-theoretical intervention, as it combines several components and recommendations that could be categorized within ACT, PPI, mindfulness, expressive writing, gratitude, among other. The study found support for an effect in improved mental wellbeing in both general and physically ill populations, despite small effect sizes (Hedges' G = 0.2). While none of the studies reported used similar instruments to the current study, it nonetheless provides support that such mHealth interventions can positively impact the mental wellbeing of individuals.

Anxiety, depression and stress.

We found good evidence to suggest that anxiety, depression and stress levels are reduced after intervention with the syd app. While reduction in scores were observed across both groups in the first 3 months of the trial, they were more pronounced in the syd arm (Figure 5) and our analysis across different models strongly indicates an effect of the intervention.

Additionally, a larger proportion of participants in the syd group improved to below cut-off anxiety and depression levels (HADS-A/D < 8) in the first 3 months compared to the wait-list control group (anxiety: 77% vs. 71% change; depression: 19% vs. 6%, Supplementary Table 2 and Supplementary Figure 1), and participants who scored high levels of anxiety or depression (Moderate and Severe) at baseline displayed higher effects in anxiety and depression scores at 3 months compared to lower-scored participants (Table 4), suggesting that syd is clinically meaningful in reducing anxiety and depression.

We did not find that anxiety or depression score changes in the syd group were dependent on the syd app activity levels. It's possible that these changes were mediated by other components of the syd app that were not measured in the scope of this study (e.g., interactions with the chatbot agent, journaling, LQi and biometrics tracking or internalisation of lifestyle informative content), or that participants in the syd group were more actively engaged with lifestyle activities that could result in the changes observed.

Other studies have found mHealth interventions to impact anxiety, depression and stress levels. Mindfulness meditation mHealth interventions are amongst the most studied, with several showing the ability to reduce levels of stress [52, 53], anxiety [33] and depression [35, 54]. While mindfulness meditation audio tracks are available in syd and participants were free to access all content, this study was not designed to particularly test their efficacy on outcome measures and engagement was not requested or enforced. Indeed, engagement with mindfulness meditation was relatively low (only 29% of participants in the syd group engaged at least 1 time/week in month 1, reducing to 7% at month 2 and 3% at month 3), thus comparison with these studies should be taken lightly

Limitations.

While this study provides a valuable step towards validating the efficacy of the mHealth app syd in reducing mental health burden and improving quality of life of HCWs, we note several limitations:

(1), our inclusion criteria were restricted to HCWs in the UK that were already showing mild to moderate levels of anxiety and/or depression. In designing the study, we postulated that these individuals would likely benefit most from this type of intervention [38], and had the potential to provide a tool to relieve the increased mental health burden of NHS staff in light of the COVID-19 pandemic. Due to these factors, and that the population demographics of this study align with those of the NHS, the generalizability of our findings to a more diverse and mentally well population needs to be addressed.

(2), the dropout rate in the intervention group was high (71% vs. 26% at the primary endpoint), while on par with similar mHealth interventions [57]. Thus, it's possible that the group imbalance may have contributed to an imprecise estimation of our main findings. To address this, we used linear mixed models (LMM) in our main statistical analysis without imputation, an approach known to be strong in dealing with missing data in longitudinal clinical trials [58]. Several factors may have contributed to imbalance in the intervention arm. While syd was built to be easily used by everyone, the version of the app in this trial did not include a tutorial to clearly explain how to use the app and there could have been a high entry barrier, which could have been especially pronounced in this population of HCWs at a time where COVID-19 had a large impact on the UKs healthcare system and its workers. Moreover, because this trial had no compensation, aside from potential health benefits, to participate, there was no extrinsic motivation to remain engaged in the study. Indeed, our analysis of dropout predictors indicates that aside from group allocation, participants that were

recruited through the open call process were more than 3 times more likely to miss an assessment than those recruited through the registry [Supplementary Table 3]. As registry-recruited participants were previously enrolled and indicated they were open to participate in research studies, this suggests that intrinsic motivation to participate might have been a key factor in retention in this study. A qualitative analysis with the participants of this study or a separate feasibility study might help identify the factors underlying retention to the syd app [58]. Also, recruiting a larger number of participants would allow diminish the possible effects of dropout.

(3), syd gives the ability of participants to measure and track several attributes of their quality of life (LQi) in real time from the app. It is possible that the acknowledgement and tracking of these changes in the app could have introduced a positive bias in participants using the app compared to the wait-list group, thus magnifying the effect of the intervention. While this might be difficult to account for in this type of study and may pose ethical concerns, it could potentially be addressed using an active control group with access to a modified app where the tracked quality of life metrics follows the same distribution of the intervention group.

(4), we did not collect information about the participants' actual lifestyle or behavioural changes, relying instead on proxy measurements of activity types in the syd app to infer mediated effects. This information would allow us to better infer how syd mediates the observed effects in mental health and quality of life scores, which can be addressed in a separate study by addition of active (e.g., self-reports) or passive (e.g., biometrics, geolocation) measures of participants' behaviour.

CONCLUSIONS.

While most previous research focused on the impact of mental health applications in reducing symptoms of anxiety and/or depression, this study further explored the impact on quality of life in all its dimensions, providing deeper insights into the effects of such interventions on the whole life of individuals.

The findings of this randomized controlled study demonstrate the efficacy of the mHealth app syd in reducing anxiety, depression and stress in HCW, and that these effects are clinically meaningful. It further finds suggestive evidence that it may improve QoL, however, these results need to be replicated in a larger and more diverse population to reach a more definitive conclusion.

Studies such as this are likely to enable healthcare professionals to better access alternative, cost-effective treatment and/or preventive pathways for themselves and their patients, thus reducing the burden of mental health globally and more specifically across the healthcare system.

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Tables:

Table 1. Demographic, outcome and other covariates' statistics at baseline (Mean (SD)). Categorical variables with less than 5 participants in both groups are omitted for simplicity.

Group	Label	Category	syd (n=298)	Wait-list (n=297)
Demographics	**Age**	**21 - 24**	13 (4.4)	12 (4.0)
		25 - 34	70 (23.5)	61 (20.5)
		35 - 44	77 (25.8)	73 (24.6)
		45 - 54	90 (30.2)	100 (33.7)
		55 - 64	44 (14.8)	47 (15.8)
	Gender	**Female**	263 (88.3)	272 (91.6)
		Male	34 (11.4)	23 (7.7)
	Ethnicity	**White British**	273 (91.6)	273 (91.9)
		Other White background	9 (3.0)	8 (2.7)
	Religion	**No religion**	164 (55.0)	170 (57.2)
		Christian	124 (41.6)	114 (38.4)
		Other	9 (3.0)	6 (2.0)
	Years in NHS	**Less than 8 months**	8 (2.7)	7 (2.4)
		1 to 5 years	76 (25.5)	78 (26.3)
		6 to 10 years	62 (20.8)	50 (16.8)
		More than 10 years	145 (48.7)	160 (53.9)
Employment	**Full time**	**Yes**	213 (71.5)	217 (73.1)
	Part time	**Yes**	83 (27.9)	78 (26.3)
	Student	**Yes**	5 (1.7)	6 (2.0)
Work	**Profession**	**Administration**	93 (31.2)	89 (30.0)
		Nurse	86 (28.9)	84 (28.3)
		Other allied health professional	54 (18.1)	47 (15.8)

		Healthcare Support Worker	27 (9.1)	20 (6.7)
		Biomedical Scientist	11 (3.7)	9 (3.0)
		Doctor	9 (3.0)	6 (2.0)
		Other	5 (1.7)	7 (2.4)
	Work setting	**Hospital**	103 (34.6)	116 (39.1)
		Mental health	83 (27.9)	62 (20.9)
		Community	68 (22.8)	72 (24.2)
		Other	8 (2.7)	17 (5.7)
		Office	7 (2.3)	9 (3.0)
		Home	9 (3.0)	5 (1.7)
	Shift work	**Yes**	62 (20.8)	65 (21.9)
	COVID-19 contact	**Yes**	75 (25.2)	80 (26.9)
	COVID-19 care	**Yes**	51 (17.1)	59 (19.9)
Mobile use	**Apps**	**Yes**	280 (94.0)	271 (91.2)
	Web	**Yes**	292 (98.0)	287 (96.6)
	Messaging	**Yes**	293 (98.3)	285 (96.0)
	Social media	**Yes**	275 (92.3)	258 (86.9)
	Healthcare apps	**Yes**	181 (60.7)	187 (63.0)
	Calls	**Yes**	295 (99.0)	294 (99.0)
	Phone usage	**Under 1 hour**	12 (4.0)	15 (5.1)
		1 -2 hours	84 (28.2)	91 (30.6)
		2 - 5 hours	170 (57.0)	163 (54.9)
		Over 5 hours	32 (10.7)	28 (9.4)
Mental health diagnosis	**Anxiety**	**Yes**	91 (30.5)	79 (26.6)
	Panic Attacks	**Yes**	17 (5.7)	19 (6.4)
	Depression	**Yes**	96 (32.2)	79 (26.6)
	PTSD	**Yes**	11 (3.7)	13 (4.4)
Deprivation	**Deprivation**	**Townsend deprivation quintile**	3.1 (1.2)	3.1 (1.2)
		LSOA IMD decile	5.6 (2.3)	5.3 (2.4)

COVID-19	**COVID-19**	**COVID-19 restriction index**	40.6 (11.4)	42.8 (10.9)
		COVID-19 hospitalisations	0.6 (0.1)	0.6 (0.1)
Cohort	**Cohort**	**Initial**	154 (51.7)	174 (58.6)
		Open	144 (48.3)	123 (41.4)
Season	**Season**	**Summer**	149 (50.0)	169 (56.9)
		Winter	91 (30.5)	85 (28.6)
		Spring	53 (17.8)	38 (12.8)
		Autumn	5 (1.7)	5 (1.7)
Region	**Region**	**South East**	109 (36.6)	85 (28.6)
		Yorkshire and The Humber	58 (19.5)	64 (21.5)
		South West	40 (13.4)	43 (14.5)
		East Midlands	36 (12.1)	45 (15.2)
		East of England	29 (9.7)	22 (7.4)
		North West	10 (3.4)	18 (6.1)
		West Midlands	7 (2.3)	14 (4.7)
		North East	5 (1.7)	5 (1.7)
Outcomes	**QoL**	**General QoL**	3.6 (0.8)	3.6 (0.7)
		General health	2.8 (1.0)	2.9 (1.0)
		Physical health	64.9 (14.7)	64.5 (15.5)
		Psychological	45.7 (14.8)	46.2 (15.8)
		Social relationships	52.1 (20.1)	52.7 (19.5)
		Environment	65.3 (14.9)	65.8 (14.9)
	HRQoL	**Mobility**	4.8 (0.6)	4.8 (0.6)
		Self-care	4.9 (0.4)	4.9 (0.3)
		Usual activities	4.6 (0.7)	4.5 (0.7)
		Pain/discomfort	4.2 (0.8)	4.2 (0.8)
		Anxiety/Depression	3.7 (0.7)	3.7 (0.7)
		VAS	68.8 (16.7)	68.7 (16.5)
	Outcomes	**Anxiety**	10.8 (2.6)	10.7 (2.8)

		Depression	7.7 (3.2)	7.5 (3.3)
		Stress	8.4 (2.4)	8.4 (2.4)

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Table 2. Mean (SD) outcome scores across all assessment timepoints for syd (N = 298) and Wait-list control (N = 297) groups and time x group estimates from linear mixed effects models (LMM) for all outcome measures at the primary (Month 3) and follow-up (Month 6) endpoints. Significant coefficient p-values are shown in bold.

		Group		Model 1		Model 2		Model 3	
		syd	Wait-list	Coeff. [95% CI]	p-value	Coeff. [95% CI]	p-value	Coeff. [95% CI]	p-value
Outcome	**Timepoint**								
QoL - General QoL	**Baseline**	3.6 (0.8)	3.6 (0.7)						
	Month 1	3.8 (0.7)	3.6 (0.8)						
	Month 2	3.8 (0.7)	3.8 (0.7)						
	Month 3	3.8 (0.9)	3.7 (0.9)	0.02 [-0.03, 0.06]	0.477	0.01 [-0.03, 0.06]	0.595	0.01 [-0.03, 0.06]	0.579
	Month 6	3.7 (0.8)	3.7 (0.8)	0.07 [0.03, 0.11]	**0.002**	0.16 [0.03, 0.30]	**0.016**	0.19 [-0.19, 0.57]	0.327
QoL - General health	**Baseline**	2.8 (1.0)	2.9 (1.0)						
	Month 1	3.0 (1.0)	2.9 (1.0)						
	Month 2	3.1 (1.1)	3.0 (1.0)						
	Month 3	3.1 (1.1)	3.0 (1.0)	0.03 [-0.03, 0.09]	0.341	0.03 [-0.03, 0.08]	0.406	0.03 [-0.03, 0.09]	0.362
	Month 6	2.9 (1.0)	3.2 (1.0)	0.09 [0.02, 0.15]	**0.008**	0.13 [-0.06, 0.31]	0.171	0.03 [-0.43, 0.49]	0.899
QoL - Physical health	**Baseline**	64.9 (14.7)	64.5 (15.6)						
	Month 1	65.1 (17.8)	63.0 (16.1)						
	Month 2	66.0 (15.8)	65.6 (16.0)						
	Month 3	64.8 (18.5)	62.7 (17.0)	0.45 [-0.36, 1.27]	0.278	0.40 [-0.42, 1.21]	0.337	0.38 [-0.43, 1.20]	0.357
	Month 6	63.2 (16.9)	66.1 (15.9)	0.98 [-0.02, 1.98]	0.056	1.17 [-1.78, 4.13]	0.437	-2.96 [-10.42, 4.51]	0.438
QoL - Psychological	**Baseline**	45.7 (14.9)	46.2 (15.8)						
	Month 1	47.4 (17.4)	46.0 (17.1)						
	Month 2	50.8 (16.6)	49.0 (16.5)						
	Month 3	50.2 (19.4)	47.1 (18.2)	0.91 [0.06, 1.76]	**0.035**	0.82 [-0.03, 1.68]	0.057	0.84 [-0.01, 1.69]	0.052
	Month 6	46.5 (16.0)	50.0 (17.1)	1.26 [0.21, 2.32]	**0.018**	3.99 [0.90, 7.07]	**0.011**	5.82 [-1.72, 13.35]	0.130
QoL - Social relationships	**Baseline**	52.1 (20.1)	52.7 (19.5)						

	Month 1	51.9 (22.7)	52.9 (21.0)						
	Month 2	55.8 (21.5)	53.3 (20.4)						
	Month 3	54.1 (22.5)	51.7 (21.8)	1.01 [-0.14, 2.15]	0.084	0.95 [-0.19, 2.09]	0.103	0.99 [-0.15, 2.13]	0.090
	Month 6	50.8 (22.7)	54.1 (20.2)	1.57 [0.36, 2.78]	**0.011**	4.31 [0.58, 8.04]	**0.024**	14.53 [4.78, 24.28]	**0.004**
QoL - Environment	**Baseline**	65.3 (14.9)	65.8 (14.9)						
	Month 1	67.8 (15.5)	65.3 (16.1)						
	Month 2	68.3 (15.5)	67.7 (15.2)						
	Month 3	67.2 (19.1)	65.5 (17.2)	0.34 [-0.38, 1.06]	0.355	0.28 [-0.44, 1.00]	0.442	0.32 [-0.40, 1.04]	0.385
	Month 6	65.7 (17.1)	66.8 (16.0)	0.64 [-0.10, 1.39]	0.092	3.00 [0.79, 5.21]	**0.008**	2.05 [-4.86, 8.96]	0.561
HRQoL - Mobility	**Baseline**	4.8 (0.6)	4.8 (0.6)						
	Month 1	4.5 (0.9)	4.7 (0.6)						
	Month 2	4.5 (0.8)	4.7 (0.6)						
	Month 3	4.6 (0.7)	4.6 (0.7)	0.00 [-0.03, 0.04]	0.870	0.00 [-0.03, 0.04]	0.840	0.00 [-0.03, 0.04]	0.931
	Month 6	4.5 (0.8)	4.7 (0.6)	0.01 [-0.03, 0.04]	0.673	-0.03 [-0.13, 0.07]	0.550	-0.14 [-0.43, 0.15]	0.348
HRQoL - Self-care	**Baseline**	4.9 (0.4)	4.9 (0.4)						
	Month 1	4.8 (0.5)	4.9 (0.3)						
	Month 2	4.8 (0.5)	4.9 (0.4)						
	Month 3	4.9 (0.3)	4.9 (0.5)	-0.01 [-0.03, 0.02]	0.618	-0.01 [-0.03, 0.02]	0.653	-0.00 [-0.03, 0.02]	0.710
	Month 6	4.9 (0.5)	4.9 (0.4)	-0.01 [-0.01, 0.00]	0.264	-0.02 [-0.05, 0.02]	0.399	-0.17 [-0.31, -0.03]	**0.020**
HRQoL - Usual activities	**Baseline**	4.6 (0.7)	4.5 (0.7)						
	Month 1	4.4 (0.7)	4.4 (0.7)						
	Month 2	4.3 (0.8)	4.5 (0.7)						
	Month 3	4.3 (0.8)	4.4 (0.8)	-0.05 [-0.09, -0.00]	**0.045**	-0.05 [-0.09, -0.00]	**0.039**	-0.05 [-0.10, -0.00]	**0.033**
	Month 6	4.3 (0.9)	4.5 (0.7)	0.02 [-0.03, 0.07]	0.471	-0.14 [-0.29, 0.00]	0.054	-0.56 [-0.94, -0.18]	**0.004**
HRQoL - Pain/discomfort	**Baseline**	4.2 (0.8)	4.2 (0.8)						
	Month 1	4.0 (0.8)	4.1 (0.8)						
	Month 2	4.1 (0.8)	4.1 (0.8)						
	Month 3	4.0 (0.8)	4.1 (0.9)	-0.00 [-0.05, 0.04]	0.876	-0.00 [-0.05, 0.04]	0.877	-0.00 [-0.05, 0.05]	0.934
	Month 6	4.1 (0.8)	4.1 (0.8)	-0.00 [-0.06, 0.06]	0.972	-0.04 [-0.20, 0.12]	0.631	-0.34 [-0.72, 0.05]	0.085

HRQoL - Anxiety/Depression	**Baseline**	3.7 (0.7)	3.7 (0.7)						
	Month 1	3.7 (0.8)	3.6 (0.8)						
	Month 2	3.8 (0.8)	3.8 (0.7)						
	Month 3	3.7 (0.9)	3.7 (0.8)	0.01 [-0.04, 0.06]	0.780	0.00 [-0.04, 0.05]	0.867	0.00 [-0.05, 0.05]	0.956
	Month 6	3.5 (0.8)	3.7 (0.8)	0.02 [-0.04, 0.08]	0.596	-0.01 [-0.18, 0.15]	0.868	-0.14 [-0.53, 0.26]	0.497
HRQoL - VAS	**Baseline**	68.8 (16.7)	68.7 (16.6)						
	Month 1	68.4 (16.8)	68.2 (17.5)						
	Month 2	69.6 (15.8)	70.7 (17.5)						
	Month 3	70.5 (18.7)	68.9 (16.6)	0.01 [-1.02, 1.04]	0.988	-0.11 [-1.14, 0.92]	0.833	-0.12 [-1.15, 0.91]	0.821
	Month 6	65.8 (19.7)	71.2 (16.7)	1.20 [0.12, 2.28]	**0.029**	-0.29 [-3.38, 2.81]	0.856	-8.65 [-16.57, -0.73]	**0.032**
Anxiety	**Baseline**	10.8 (2.6)	10.7 (2.8)						
	Month 1	9.6 (3.5)	10.2 (3.4)						
	Month 2	9.2 (3.7)	9.9 (3.5)						
	Month 3	9.6 (4.1)	10.2 (3.5)	-0.31 [-0.51, -0.11]	**0.002**	-0.30 [-0.50, -0.10]	**0.003**	-0.30 [-0.50, -0.10]	**0.003**
	Month 6	9.7 (3.8)	9.6 (3.6)	-0.29 [-0.55, -0.04]	**0.021**	-0.27 [-0.98, 0.44]	0.454	-2.28 [-4.01, -0.54]	**0.010**
Depression	**Baseline**	7.7 (3.2)	7.5 (3.3)						
	Month 1	7.5 (3.9)	7.6 (3.6)						
	Month 2	6.8 (3.9)	7.1 (3.6)						
	Month 3	6.9 (4.2)	7.3 (3.7)	-0.24 [-0.44, -0.04]	**0.020**	-0.22 [-0.42, -0.02]	**0.033**	-0.23 [-0.43, -0.03]	**0.027**
	Month 6	8.0 (3.8)	6.9 (4.0)	-0.35 [-0.59, -0.11]	**0.004**	-0.72 [-1.43, -0.02]	**0.044**	-0.55 [-2.31, 1.22]	0.546
Stress	**Baseline**	8.4 (2.4)	8.4 (2.5)						
	Month 1	7.8 (2.8)	8.4 (2.7)						
	Month 2	7.2 (2.6)	7.8 (2.6)						
	Month 3	7.2 (3.2)	8.1 (2.8)	-0.23 [-0.39, -0.07]	**0.005**	-0.21 [-0.37, -0.05]	**0.010**	-0.21 [-0.37, -0.05]	**0.010**
	Month 6	8.1 (3.2)	7.7 (3.1)	-0.25 [-0.42, -0.08]	**0.004**	-0.40 [-0.93, 0.12]	0.135	-0.28 [-1.85, 1.29]	0.729

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Table 3. Linear mixed effects model (LMM) coefficient and p-value estimates for the time (Month) x anxiety/depression category at baseline interaction for all outcomes at the primary (Month 3) endpoint. Significant coefficient p-values are shown in bold.

	Anxiety						Depression					
	Mild		Moderate		Severe		Mild		Moderate		Severe	
	Coeff. [95% CI]	p-value	Coeff. [95% CI]	p-value	Coeff. [95% CI]	p-value	Coeff. [95% CI]	p-value	Coeff. [95% CI]	p-value	Coeff. [95% CI]	p-value
Outcome												
QoL - General QoL	-0.05 [-0.14, 0.04]	0.311	-0.01 [-0.10, 0.07]	0.762	-0.04 [-0.14, 0.07]	0.524	0.05 [0.00, 0.11]	**0.044**	0.01 [-0.06, 0.08]	0.789	0.04 [-0.13, 0.20]	0.666
QoL - General health	-0.07 [-0.18, 0.04]	0.218	-0.02 [-0.13, 0.09]	0.729	-0.03 [-0.16, 0.11]	0.714	0.06 [-0.00, 0.13]	0.066	-0.03 [-0.12, 0.05]	0.485	0.06 [-0.14, 0.27]	0.539
QoL - Physical health	-0.67 [-2.24, 0.90]	0.401	-0.02 [-1.57, 1.53]	0.980	0.91 [-0.98, 2.81]	0.346	0.00 [-0.92, 0.93]	0.995	-0.41 [-1.60, 0.77]	0.496	1.61 [-1.24, 4.47]	0.268
QoL - Psychological	-2.33 [-3.95, -0.72]	**0.005**	-1.16 [-2.76, 0.43]	0.153	-0.70 [-2.65, 1.25]	0.482	0.14 [-0.81, 1.09]	0.772	0.12 [-1.09, 1.34]	0.841	3.85 [0.90, 6.79]	**0.011**
QoL - Social relationships	-1.32 [-3.52, 0.88]	0.238	-0.47 [-2.64, 1.71]	0.674	0.32 [-2.34, 2.98]	0.812	-0.19 [-1.49, 1.10]	0.769	0.25 [-1.42, 1.91]	0.772	7.09 [3.08, 11.11]	**<0.001**
QoL - Environment	-1.43 [-2.81, -0.04]	**0.043**	-0.27 [-1.64, 1.09]	0.694	-0.02 [-1.70, 1.65]	0.979	-0.65 [-1.47, 0.17]	0.120	-1.00 [-2.05, 0.05]	0.062	-0.14 [-2.67, 2.38]	0.910
QoL - Total	-1.43 [-2.66, -0.20]	**0.023**	-0.40 [-1.62, 0.82]	0.521	0.11 [-1.39, 1.60]	0.889	-0.06 [-0.79, 0.67]	0.866	-0.39 [-1.32, 0.54]	0.410	2.25 [0.00, 4.49]	0.050
HRQoL - Mobility	-0.01 [-0.08, 0.06]	0.745	0.00 [-0.07, 0.07]	0.950	-0.01 [-0.09, 0.08]	0.877	-0.03 [-0.07, 0.01]	0.190	-0.02 [-0.07, 0.03]	0.409	0.03 [-0.10, 0.16]	0.632
HRQoL - Self-care	0.01 [-0.04, 0.05]	0.730	-0.00 [-0.04, 0.04]	0.906	-0.05 [-0.10, 0.00]	0.062	-0.00 [-0.03, 0.02]	0.895	0.02 [-0.01, 0.05]	0.221	0.02 [-0.06, 0.10]	0.680
HRQoL - Usual activities	0.08 [-0.01, 0.17]	0.093	0.07 [-0.01, 0.16]	0.104	0.04 [-0.07, 0.14]	0.495	0.00 [-0.05, 0.06]	0.910	0.00 [-0.07, 0.07]	0.959	-0.02 [-0.19, 0.14]	0.781
HRQoL - Pain/discomfort	-0.05 [-0.14, 0.04]	0.279	-0.01 [-0.10, 0.09]	0.895	-0.06 [-0.17, 0.06]	0.315	-0.01 [-0.06, 0.05]	0.867	-0.02 [-0.09, 0.05]	0.629	-0.05 [-0.23, 0.12]	0.534
HRQoL - Anxiety/Depression	-0.02 [-0.11, 0.07]	0.699	-0.03 [-0.12, 0.07]	0.583	0.00 [-0.11, 0.11]	0.990	-0.03 [-0.08, 0.03]	0.334	-0.05 [-0.12, 0.02]	0.155	0.21 [0.04, 0.39]	**0.015**
HRQoL - VAS	0.89 [-1.11, 2.88]	0.383	0.83 [-1.14, 2.80]	0.409	1.31 [-1.09, 3.72]	0.285	0.70 [-0.48, 1.87]	0.244	-0.40 [-1.90, 1.10]	0.603	3.36 [-0.29, 7.00]	0.071
HRQoL - Total	0.02 [-0.20, 0.24]	0.855	0.06 [-0.17, 0.27]	0.624	-0.07 [-0.34, 0.20]	0.619	-0.05 [-0.18, 0.08]	0.466	-0.07 [-0.23, 0.10]	0.431	0.18 [-0.23, 0.58]	0.390
Anxiety	-0.13 [-0.48, 0.23]	0.485	-0.47 [-0.82, -0.12]	**0.008**	-0.47 [-0.90, -0.04]	**0.032**	0.11 [-0.10, 0.32]	0.300	0.12 [-0.15, 0.38]	0.398	-1.63 [-2.28, -0.97]	**<0.001**
Depression	0.16 [-0.20, 0.52]	0.370	0.09 [-0.26, 0.45]	0.615	0.43 [-0.00, 0.86]	0.051	-0.41 [-0.62, -0.20]	**<0.001**	-0.53 [-0.80, -0.27]	**<0.001**	-2.68 [-3.34, -2.02]	**<0.001**
Stress	-0.15 [-0.46, 0.16]	0.341	-0.19 [-0.49, 0.12]	0.225	-0.26 [-0.62, 0.12]	0.177	-0.16 [-0.34, 0.02]	0.077	-0.14 [-0.38, 0.09]	0.217	-0.60 [-1.16, -0.04]	**0.036**

Table 4. Linear mixed effects model (LMM) coefficient and p-value estimates for the time (Month) x anxiety/depression category at baseline interaction for all outcomes at the primary (Month 3) endpoint. Significant coefficient p-values are shown in bold.

	Sessions		Meditations		Recommendations	
	Coeff. [95% CI]	p-value	Coeff. [95% CI]	p-value	Coeff. [95% CI]	p-value
Outcome						
QoL - General QoL	0.05 [0.01, 0.09]	**0.016**	0.04 [-0.01, 0.09]	0.130	0.01 [-0.03, 0.05]	0.544
QoL - General health	0.06 [0.00, 0.11]	**0.037**	0.07 [0.01, 0.13]	**0.018**	0.01 [-0.04, 0.05]	0.800
QoL - Physical health	1.33 [0.61, 2.04]	**<0.001**	1.05 [0.23, 1.88]	**0.013**	0.58 [-0.03, 1.19]	0.061
QoL - Psychological	0.69 [-0.09, 1.46]	0.083	0.46 [-0.43, 1.36]	0.311	0.29 [-0.37, 0.94]	0.390
QoL - Social relationships	0.46 [-0.51, 1.44]	0.353	-0.38 [-1.50, 0.75]	0.511	-0.23 [-1.05, 0.59]	0.584
QoL - Environment	0.52 [-0.17, 1.21]	0.142	0.34 [-0.45, 1.13]	0.400	-0.05 [-0.63, 0.52]	0.858
HRQoL - Mobility	0.01 [-0.03, 0.04]	0.659	0.01 [-0.03, 0.05]	0.719	0.02 [-0.01, 0.04]	0.288
HRQoL - Self-care	0.01 [-0.01, 0.03]	0.601	-0.01 [-0.03, 0.02]	0.671	0.00 [-0.01, 0.02]	0.742
HRQoL - Usual activities	0.07 [0.03, 0.10]	**<0.001**	0.03 [-0.01, 0.07]	0.196	0.03 [-0.01, 0.06]	0.131
HRQoL - Pain/discomfort	0.02 [-0.02, 0.06]	0.330	-0.00 [-0.05, 0.05]	0.983	-0.01 [-0.04, 0.03]	0.635
HRQoL - Anxiety/Depression	0.06 [0.01, 0.10]	**0.012**	0.07 [0.02, 0.12]	**0.005**	0.03 [-0.01, 0.06]	0.181
HRQoL - VAS	0.59 [-0.32, 1.49]	0.202	0.31 [-0.74, 1.37]	0.561	-0.63 [-1.39, 0.14]	0.107
Anxiety	-0.16 [-0.34, 0.02]	0.082	-0.07 [-0.28, 0.14]	0.532	-0.05 [-0.20, 0.10]	0.524
Depression	-0.15 [-0.32, 0.03]	0.106	-0.17 [-0.37, 0.04]	0.104	-0.15 [-0.30, -0.00]	**0.049**
Stress	-0.12 [-0.27, 0.04]	0.133	-0.15 [-0.33, 0.02]	0.087	0.02 [-0.11, 0.15]	0.738

Supplementary Table 1. Weakly activity levels as mean (SD) and N (%) for each activity component and activity category across all timepoints and groups that engaged with the syd app. Activity weekly thresholds for each activity component are: Sessions (None = 0, 0 < Low <= 4.67, 4.67 < Medium <= 10.38, High > 10.38), Meditations (None = 0, 0 < Low <= 1, 1 < Medium <= 2, High > 2), Recommendations (None = 0, 0 < Low <= 1.9, 1.9 < Medium <= 7, High > 7).

			Mean	Category			
			Mean (SD)	None	Low	Medium	High
Activity	**Group**	**Timepoint**					
Sessions	**syd**	**Month 1**	6.54 (7.10)	69 (23.2%)	60 (20.1%)	112 (37.6%)	57 (19.1%)
		Month 2	1.44 (3.54)	211 (70.8%)	51 (17.1%)	26 (8.7%)	10 (3.4%)
		Month 3	0.67 (2.14)	251 (84.2%)	31 (10.4%)	12 (4.0%)	4 (1.3%)
		Month 6	0.40 (1.54)	260 (87.2%)	32 (10.7%)	5 (1.7%)	1 (0.3%)
	Wait-list	**Month 6**	7.03 (6.68)	11 (16.7%)	13 (19.7%)	29 (43.9%)	13 (19.7%)
Meditations	**syd**	**Month 1**	0.31 (0.81)	243 (81.5%)	33 (11.1%)	12 (4.0%)	10 (3.4%)
		Month 2	0.05 (0.30)	287 (96.3%)	7 (2.3%)	3 (1.0%)	1 (0.3%)
		Month 3	0.02 (0.17)	294 (98.7%)	3 (1.0%)	0 (0.0%)	1 (0.3%)
		Month 6	0.01 (0.14)	296 (99.3%)	1 (0.3%)	0 (0.0%)	1 (0.3%)
	Wait-list	**Month 6**	0.10 (0.42)	62 (93.9%)	2 (3.0%)	1 (1.5%)	1 (1.5%)
Scheduled	**syd**	**Month 1**	3.50 (8.38)	114 (38.3%)	56 (18.8%)	82 (27.5%)	46 (15.4%)
		Month 2	0.59 (2.37)	253 (84.9%)	14 (4.7%)	24 (8.1%)	7 (2.3%)
		Month 3	0.19 (0.86)	276 (92.6%)	8 (2.7%)	12 (4.0%)	2 (0.7%)
		Month 6	0.17 (0.75)	277 (93.0%)	9 (3.0%)	11 (3.7%)	1 (0.3%)
	Wait-list	**Month 6**	2.26 (3.83)	22 (33.3%)	9 (13.6%)	30 (45.5%)	5 (7.6%)

Supplementary Table 2. Linear mixed model (LMM) statistics for all models fitted to each of the outcome measures and endpoints presented in Table 2.

		Model 1				Model 2				Model 3			
		AIC	R2	RMSE	ICC	AIC	R2	RMSE	ICC	AIC	R2	RMSE	ICC
Outcome	**Timepoint**												
QoL - General QoL	**Month 3**	2864	0.636	0.766	0.62	2892	0.635	0.741	0.594	2888	0.637	0.724	0.577
	Month 6	262	0.778	0.75	0.741	268	0.786	0.587	0.581	260	0.793	0.461	0.346
QoL - General health	**Month 3**	3579	0.668	1.0	0.655	3589	0.672	0.966	0.628	3585	0.672	0.937	0.607
	Month 6	323	0.661	0.863	0.596	334	0.66	0.715	0.403	318	0.657	0.56	0.02
QoL - Physical health	**Month 3**	11311	0.732	15.682	0.719	11339	0.732	15.258	0.701	11339	0.732	14.887	0.688
	Month 6	1062	0.664	14.41	0.628	1053	0.665	11.658	0.427	1036	0.675	9.042	0.073
QoL - Psychological	**Month 3**	11423	0.726	16.293	0.716	11445	0.724	15.629	0.692	11413	0.726	14.931	0.665
	Month 6	1087	0.715	16.409	0.685	1068	0.718	12.494	0.466	1040	0.716	9.186	0.0
QoL - Social relationships	**Month 3**	12187	0.688	20.185	0.671	12202	0.686	19.24	0.639	12200	0.685	18.814	0.622
	Month 6	1123	0.725	18.725	0.678	1117	0.71	15.217	0.499	1101	0.723	11.724	0.194
QoL - Environment	**Month 3**	11090	0.785	15.403	0.778	11100	0.784	14.704	0.755	11099	0.786	14.381	0.745
	Month 6	1031	0.813	14.572	0.8	997	0.827	10.009	0.607	1003	0.827	8.388	0.44
HRQoL - Mobility	**Month 3**	2158	0.665	0.624	0.644	2191	0.671	0.61	0.633	2208	0.671	0.601	0.623
	Month 6	178	0.769	0.55	0.75	191	0.771	0.441	0.605	184	0.773	0.344	0.362
HRQoL - Self-care	**Month 3**	870	0.705	0.404	0.695	901	0.705	0.389	0.673	895	0.704	0.378	0.653
	Month 6	-2	0.959	0.422	0.958	22	0.958	0.339	0.933	5	0.961	0.239	0.88
HRQoL - Usual activities	**Month 3**	2744	0.578	0.719	0.562	2780	0.581	0.705	0.543	2776	0.579	0.685	0.518
	Month 6	265	0.682	0.722	0.668	274	0.674	0.576	0.466	264	0.685	0.457	0.172
HRQoL - Pain/discomfort	**Month 3**	2969	0.645	0.791	0.615	3001	0.646	0.772	0.595	3017	0.644	0.758	0.582
	Month 6	296	0.629	0.769	0.565	296	0.635	0.603	0.302	272	0.687	0.467	0.0
HRQoL - Anxiety/Depression	**Month 3**	2883	0.539	0.733	0.518	2913	0.539	0.713	0.49	2874	0.543	0.68	0.445
	Month 6	301	0.626	0.78	0.553	303	0.636	0.625	0.335	278	0.683	0.478	0.0
HRQoL - VAS	**Month 3**	11786	0.611	16.758	0.604	11816	0.614	16.329	0.583	11798	0.613	15.754	0.556

	Month 6	1082	0.689	15.544	0.63	1064	0.703	12.181	0.431	1050	0.721	9.559	0.122
Anxiety	**Month 3**	6997	0.584	3.156	0.558	7033	0.585	3.065	0.537	7018	0.591	2.99	0.518
	Month 6	669	0.552	3.076	0.488	671	0.543	2.563	0.244	660	0.593	2.1	0.0
Depression	**Month 3**	7157	0.659	3.502	0.647	7172	0.655	3.332	0.612	7162	0.658	3.233	0.592
	Month 6	703	0.736	3.888	0.706	690	0.734	2.916	0.496	664	0.732	2.14	0.056
Stress	**Month 3**	6403	0.6	2.599	0.587	6432	0.599	2.508	0.559	6435	0.601	2.462	0.544
	Month 6	620	0.764	2.905	0.737	623	0.755	2.315	0.575	621	0.78	1.909	0.436

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Supplementary Table 3. Logistic prediction model statistics of dropout.

Predictor	Odds Ratio [95% CI]	p-value
Intercept	17.60 [3.69, 83.89]	**<0.001**
Group (Wait-list)	0.17 [0.11, 0.27]	**<0.001**
Cohort (Open)	3.16 [1.94, 5.14]	**<0.001**
Gender (Male)	0.54 [0.26, 1.10]	0.089
Gender (Other)	1.89 [0.05, 74.68]	0.734
Profession (Biomedical Scientist)	2.17 [0.56, 8.41]	0.263
Profession (Doctor)	3.17 [0.59, 16.93]	0.177
Profession (Healthcare Support Worker)	4.67 [1.42, 15.40]	**0.011**
Profession (IT specialist)	1.48 [0.15, 14.87]	0.74
Profession (Nurse)	1.83 [0.98, 3.42]	0.056
Profession (Other)	3.44 [0.64, 18.49]	0.15
Profession (Other allied health professional)	0.85 [0.44, 1.62]	0.612
Profession (Pharmacist)	1.60 [0.28, 9.09]	0.598
Profession (Radiographer)	0.34 [0.05, 2.17]	0.255
Profession (Therapist)	1.76 [0.56, 5.57]	0.337
Employment (Part time)	1.06 [0.65, 1.70]	0.826
Job requires shift work	1.23 [0.62, 2.45]	0.551
Job requires COVID-19 contact	0.80 [0.40, 1.61]	0.534
Job requires COVID-19 care	1.18 [0.53, 2.64]	0.689
Diagnosis (Panic Attacks)	1.46 [0.53, 4.00]	0.463
Diagnosis (Depression)	0.74 [0.40, 1.36]	0.326
Diagnosis (PTSD)	2.34 [0.73, 7.56]	0.154
Use healthcare apps	0.91 [0.58, 1.43]	0.694
Region (East Midlands)	0.30 [0.15, 0.63]	**0.001**
Region (East of England)	1.41 [0.57, 3.49]	0.452
Region (London)	0.60 [0.06, 5.96]	0.663
Region (North East)	0.34 [0.06, 1.93]	0.224
Region (North West)	0.49 [0.18, 1.29]	0.147
Region (South West)	0.91 [0.44, 1.89]	0.809
Region (West Midlands)	0.52 [0.18, 1.55]	0.244
Region (Yorkshire and The Humber)	0.89 [0.48, 1.63]	0.697
Age	0.99 [0.97, 1.02]	0.547
NHS years	0.98 [0.90, 1.06]	0.614
Phone usage	1.07 [0.88, 1.29]	0.501
LSOA IMD decile	0.85 [0.77, 0.94]	**0.001**

Figures:

Figure 1. syd app screenshots. From left to right (1) chatbot agent, (2) recommendations schedule, (3) LQi tracking, (4) mindfulness meditations.

Figure 2. CONSORT Diagram of participant flow through the study. Lost to follow-up refers to participants that failed to complete any more assessments from the specified timepoint.

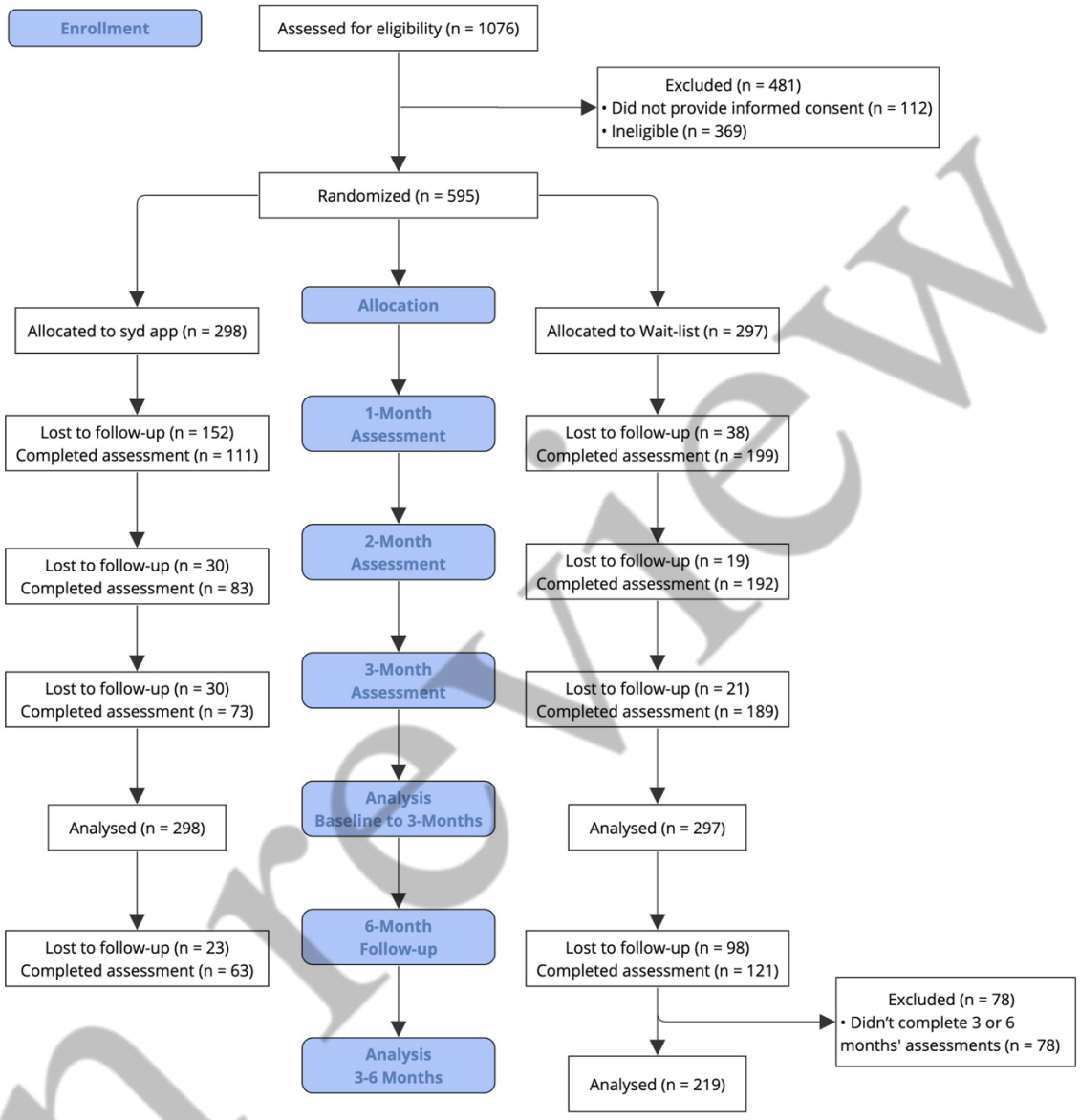


Figure 3. Average changes in the quality of life (QoL) domains for all assessment timepoints for syd (red), wait-list (blue), and wait-list + syd (magenta) groups. Values are presented as mean +/- SE. Percentage changes in each group for all timepoints is shown below each plot.

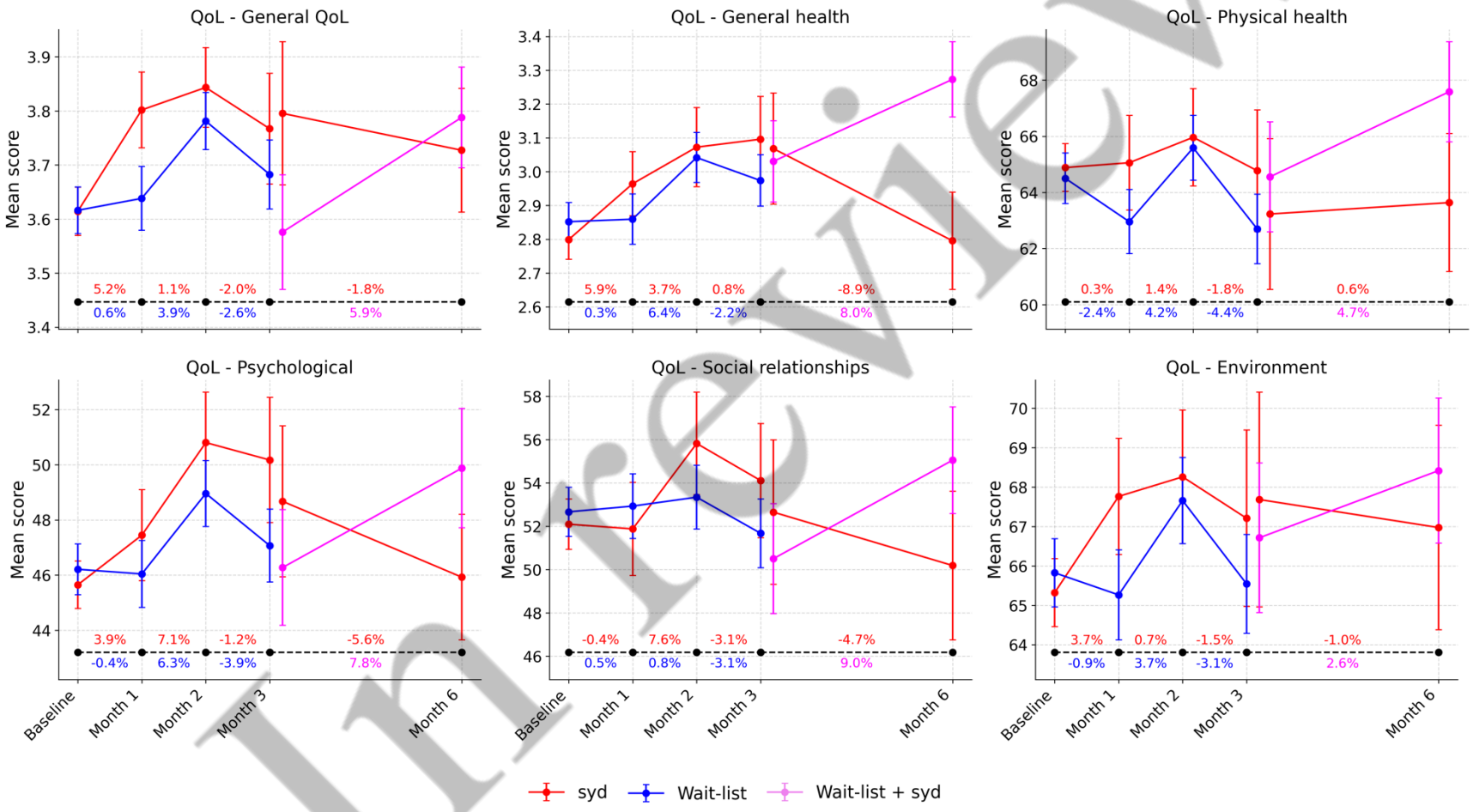


Figure 4. Average changes in health-related quality of life (HRQoL) domains for all assessment timepoints for syd (red), wait-list (blue), and wait-list + syd (magenta) groups. Values are presented as mean +/- SE. Percentage changes in each group for all timepoints is shown below each plot.

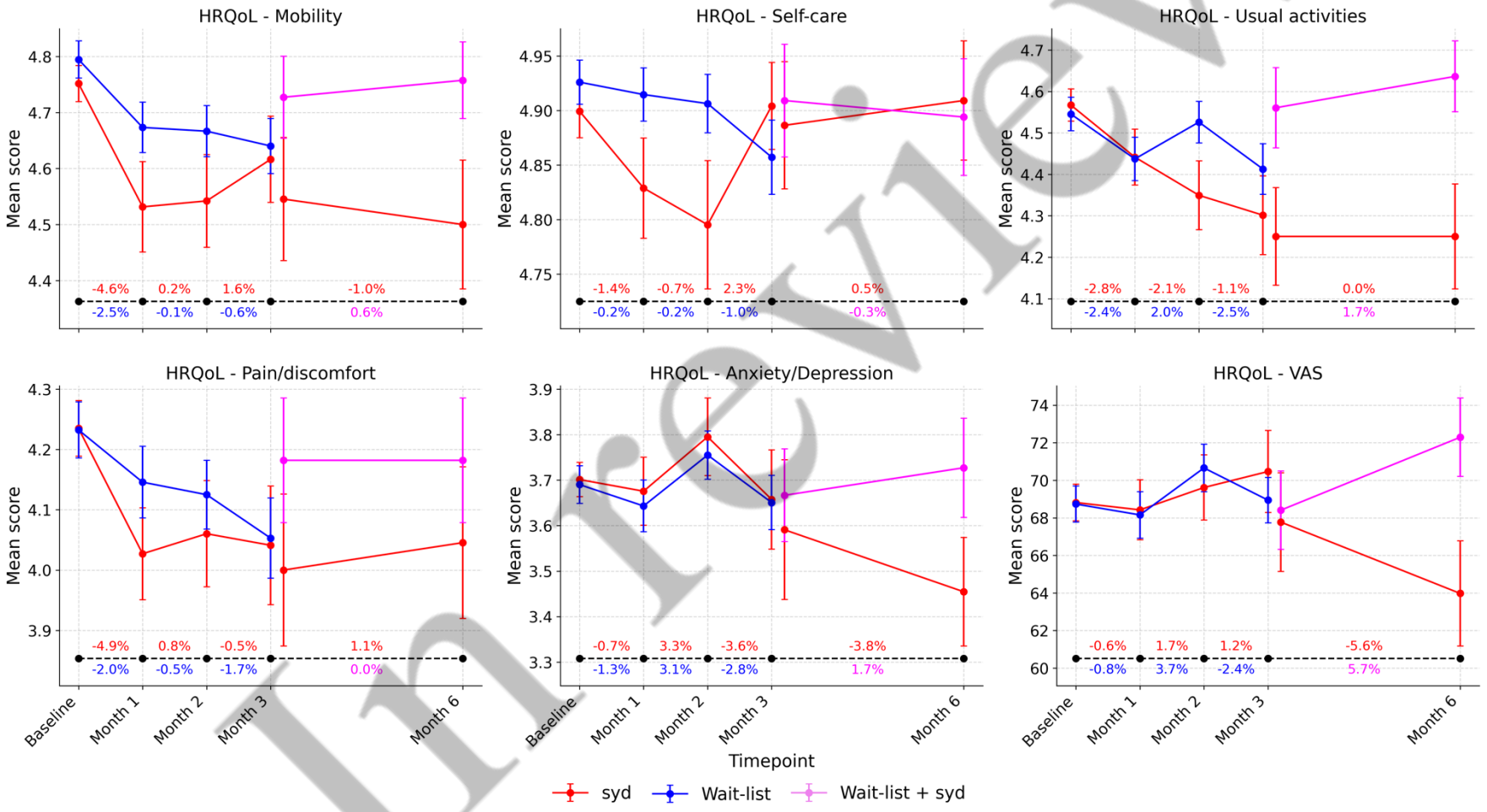


Figure 5. Average changes in anxiety (HADS-A), depression (HADS-D), and stress (PPS-4) for all assessment timepoints for syd (red), wait-list (blue), and wait-list + syd (magenta) groups. Values are presented as mean +/- SE. Percentage changes in each group for all timepoints is shown below each plot.

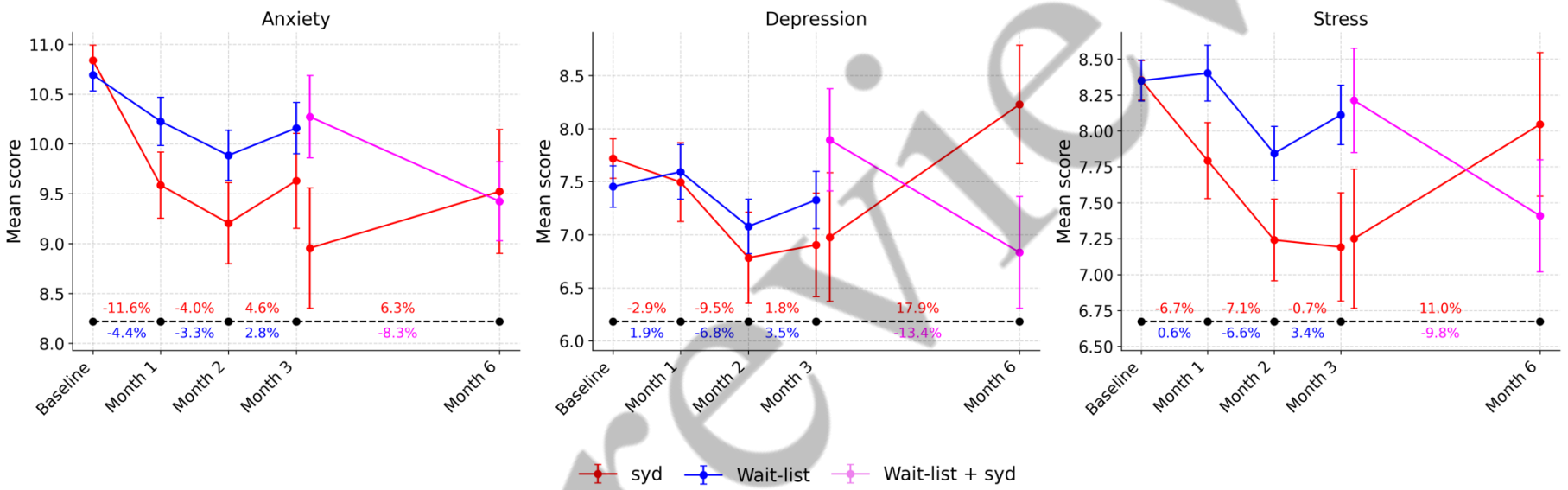
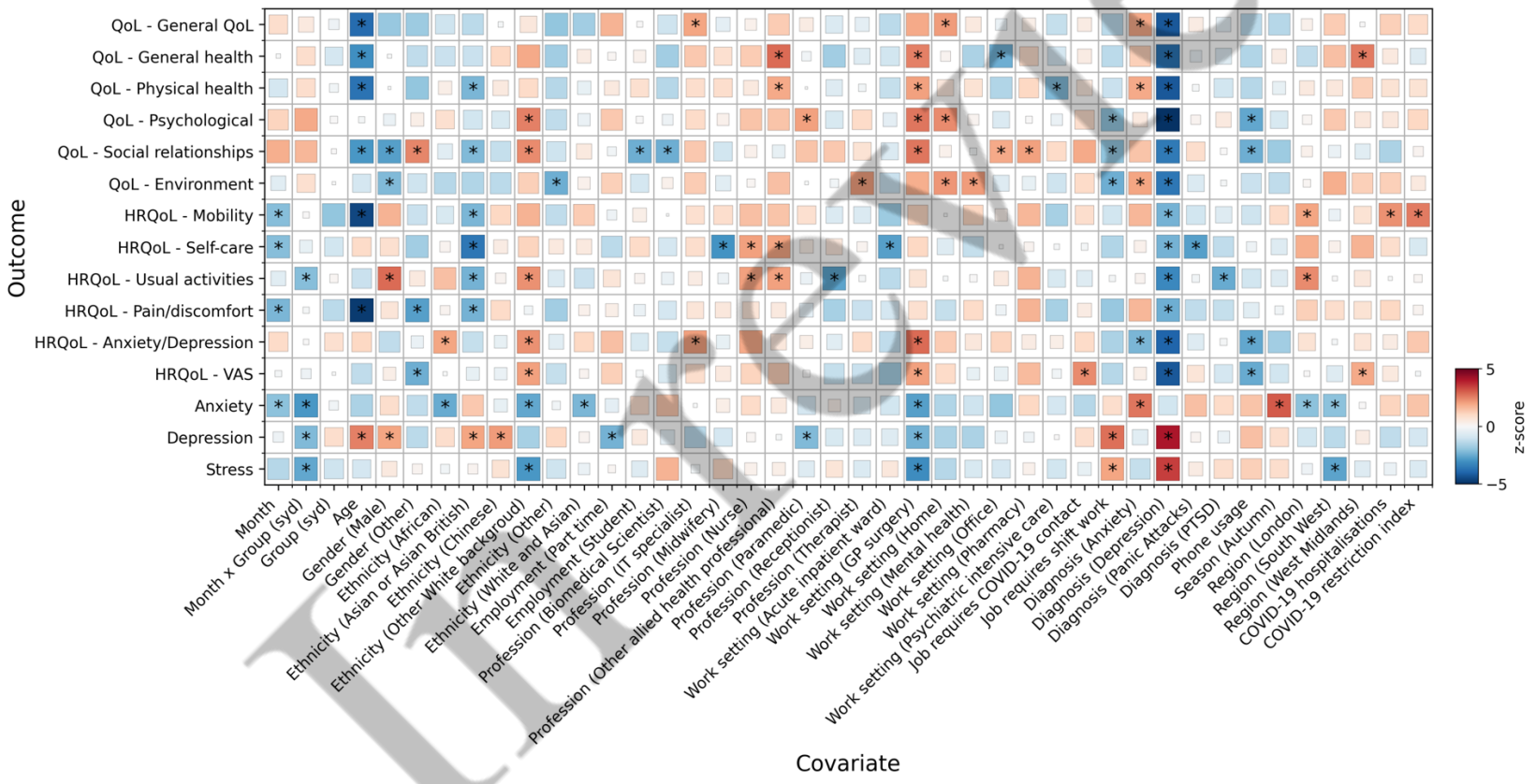
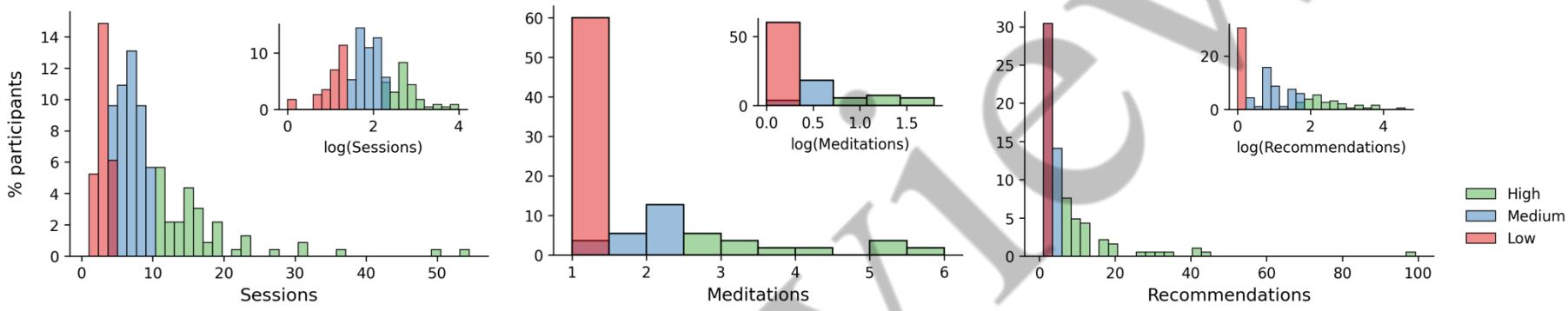


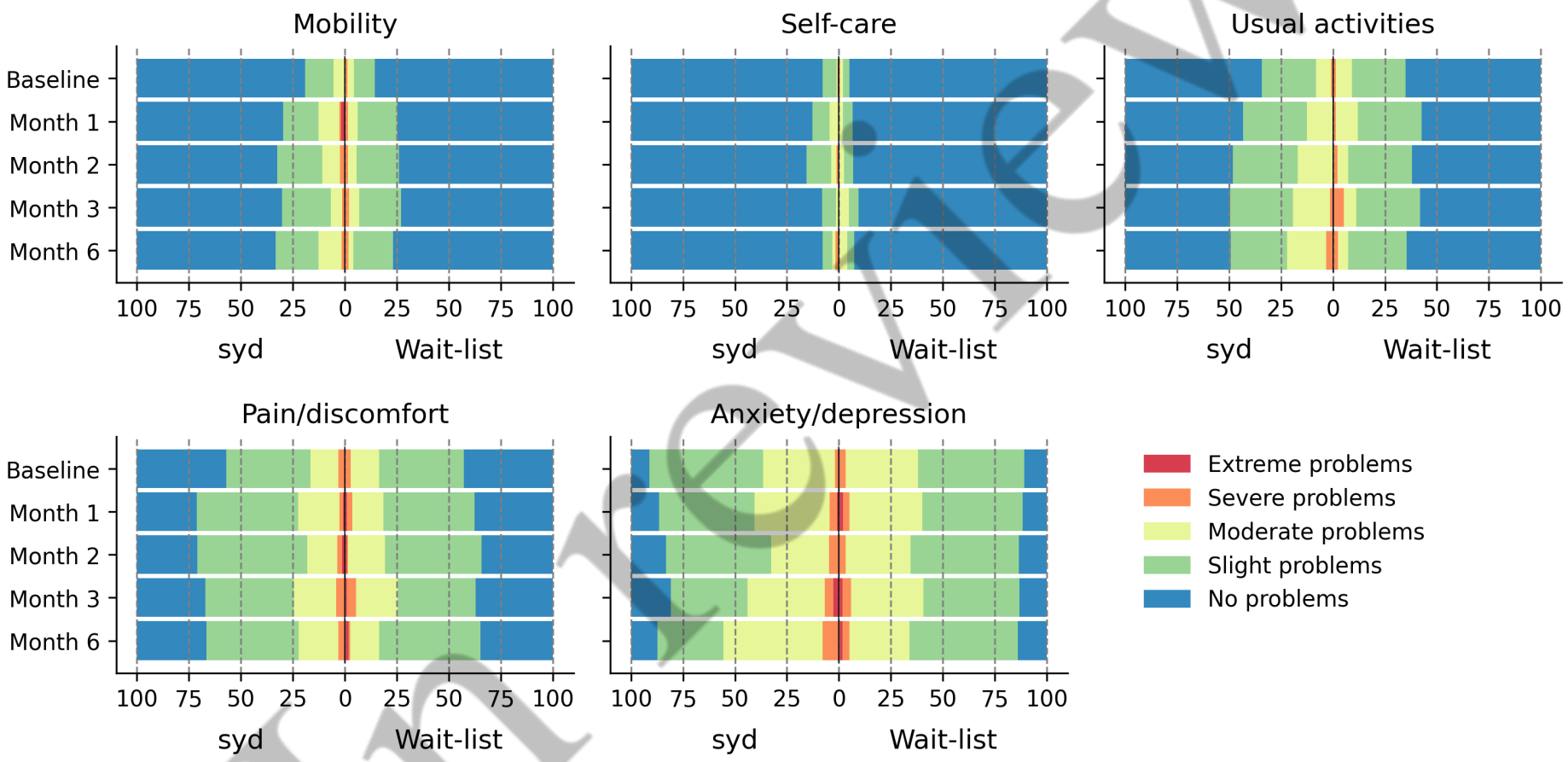
Figure 6. Z-scored coefficients for all covariates in the full linear mixed model (Model 3) for each outcome comparing the syd app intervention to the wait-list control groups from baseline to month 3. Boxes are coloured based on z-score of the coefficients for ease of comparison between covariates and outcomes. The size of the boxes is scaled to according to the *p*-value of the coefficients, with larger sizes corresponding to lower *p*-values. Black asterisks represent coefficients at *p*-value < 0.05. Covariates without any significant ($p < 0.05$) coefficient across all outcomes were excluded for simplicity. Reference values for categorical variables: Group (syd); Gender (Female); Ethnicity (White British); Profession (Administration); Work setting (Hospital); Season (Summer); Region (South-East).



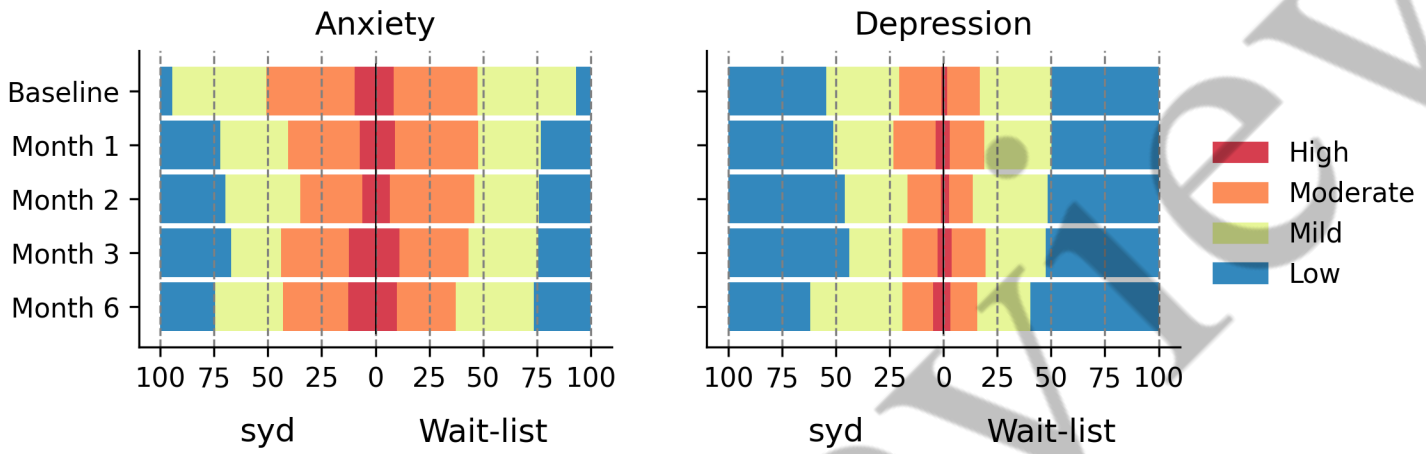
Supplementary Figure 1. Weekly and log-transformed (inset) weekly activity distributions of sessions, mediations and recommendations syd activities in Month 1 for participants in the syd group.



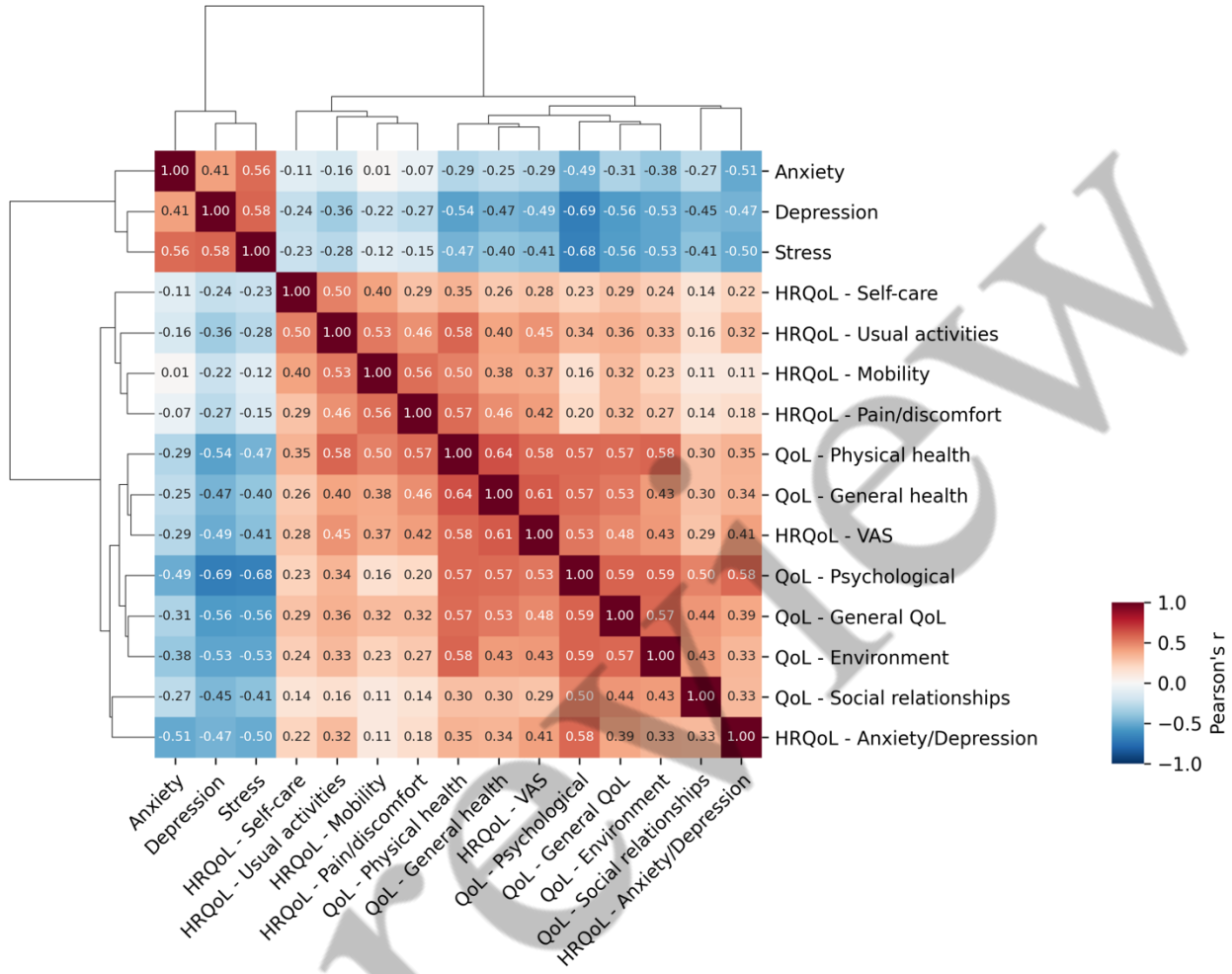
Supplementary Figure 2. Distribution of participants in the syd and wait-list groups for each response category of the EQ-5D-5L across all instrument domains and assessment timepoints.



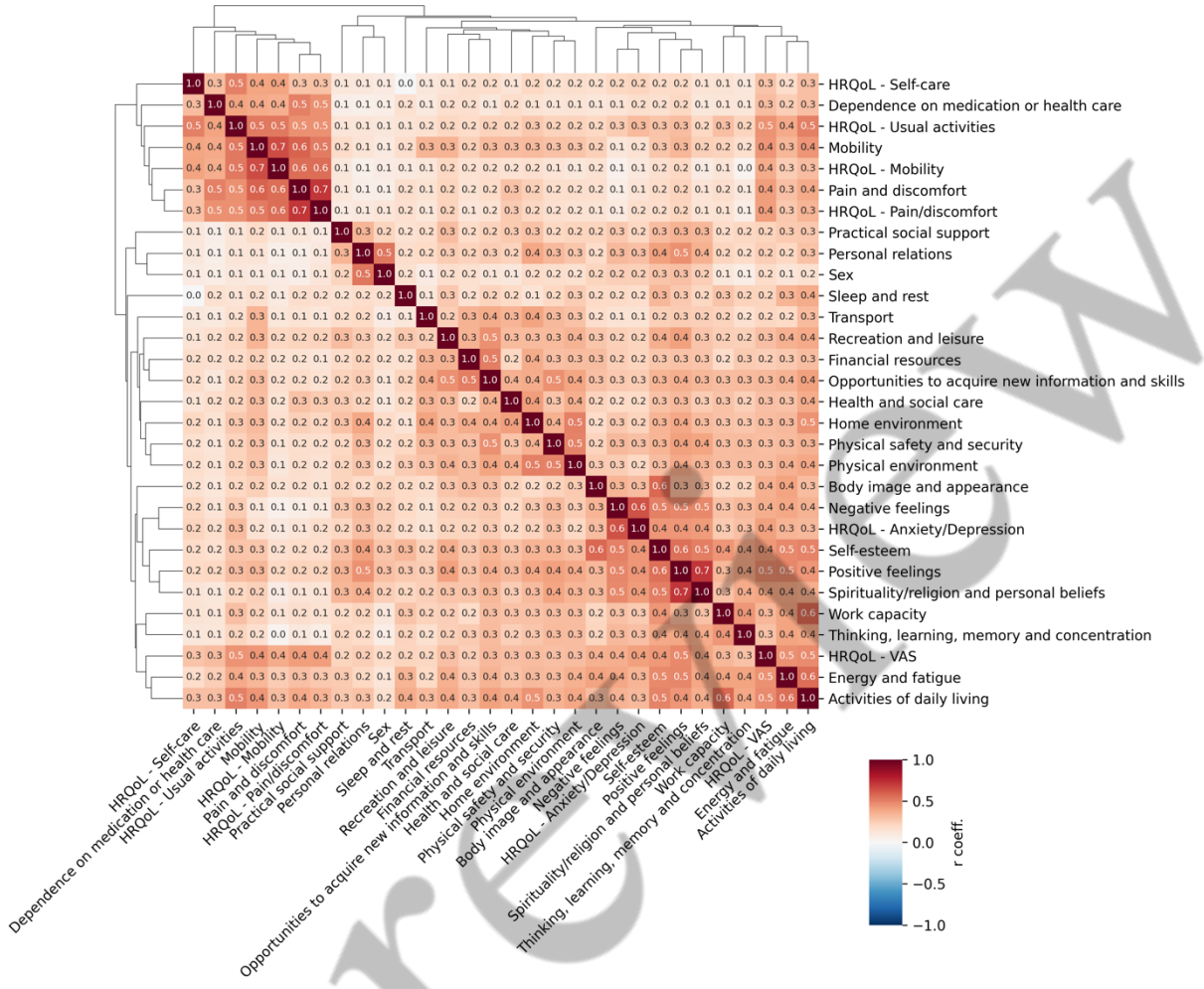
Supplementary Figure 3. Distribution of participants in the syd and wait-list groups for each of the category levels of anxiety (HADS-A) and depression (HADS-D) across all assessment timepoints.



Supplementary Figure 4. Hierarchal clustering of correlation coefficients of all measures.



Supplementary Figure 5. Hierarchal clustering of correlation coefficients of all EQ-5D-5L (HRQoL) domains and WHOQOL-BREF facet level scores.



Supplementary Figure 6. Mean facet-level score of the WHOQOL-BREF instrument for syd and wait-list groups across all assessment timepoints.