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A pilot study on the impacts of lung-strengthening Qigong on wellbeing

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ABSTRACT

Background: Qigong embraces a range of self-care exercises originating from China. Lung-Strengthening Qigong (LSQ) is a specific technique for maintaining and improving physical and mental wellbeing.
Methods: We recruited 170 practitioners and 42 non-practitioner/control samples to investigate the impacts of LSQ practice on body, mind, thoughts, and feelings. This is a pilot study pursued to plan for an adequately powered, non-clinical randomized controlled trials (RCT) on overall wellbeing and health and to evaluate the adequacy of delivering the physical activity intervention with fidelity. Self-evaluation-based data collection schemes were developed by regularly requesting completion of a questionnaire from both practitioner and control group, and an online diary and end of study survey (EOS) completion only from the practitioners. Diverse types of analyses were conducted, including statistical tests, machine learning, and qualitative thematic models.
Results: We evaluated all different data resources together and observed that (a)the impacts are diverse, including improvements in physical (e.g., elevated sleep quality, physical energy, reduced fatigue), mental (e.g., increased positivity, reduced stress), and relational (e.g., enhanced connections to self and nature) wellbeing, which were not observed in control group; (b)measured by the level-of-effectiveness, four distinct clusters were identified, from no-effect to a high-level of effect; (c)a majority (84 %) of the LSQ practitioners experienced an improvement in wellbeing; (d)qualitative and quantitative analyses of the diary entries, questionnaires, and EOS were all found to be consistent, (e)majority of the positively impacted practitioners had no or some little prior experience with LSQ.
Conclusions: Novel features of this study include (i)an increased sample size vis-à-vis other related studies; (ii) provision of weekly live-streamed LSQ sessions; (iii)integration of quantitative and qualitative type of analyses. The pilot study indicated that the proportion of practitioners who continued to engage in completing the regular-interval questionnaires over time was higher for practitioners compared to the control group. The engagement of practitioners may have been sustained by participation in the regular live LSQ sessions. To fully understand the impacts of LSQ on clinical/physiological outcomes, especially for specific patient groups, more objective biomarkers (e.g. respiratory rate, heart rate variation) could be tracked in future studies.

1. Introduction

Qigong embraces a family of self-care exercises originating in China several thousand years ago and are considered in much of Asian culture as a normal aspect of personal health maintenance. The term was coined in China in the mid-20th Century and consists of qi (气), frequently translated as 'energy' (Kohn, 1993) and gong (功) work. Qigong literally means, exercise for working with qi energy.

Abbreviations: DE, Diary entries; EOS, End of study survey; I2E, Initial timepoint versus endpoint; I2M, Initial timepoint versus midpoint; LSQ, Lung-Strengthening Qigong; ML, Machine Learning; M2E, Midpoint versus endpoint; NLP, Natural Language Processing; PFN, Pseudo False Negatives; PFP, Pseudo False Positive; PTN, Pseudo True Negatives; PTP, Pseudo True Positive; RIQ, Regular-Interval Questionnaire; TF-IDF, Term frequency - inverse document frequency; TCM, Traditional Chinese Medicine.

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Existing studies have shown that Qigong practice offers a wide range of benefits, including alleviating various health conditions, such as asthma, hypertension, and diabetes, preventing psychosomatic and respiratory infectious diseases [1,2], providing osteoporosis prevention [3] and significant therapeutic benefits for cancer patients, [4–9] and strengthening immune system. Qigong practitioners experience a significant increase in the number of white blood cells and lymphocytes [10,11] and an evident decrease in total cholesterol, blood pressure, [12,13] as well as improvements in depression scores. [14–16] Qigong, together with other healthy life conditions (e.g. healthy eating habits), can also reduce cardiovascular mortality ratio [17] and can complement the treatment of cognitive impairments, mood and mental health conditions [14,18]. However, existing studies suffer from a number of limitations, such as small sample sizes (less than 30) [10,11,13], substantial reliance on quantitative analysis (e.g. measuring bodily functions and symptoms, immune cell count, blood pressure, cardiac function), [11,12, 19–23] as well as lack of control samples for comparison. [24–26]

In recent decades a gradual move in China to incorporate Traditional Chinese Medicine (TCM) within a scientific framework has resulted in the development of Medical Qigong that focuses more closely on physiology and on prescribing a particular practice for specific health conditions. Lung-Strengthening Qigong (LSQ), which is the focus of our study, is one typical example.

The LSQ exercise employed in this study was designed by Jiangxi Univers of Chinese Medicine during the early months of the Covid-19 pandemic in 2020, and was prescribed for supporting lung resilience, constitutional robustness, and general wellbeing. The underlying principle of the exercise is to manipulate Qi energy and direct it to specific areas of the body using mostly slow arm movements. It is carried out in a standing position while maintaining sustained focus on the physical movements.

Despite extensive studies conducted to explore various benefits of common Qigong practice, a literature review indicates no prior investigations into LSQ, neither as an RCT nor as a pilot study. Therefore, in this study we investigated the impact of LSQ practice on (i) physical symptoms; (ii) mental wellbeing; (iii) connection to nature and others, and (iv) relational and life-energy awareness. We also investigated the feasibility of conducting a non-clinical RCT study investigating the impacts of LSQ on overall wellbeing. Quantitative and qualitative analyses were conducted on the data collected from 170 participants by survey, questionnaire, and diary entries. We also recruited 42 people as a control group for comparison. Our study fills the gaps in the literature by: (i) encompassing both quantitative analysis (based on a statistical and machine learning-based semantic analysis of surveys and diary entries) and qualitative analysis (based on thematic analyses completed in NVIVO software and manual classification of diary entries); (ii) recruiting a larger number of participants (170 practitioners) in contrast with the small sample size (typically around 30) commonly employed in existing studies; (iii) incorporating 42 control users; (iv) grounding our perspective in systems theory.

1.1. An integrative model of wellbeing

An integrative model of wellbeing was used in this study (as shown in Fig. 1). The model was previously used to evaluate wellbeing among staff and patients in public health services. [27,28] An integrated view of the processes in a human living system consists of the following components:

·Body - physiological processes and systems working together, e.g., immune system, nervous system, and endocrine system.

·Mind - mental activities and processes, e.g., thoughts, images, feelings, concepts, and narratives.

·Relational processes - processes of mutual coupling with the environment, e.g., interaction with other living beings, nature, artefacts.

·Awareness - processes of becoming aware of sensory, somatic, mental and relational experiences.

The human system acts and evolves with its environment. [29–32] Porges suggests that humans first orient themselves and then act. [33] This is interpreted in the model (Fig. 1) as valence, that is, a positive or negative disposition that arises from the complex interrelated processes of body, mind, and awareness within the environment of the individual. Thus, wellbeing may be defined as a state of body, mind, relational and awareness coherence. [28,34] This definition is consistent with the biological systems perspective of wellbeing as a coherent and energised state of functioning. [35] A coherent state is one in which each component of the system is differentiated and at the same time integrated in the whole. [35,36] An energised state is characterised by the capacity of the system to adapt, respond and evolve [35–37]. Multiple research studies provide evidence that the physical, mental, relational, and awareness processes are in reciprocal dynamic relationship, and impact wellbeing (Additional file 1). Therefore, in this study we measured the four pillars of the integrative model of wellbeing, i.e., body, mind, relational processes, and awareness, for the LSQ participants.

1.2. Design of data collection

Data collected from first-person accounts is essential for understanding the characteristics of experience. [38–40] Thus, in our study an online diary was developed to capture participants' immediate experience after each practice, structured by prompts mirroring features of the LSQ exercise (Additional file 2). At the end of the study (EOS), participants were asked to record their experiences and indicate perceived changes in physical, mental and relational wellbeing (Additional file 3). In addition to the diary and the EOS survey, a regular-interval self--assessment questionnaire was designed to capture behavioural aspects of change in participants' wellbeing (Additional file 4). The questionnaire was completed at the beginning, mid and endpoint of the study. The design of all data collection tools was informed by the integrative model of wellbeing. Thus, the Diary Entries (DE), the Regular-Interval Questionnaire (RIQ) and the End of Study Survey (EOS) were designed to capture changes relating to the physical, mental, awareness, and relational domains with reference to the research literature (Additional file 1).

The Regular-Interval Questionnaire included questions relating to the frequency with which participants experienced different states that undermined or supported their wellbeing (Additional file 4). Numerical scales [41] were used for all questions to capture the responses, excluding question RIQ4, where radio buttons were used for specific symptoms (Additional file 1). A scale of 1–100 (implemented in a slider) was used to capture a high granularity of detail in the responses (as suggested by [41,42]) for a group of questions (Additional file 1 and Additional file 5). To ensure that the participants engage mindfully and reflect on their response, a counterintuitive reversal of the positive scale questions (so that a lower score shows improvement) was deployed. [43] It is important to emphasise that the quantitative data was triangulated with the diary and the EOS text data to cross-reference the meaning participants attributed to the sliders. [41]

1.3. The research questions explored in this study are

(i) What is the impact of LSQ on physical, mental and relational wellbeing? (ii) What are the characteristics of the participants' experiences of the LSQ practice? (iii) How does the LSQ practice impact the participants' awareness of their mental, physical states, and relational states? (iv) How feasible is it to conceive a non-clinical large-scale RCT investigating impacts of LSQ practice on health outcomes. Our goal was to test particular ***hypotheses*** to answer these questions by performing quantitative and qualitative analyses using the data collected:

Hypothesis 1. : The LSQ practice enhances practitioners' physical, mental, and relational wellbeing compared to the control group (null hypothesis states that there is no difference between the practicing and

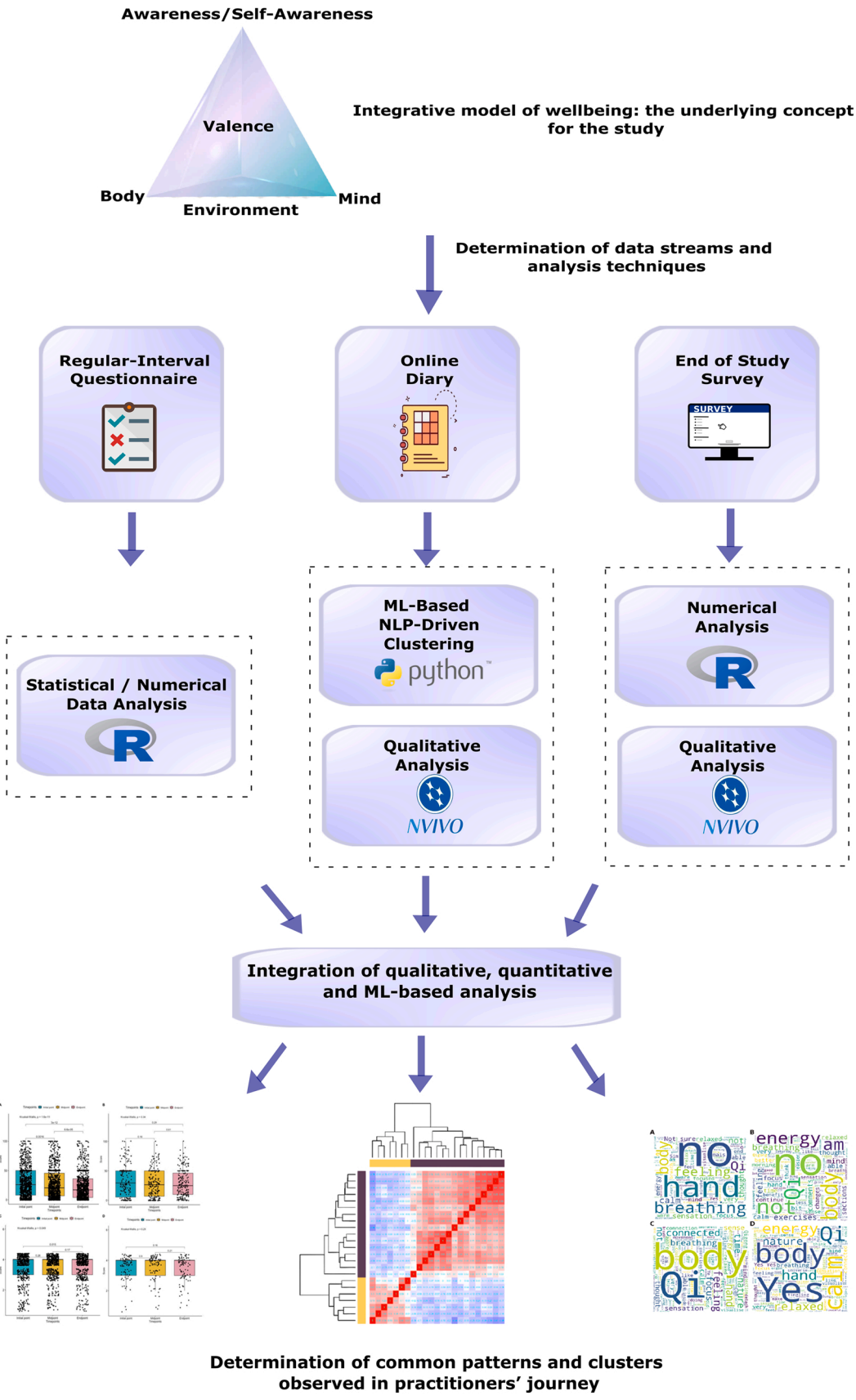

Fig. 1. Framework and underlying concept of the proposed study model.

control groups).

Hypothesis 2. : LSQ enhances the participants' awareness of their environment, body, mental activity, and perception of Qi compared to the control (null hypothesis states that there is no difference between the two groups).

Hypothesis 3. : All participants perceive the same level of effectiveness from LSQ, regardless of variations in prior experiences (e.g. non-experienced, beginner, advanced-level) (null hypothesis denotes there is no difference in benefits caused by prior experience).

Hypothesis 4. : We can recruit similarly sized practitioner and control samples and that we can ensure a high ratio of continuity for both groups (null hypothesis denote cohort size is similar for practitioners and control group and most of the samples in both groups remain in the study).

2. Material and methods

The pilot study was conceived by Northumbria University in collaboration with Confucius Institute at the University of Wales Trinity Saint David (UWTSD) and Jiangxi University of Traditional Chinese Medicine (JUTCM). Participants joined live Qigong sessions over Zoom, once a week on Saturdays between 13:00 and 14:00 GMT over an eight-week period starting on 20 February 2021 and ending on 17 April 2021. The participants were asked to complete an online diary, as well as a questionnaire at three different time points (induction week, midpoint, and endpoint). Questionnaire responses were analysed to understand whether there were significant differences in scores across different timepoints. The online diary allowed participants to enter free-text data which could be completed multiple times during any given week immediately after Qigong practice. Free text data in the diary was analysed using natural language processing (NLP) and clustering techniques. Diary text data was also evaluated with a thematic analysis tool known as NVivo. At the end of study, an overall evaluation survey was applied to practitioners.

In our prospective cohort study, a separate control group was recruited and asked to complete an identical questionnaire at the same three time-points during the study period.

2.1. Recruitment to the Qigong practice and control groups

A webpage describing the Qigong research project was created on the organiser's (Confucius Institute at the UWTSD) website. The webpage included a registration form where volunteer participants could register their interest by entering their names, email addresses and indicating their level of experience of Qigong practice. A similar webpage was created to recruit control group volunteers. In addition to email advertising sent to networks and mailing lists of people who had previously attended Chinese wellbeing workshops, a social media campaign was launched on Facebook and Twitter, directing interested individuals to the Qigong Research project webpage. The same process was followed to publicise the call for control group volunteers. An introductory online welcome event was hosted by the research team where potential volunteers listened to presentations on the project and were able to ask questions. Subsequently, the practice and control group volunteers were asked to confirm their participation through the web-based platform. The practitioner group was clearly told that they would be attending weekly live streamed sessions of a special form of Qigong training (LSQ) developed by JUTCM. Practitioners were asked to practice LSQ as instructed for a minimum of 20–30 min daily and avoid starting/engaging in any other new wellbeing activity during the study. Participants who did not meet these inclusion criteria and participants that did not provide the requested data (e.g. did not complete the diary entries) within the suggested time intervals (see also Results) were excluded from the study. The communications used to recruit participants (email, social media, website), explained that the control group would be offered the opportunity to attend future wellbeing courses organised by the UWTSD Confucius Institute free of charge and that the first 15 volunteers would receive Amazon Vouchers worth £ 10 on completion of the study. This was intended as a small, token incentive that would not affect the voluntary nature of participation as it was likely to be insufficient to entice participants to join the study. It was clearly explained to the control group that the study's organisers wished to compare the data collected from the practitioner group with that of the control group that would not follow the live streamed LSQ exercises. In the control group's consent form, participants were informed that having practised Qigong, Tai Chi/Taiji or some other related exercise for more than six months prior to the start of the study, would not affect their participation. However, they were asked to not start any "new" well-being activity during the 8 weeks of the study since that may affect the results.

The data collection process for this study was adhered to the human ethics guidelines and ethical approval for this research was granted by the Ethics Committee of the Faculty of Engineering and Environment at Northumbria University, Newcastle upon Tyne, with an approval reference # of 23709. Informed consent was obtained from the participants during registration for the study. Participants were shown the participant information details and were asked to agree to take part before any data was collected *(Additional files 6 and 7 – Participant Consent Forms #1 and 2 for practitioner and control samples, respectively*). We confirmed that any personal information that is collected during the course of the research is kept strictly confidential, held securely, and all data will be anonymised on completion of the study. Due care will be taken that individuals are not indirectly identifiable. Fully anonymised research data may be deposited in a research repository, with the requirements of the UK Data Protection legislation: https://www.gov.uk/data-protection. Distribution of demographics of participants based on age, gender, previous experience with Qigong, occupation/work status, ethnicity is shown in segmented bar graphs (see Fig. 2).

2.2. Preparation of the screening tools and regular-interval questionnaire

The Qigong Practice Research Project is a web-based platform that allows participants to follow the LSQ exercise and to maintain a practice diary noting their experiences. New users registered online (see Additional file 8 A) to create an account ensuring secure logon and access to the application. Upon registration participants were able to access information on the study in order to consent to participation and comply with ethical approval procedures. Demographic data and participants' questionnaire information was anonymised.

After first logging in the participants completed a general health and wellbeing questionnaire (see Additional file 4) to establish their personal baseline and later on to follow up their conditions regularly. Questions included, for example, general health, quality of sleep, stress (using a scale of 1–100) and whether participants had Covid-19 or long-Covid (yes / no responses). At the mid and endpoints of the trial the questionnaire was reactivated, and the participants asked to complete it again. Quantitative and qualitative data was collected to enable both statistical analysis and thematic and sentiment analysis of regular-interval questionnaires to measure changes in health and the potential impact of the LSQ practice over the course of the trial.

2.3. Practice videos and practice diary

Once logged in participants were able to access a sequence of four videos demonstrating the practice routine of the LSQ exercise (Additional file 8B and 8 C). These were recorded by an experienced TCM Qigong trainer who also delivered the weekly live-streamed sessions. Participants were asked to watch and practice the whole sequence at least once a week. The practice videos were hosted on YouTube and were embedded within the online platform (Additional file 8 C), for ease of navigation.

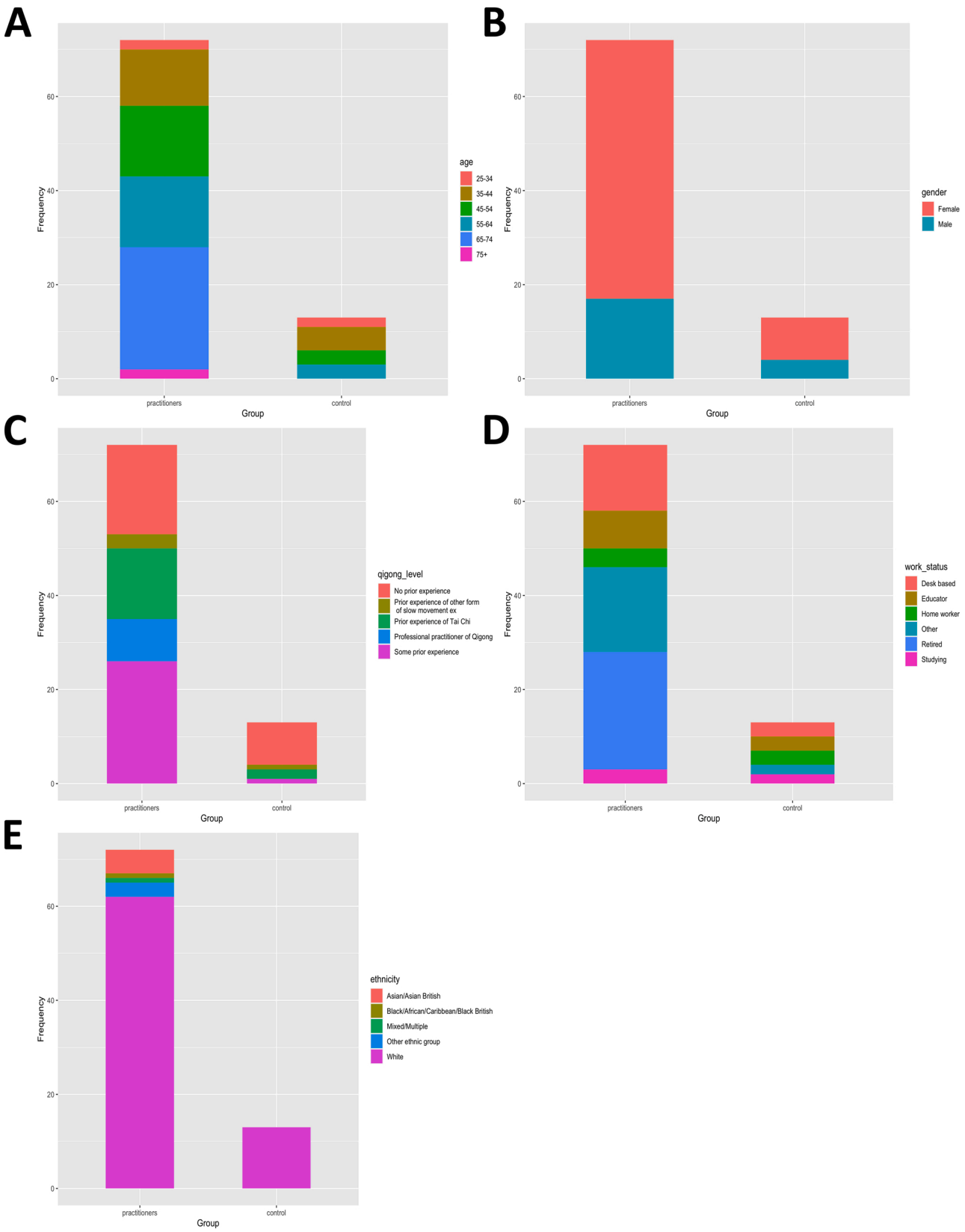

Fig. 2. Distribution of demographics based on (A) age, (B) gender, (C) previous experience with Qigong, (D) Occupation/work status, (E) Ethnicity.

Participants were asked to complete the practice diary (Additional file 2) after each session. The diary approach [38–40] was adopted to implement an autopoietic perspective by creating the conditions for paying attention to and accessing one's immediate personal experience through a disciplined act of cultivating the capacity 'of becoming aware' of the sources of this experience. [44] The design of the diary reflects the five dimensions of the integrative wellbeing model shown in Fig. 1 and allowed free articulation of experience. These included noting instances

of body awareness (including changes to breathing after the practice), focused attention, Qi energy awareness, relational awareness (sense of connection to self and others) and sense of satisfaction and meaning. The data was analysed using thematic and sentiment analysis methods, as well as machine learning (natural language processing-NLP) techniques.

The Qigong practice platform also incorporated a 'My Diary' feature (Additional file 8D) which allows participants to manage personal account details and to view previous entries and regular-interval questionnaire responses.

2.4. Quantitative analysis of the regular-interval questionnaire

There are three separate scoring schemes for the regular-interval questionnaire items. The first is based on a scale of 1–100 (the lower the score, the better the improvement). The second is scaled 1–4 (the higher the score, the better the improvement), and the last one is a binary scoring scheme (yes / no response). The questionnaire items and scoring scheme are summarized in Additional file 5.

We investigated changes in the questionnaire scores across the three timepoints (the beginning, mid and endpoints of the study). Our analyses were based on both an integrative approach in which we combined scores from all the questionnaire items, and an individual approach in which we analysed each questionnaire item separately. The former analysis gave us an overview of the overall tendency in the score changes, while the latter provided us a finer grained analysis, and specific details regarding the score changes for each separate question. In our integrative analysis, questionnaire items scored between 1 and 100 were combined together (Fig. 3A). Similarly, items scored between 1 and 4 were combined together (Fig. 3B) and were separately analysed across the three timepoints. In the individual analysis, we tracked the score changes in each questionnaire item separately (e.g., score changes in general health were plotted, individually - Fig. 4) across different time points.

We applied a non-parametric test – the Mann-Whitney-Wilcoxon (Wilcoxon rank sum) test – to compare the mean score of questionnaire items in each time point in a pairwise manner (i.e., initial

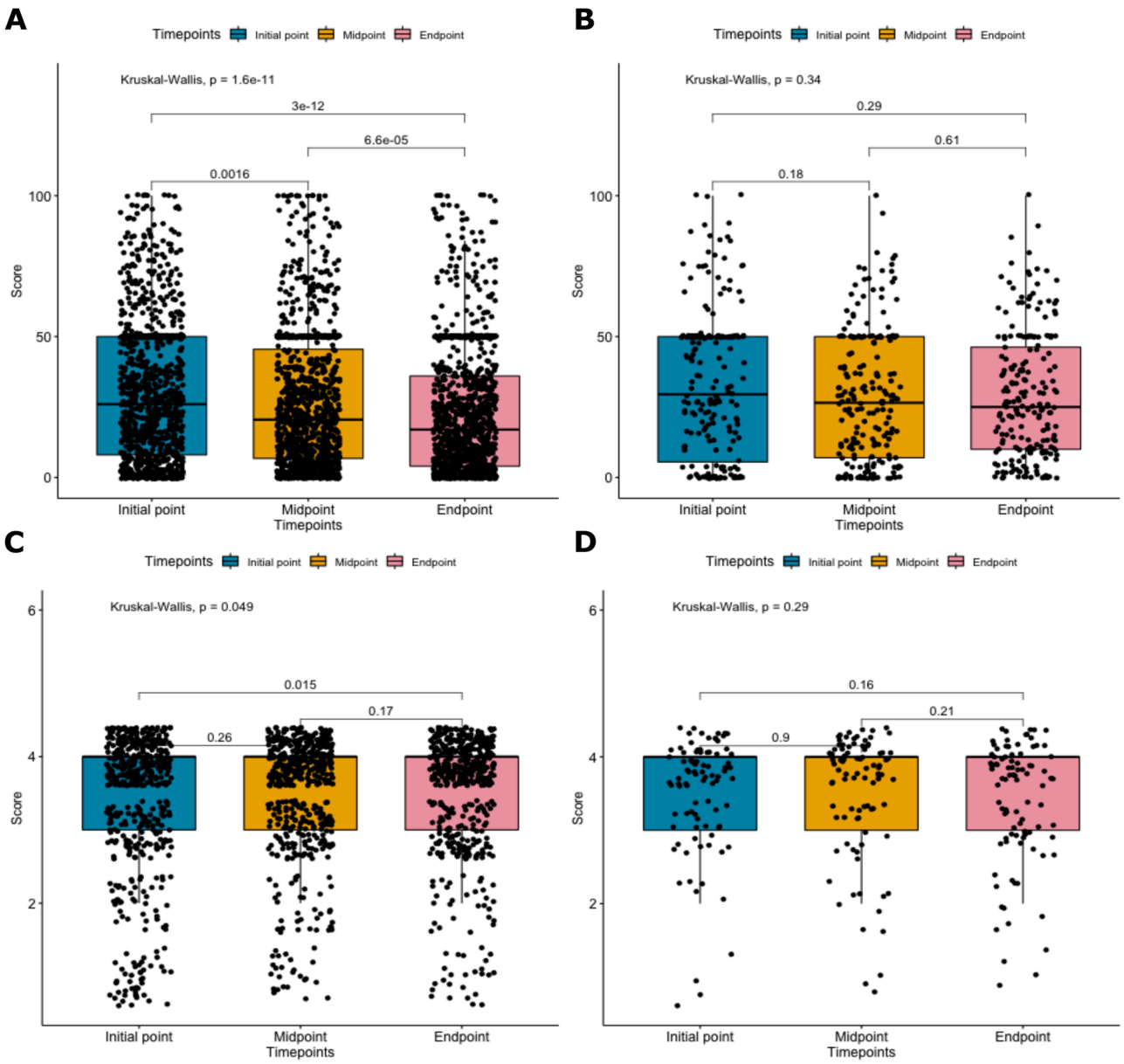

Fig. 3. - Statistical analysis of the RIQ for (A) items scored between 1 and 100 over 3 timepoints in practitioners group; (B) items scored between 1 and 100 in control group; (C) items scored 1–4 over 3 timepoints in practitioners group; (D) items scored 1–4 in control group.

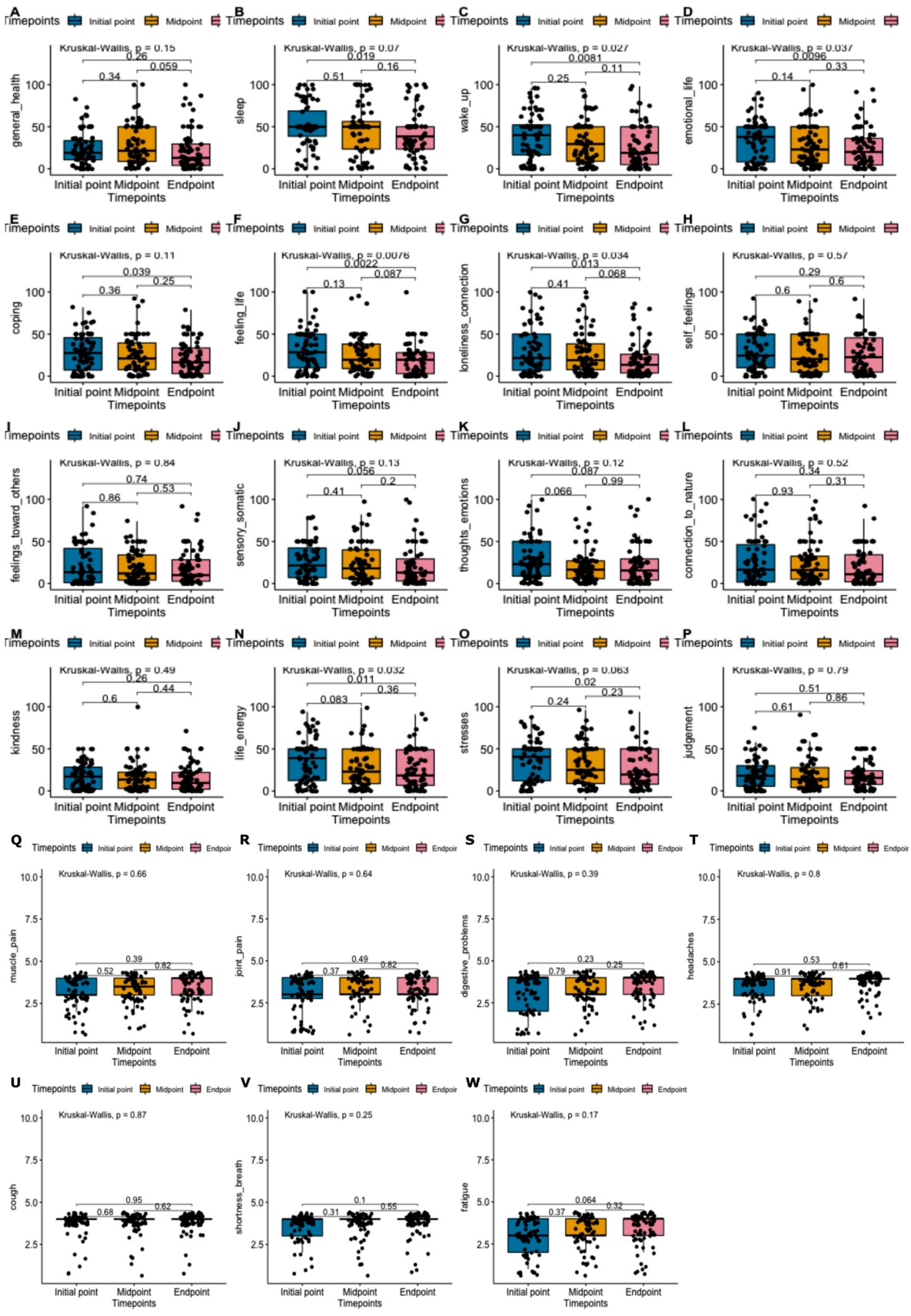

Fig. 4. (A)-(P) Individual analyses of the RIQ items scored between 1 and 100 on practitioner group; (Q)-(W) Individual analyses of the RIQ items scored between 1 and 4 on practitioner group.

timepoint versus midpoint [I2M] scores, midpoint versus endpoint [M2E], and initial versus endpoint [I2E]). Additionally, we applied another non-parametric test – Kruskal-Wallis – for multiple group comparison to check whether there was any significant change in scores among all three timepoints. Both the non-parametric pairwise (Wilcoxon rank sum) and multiple group comparison (Kruskal-Wallis) tests were applied to the integrated and individual analysis of the questionnaire items. In addition to these comparisons across three timepoints within the practice and control groups, a comparison between the practice and control samples within each timepoint was also conducted using the Wilcoxon rank sum test. All analyses were performed in R. Boxplots demonstrating the scores of the questionnaire items were created in R using the *ggboxplot* function available in the *ggplot* library. Correlation scores between the pairs of questionnaire items were calculated with the Spearman coefficients.

2.5. Semantic and thematic analyses of the diary entries

The qualitative data were evaluated using thematic analysis. The data were uploaded and organised in NVIVO12 Software. [45] The analysis focused on discerning experiences within the physical, mental, relational and awareness domains as observed by the participants. The text data were interpreted twice, once by a researcher who did not have experience of Qigong and a second time by a researcher with extensive experience of Qigong, then discussed and agreed within the team. The data entries were manually clustered into 4 categories already established by the sentiment analysis: - cluster 0: no change, cluster 1: low change, cluster 2: moderate change, cluster 3: high level of change, thus accounting for individual differences in receptiveness to the practice.

2.6. Machine-learning-based automatic pattern recognition for classifying the impact of Qigong

A natural language processing (NLP) approach and multiple Python libraries (including *numpy*, *pandas* and *matplotlib* [46]) were used to analyse the text data from the diary entries. The text was first pre-processed as follows: sentences were tokenized into words, all data was converted into lower case, words were lemmatized to find their roots, stopwords (non-informative but frequently repeated words such as *the, a, of, and*) were eliminated from the corpus by using the *clean_doc* function. Then the frequencies of the curated words were counted; term frequency (TF=[number of repetitions of a word in an entry] / [total number of words in an entry]) and inverse document frequency (IDF=Log[(total number of entries) / (number of entries containing this word)]) statistics of words were calculated and each word in each entry was represented by a TF*IDF score (a product of the TF and IDF statistics). Thereby, a numerical data matrix (TF-IDF) in which each entry (1265 in total) was used as an observation, and each informative word in the vocabulary was treated as an attribute (3403 dimensions in total) was created from the text data. Then a heuristic k-means clustering approach was applied to identify the optimal number of clusters contained in the TF-IDF score matrix, each cluster representing a specific level of benefit derived from the LSQ practice. The search range of the optimal cluster number (k value) was. [2,9] For each value of k, k-means clustering was implemented as follows: (i) randomly initialize the centroids of the k clusters, (ii) for each data instance (diary entry), calculate its Euclidean distances to all the cluster centroids and assign the instance to the corresponding cluster based on its proximity to the centroids, (iii) after all the samples are assigned to the closest group, update the position of the centroids for each cluster by calculating the mean of all data instances affiliated to that cluster, (iv) repeat steps (ii) and (iii) until the solution is converged, or the maximum number of iterations is reached. Convergence means that the cluster centroids become stable (which means the label assignments of all samples no longer change). The optimal k value was determined by using the *elbow* method from the *yellowbrick* library by calculating and plotting the *'distortion score'* curve (the sum of square value of Euclidean distance between each point and the centre of its assigned cluster) against the changing values of k to point out the knee point of this curve (Additional file 9 A). The knee point on the curve corresponds to the optimal k which minimizes the within cluster variations.

$$J = \sum_{i}^{n} \sum_{O_j \in C_i} (O_j - Z_i)^2$$

where i and Z_i represent the ith cluster and its centroid (e.g. see Table 1). Besides, O_j and n represent the data samples belonging to the ith cluster and the total number of clusters, respectively.

After the identification of the optimal value of k, we searched for the proper text-based tags for each numerical cluster label. The top 100 most frequent words of each cluster were listed (Additional file 9B) and were compared to the word sets derived from the NVivo tool classifications. The most similar NVivo-driven word sets, and k-means-driven word sets were hypothesized to represent the same pattern, indicating that the NVivo-driven text label could be used for tagging the numerical label of the corresponding k-means group. Additionally, sentiment analysis was used to identify the cluster labels. Firstly, the top 100 words for each cluster were collected and cleaned by removing duplication. Then, the python library *textblob* was applied to these four groups of words. Finally, the sentiment scores within the range of [−1 1] were calculated for the purpose of evaluating the level of benefit represented by each cluster, i.e., the higher the sentiment score, the higher the positive impact from the LSQ practice.

2.7. End of study (EOS) survey evaluations and comparison between EOS and other data resources

The end of study (EOS) survey allowed the participants to reflect their overall satisfaction level, share their insights, and to score their experiences of (i) body, (ii) Qi, (iii) focused awareness, (iv) connection to others and nature, (v) satisfaction, and (vi) positive wellbeing. The closed questions (i)-(vi) in the EOS survey scored between 1 and 100. The positivity of the experience and satisfaction level increases as the score rises. The maximum total scores from the evaluation of the closed questions can be as high as 600.

EOS survey results were compared to those of the regular-interval questionnaires as well as the diary entries. We hypothesized that, if a participant was satisfied with the study, then they would award a score of at least 65 % for each question in EOS, resulting in a score of 390 for all 6 questions, rounded up to 400. If the majority of the diary entries from a participant belonged to clusters 3 and 4 (moderate and high level of change) and were followed by an EOS score of more than 400, then that participant was considered to have a highly consistent positive experience throughout the entire journey of LSQ practice. We labeled such users as *Pseudo True Positive* (PTP) samples. If a participant's entries fell in clusters 1 or 2 (no or low-level change) but the EOS score was above the (default) value of 50 % per question (>300 in total), we considered them as *Pseudo False Negatives* (PFN) since the EOS directly reflects the satisfaction level (clearly and manually determined by the participants), whereas the cluster labels from the diary entries are data-driven and predicted automatically. If the diary entries reflected a low level of satisfaction (clusters 1 or 2), the EOS was also expected to be low (at least lower than average); if the EOS was higher than average, then it was supposed to be a misclassified (PFN) sample. Hence, while defining the PFN, we used a stringent threshold (>300), rather than a smaller value to identify the misclassified samples. This meant we penalized ourselves with a high level of *PFN* in order to achieve a more robust model. If both the diary-based clustering and EOS results consistently indicated no change, or a low-level of satisfaction or change (clusters 1 or 2 and EOS<200), then this group of practitioners were classified as the *Pseudo True Negatives* (PTN). Lastly, if the participant experienced a relatively high level of change (clusters 3 or 4), while giving low scores

Table 1
The centroid point and number of diary entries assigned to each cluster.

Cluster label	Body awareness	Focused attention	Qi energy awareness	Relational awareness	Satisfaction meaning	Sentiment score (positivity)	# of entries in this cluster
1 - No change	0.167	0.175	0.034	0.185	0.447	0.153	296
2 - Low-level of change	0.172	0.207	0.448	0.250	0.263	0.186	87
3 - Medium-level of change	0.205	0.296	0.045	0.101	0.00076811	0.205	773
4 - High-level of change	0.0373	-0.031	0.030	0.039	0.017	0.229	199
Total number of entries							**1355**

for the EOS survey (<200) they were labelled as a Pseudo *False Positive* (PFP, as shown in Table 2).

3. Results

In total, 170 Qigong practice volunteers and 42 control volunteers were recruited. In the practice group, 83 participants regularly logged entries in the online diary, 72 also completed the regular-interval questionnaires (RIQ) at three time points as required by the study, and 59 also completed the end of study (EOS) survey. Hence, 59 LSQ practitioners have three types of data (diary, RIQ, EOS). Among 42 control samples 13 users completed the questionnaire (the number and scoring scheme of the items in the RIQ are detailed in Additional file 5). As the control group did not participate in the LSQ exercise they did not have access to the online diary. Both the LSQ practitioner and control users who did not complete the RIQ three times and additionally practitioners who did not fill in the online diary were considered to have discontinued their participation and were excluded from the study. Three types of analysis (quantitative, semantic, and qualitative) were conducted on the collected diary and RIQ data to evaluate the dynamic responses of participants throughout their LSQ practice journey. The results indicate that the practice has a statistically significant positive impact on the wellbeing of participants. Using Machine Learning (ML) algorithms the efficacy of LSQ practice was automatically categorised into four clusters: 1) no change, 2) low change, 3) moderate change, 4) high level of change, thus accounting for individual differences in receptiveness to the practice.

Table 2
Confusion matrix of the integrative evaluation of diary, regular-interval questionnaires, and EOS survey.

	Participants whose EOS survey scores> =400	Participants whose EOS survey scores< =200	Total number of the participants
Participants whose diary entries were clustered in {3,4} [reflecting a high-level positive change] and have an improvement in regular-interval questionnaires	**Pseudo True Positive (PTP):** 28/44 = 64 %	**Pseudo False Positive (PFP):** 6/44 = 14 %	59; but, **44 among 59** (75 %) were classified as in {**PTP, PTN, PFP, PFN**}. Labels of the rest (15 users) were omitted (**NA** value)
Participants whose diary entries were clustered in {1,2} [reflecting no or a low-level change] and have stability [no improvement] in regular-interval questionnaires	**[EOS scores> = 300] Pseudo False Negative (PFN):** 5/44 = 11 %	**Pseudo True Negative (PTN):** 5/44 = 11 %	

3.1. Distribution of demographic features of participants

Among the 72 participants in the practice cohort, those aged 65–74 completed the regular-interval questionnaire more often than participants in the other age groups over the whole 8-week period (Fig. 2A). Completion by the age groups 35–44, 45–54, and 55–64 was almost the same. Three-quarters of the participants were women (Fig. 2B). More than one-third of participants declared they had some prior experience of Qigong, and more than one-quarter had no prior experience (Fig. 2C). In the control group, the age group 35–44 was found to have largest sample size among the participants (more than one-third, Fig. 2A). A majority of the participants were women (more than one-third, Fig. 2B) and had no prior experience of Qigong practice (more than one-third, Fig. 2). Other demographic details, including work status and ethnic heritage of the participants are provided in Fig. 2D and E, respectively. A majority of the practitioners were either retired (38 %) or had another occupation (30 %), whereas in the control group occupations were almost uniformly distributed. Lastly, the majority of the participants were from a white ethnic background (85 % and 100 % for the practitioner and control groups respectively).

3.2. Comparison of participant and control group regular-interval questionnaires (RIQ) highlights benefits of Qigong practice

Both the practitioner and control groups were asked to complete the regular-interval questionnaire at the beginning as a baseline, and then in midpoint and end of the study to follow-up. The questions and associated scoring schemes are summarised in Additional file 5. The scores for questions, scaled between 1 and 100, were analysed both individually and pooled together across three timepoints. Similarly, score changes in items scaled between 1 and 4 were tracked together as well as individually.

We observed a statistically significant improvement over time in the scores of the LSQ practitioners for questionnaire items scaled 1–100 (from initial point to the midpoint [I2M] of the study $P = 0.0016$, from midpoint to endpoint [M2E] $P = 6.6E\text{-}5$, and from initial to endpoint [I2E] $P = 3E\text{-}12$, Fig. 3A). Whereas in the control group, with no LSQ intervention, there is no statistically significant change in the scores across the three timepoints of our study (from I2M $P = 0.18$, from M2E $P = 0.61$, from I2E $P = 0.29$, Fig. 3B). As detailed in Methods, a decrease in the questionnaire scores reflects an improvement. For the items scaled 1–4, there is no significant change in scores over time in either the practice or control groups, except for a significant improvement in the practitioner group from the I2E of the study ($P = 0.015$, Fig. 3 C, 3D). These items are related to health conditions such as *muscle pain, headache, and coughing (*Additional file 5). An increase in scores means a *less severe* health condition.

In individual analyses of the questionnaire items, scaled 1–100, we observed a significant improvement over time in the practice group for most of the items (Fig. 4), including sleep (from I2E $P = 0.019$), waking up calmly (I2E $P = 0.0081$), emotional life (I2E $P = 0.0096$), coping with life (I2E $P = 0.039$), positive feeling towards life (I2E $P = 0.0022$), connection to others (I2E $P = 0.013$), life energy (I2E $P = 0.011$), and

levels of stress (I2E $P = 0.019$). Despite the lack of a statistically significant outcome ($P > 0.05$) for the remaining items, there is a clear trend of improvement in the scores (especially from I2E) as highlighted in Fig. 4A-P. In the individual analysis of the questions scaled 1–4, there is no statistically significant change in the practice group, yet there is an obvious trend of improvement observed in almost all items, especially in muscle and joint pain, digestive problems, headaches, and fatigue (Fig. 4Q-W).

The same analysis was performed for the control group. We observed no significant improvement or any particular trend for either the questionnaire items scaled 1–100 or those scored 1–4 (Additional file 10A-W). Hence, a significant improvement was observed in multiple aspects for the practitioner group, whereas no significant improvement (neither trends nor indicators) in the scores for the control group was found.

We also aimed to investigate the impacts of LSQ on health outcomes related to long-covid and added a relevant question in the RIQ (Additional files 4 and 5). However, only two practitioners declared that they have long-covid which did not allow us to conduct an evaluation on this factor with a proper statistical power.

3.3. RIQs reveal that specific demographic groups derive greater benefit from Qigong practice

We analysed the questionnaire score changes of the practice group in detail, based on the different demographic subgroups such as age, previous experience of Qigong, and gender. A majority of the age groups (35–44, 45–54, 55–64, and 65–74) in the practice cohort demonstrated a notable trend towards improvement in their scores over time (Additional file 11A-B), whereas the control group did not show any such improvement in any age group (Additional file 11 C-D). Score improvement was found in both male and (especially) female practice volunteers whereas no significant changes or trends were observed for the control group (Additional file 11E-H). Subgroups of the practice group with no prior experience of Qigong, some prior experience, and prior experience of Tai Chi demonstrated the most significant and distinct improvements, whereas no significant change or trends were observed in the control group for any experience level (Additional file 11I-L). The improvements observed in the practice group as a whole (see Fig. 4) were consistent in the majority of the subcategories in age groups, in both genders, and in three of the prior experience levels (no experience, some prior Qigong, and Tai Chi experience). In contrast, control samples (both as a whole, and at the sub-category level), did not demonstrate any significant changes in their scores.

3.4. Significant concordance exists between the RIQ items

We analysed the correlation between the questionnaire items in a pairwise manner to understand which items show similar change over time when paired, and to assess the impact of LSQ from multiple dimensions at a single glance. We observed that five items, *coping with life, emotional life, stress, positive feeling towards life*, and *positive feelings towards self,* demonstrated strong positive correlations with one another (*Spearman* correlation scores between 0.60 and 0.72, Additional file 12). Since the questionnaire scores for the majority of these items significantly improved and changed jointly in the same (positive or negative) direction throughout the journey of the LSQ study, we can infer that they are highly associated and improve jointly over time for the practice group. *Kindness, awareness of thoughts-emotions, judgement, sensory-somatic awareness, life energy*, and *connection to nature*, are also positively correlated (Spearman coefficients between 0.40 and 0.64). The first set of items that were observed as changing together relate to *self-awareness* and *emotions concerning coping with life*, whereas the second cluster of items concerns feelings towards others or to the environment (such as nature). Lastly, we observed a moderate to high correlation (scores within [0.25–0.50]) between the items: *headaches, digestive problems, joint pain, muscle pain*, and *fatigue* (scores within [0.4–0.5]). This indicates that particular health conditions of the practitioners (such as *headaches, joint* or *muscle pain*, and *fatigue*) are highly associated. *Fatigue* was also found to be highly correlated with the items *cough* and *shortness in breath* (correlation scores 0.41 and 0.47 respectively, Additional file 12).

3.5. NLP analysis of diary entries reveals four different clusters of Qigong experience

Participants were asked to complete regular diary entries. Diary fields for each dimension (attribute) of the Integrative Wellbeing model were provided (see Introduction): (a) body awareness, (b) focused attention, (c) Qi energy awareness, (d) relational awareness, (e) satisfaction/meaning. On average, each participant completed the diary twice a week and 15.24 times across the 8-week period of the practice. We checked whether particular patterns or levels of benefit from LSQ experience occurred among participants based on their self-reporting. Text data derived from the diary entries was converted into Term Frequency-Inverse Document Frequency (TF-IDF) statistics (see Methods). Then, *k*-means clustering (see Methods) was employed to uncover the underlying patterns embedded in the TF-IDF scores. The elbow method was applied to identify the optimal number of clusters, which was found to be 4 (see Methods, Additional file 9 A).

Hence, four different types of patterns are found in the diary entries, representing four distinct levels of benefit from LSQ practice, i.e., 1) no change, 2) low change, 3) moderate change, 4) high level of change. Each cluster is driven by a particular set of sentiments and reflects a unique type of LSQ journey. Word clouds for clusters 1,2,3,4 can be found in Fig. 5A-D respectively. Additionally, the top 100 words by frequency of occurrence in each cluster are listed in Additional file 9B. Values of the central points of each cluster across the five diary dimensions, as well as the number of the entries in each cluster are summarized in Table 1. Centroid of cluster 1 = {0.167, 0.175, 0.0338, 0.185, 0.446}, cluster 2 = {0.172, 0.207, 0.448, 0.250, 0.263}, cluster 3 = {0.205, 0.296, 0.0455, 0.101, 0.00}, and cluster 4 = {0.037, − 0.031, 0.030, 0.039, 0.017} for the attributes (a)-(e) listed above, respectively; and there were 206, 87, 773, 199 entries that were assigned to clusters 1, 2, 3, and 4 respectively. Weekly changes to the number of samples that are assigned to each cluster are given in Additional file 13 A. The top 100 most frequent words of each cluster were used to run a sentiment analysis to identify the positivity of the clusters (see Methods). In cluster 1, terms such as *tension, tiredness, no change, and difficulty,* occurred frequently and, on the basis of sentiment analysis were predicted as relating to a pattern of *no change*. In cluster 2, words such as *calm*, *improvement* and *concentration* were highly represented, whereas cluster 3 included the terms *satisfaction, energy, focused, and feel,* and cluster 4 extensively contained words such as *connected*, *warm*, and *better*. Clusters 1, 2, 3, and 4 were predicted as corresponding to (i) *no*, (ii) *low*, (iii) *moderate*, and (iv) *high*-level *of perceived change (and benefit gained)* respectively.

In addition to the natural language processing (NLP)-based analysis of the topmost frequently utilized words, a manual examination of the entries also confirmed that these four clusters exist and range from none to a high level of perceived change. Examples of the diary entries can be found in Additional file 13B. Based on narratives and frequently used vocabulary, users from the low-level change group (cluster-2) improved only in physical aspects; whereas the cluster for moderate-level (cluster-3) change reflects improvement in both physical and mental spheres. In contrast, the high-level perceived change group(cluster-4) demonstrates more intensely experienced benefits resulting from the exercise.

Lastly, among the 83 participants who regularly completed the diary, the entries of 70 practitioners were predicted as occurring in the moderate or high-level of change clusters. Hence, a majority of the participants (70/83 ~84 %) benefitted highly from the study (Additional file 14).

Fig. 5. Wordcloud produced from the top 100 frequent words of cluster (A)1, (B)2, (C)3, (D)4.

3.6. Qualitative data analysis of diary entries is consistent with the findings from NLP analysis

The participants' entries were read and coded into subthemes. The subthemes identified specific aspects of individual experience (Additional file 15A-F). 933 of the diary entries data were coded, according to specific types of experience within the five themes (Additional file 15A):

- Body awareness - experiences were related to breathing, relaxation, discomfort, specific body sensations, emotions, and balance (Additional file 15B). Reported qualities of breathing include the words: deep, slow, calm, easier breathing (Additional file 15C). Most specific body sensations were described as feeling warmth, feeling grounded and sensations of 'pins and needles' (Additional file 15D). Participants from clusters 3 and 4 consistently reported feeling relaxed (16.69 % coverage of bodily awareness - there were 116 entries, Additional file 15B). Predominant emotions in clusters 3 and 4 were peace, love, and joy. Some participants reported an improved balance (1.7 % coverage of bodily awareness - 12 entries, Additional file 15B). A small number of entries (81 entries, 11.65 % coverage of bodily awareness) described sensations of discomfort related mainly to pain and tiredness (Additional file 15E).
- Focused attention - the predominant reported experiences were steady focus, feeling calm, clarity and ability to visualise. A smaller number of entries described difficulty focusing (74 references, 14.34 % coverage of focus awareness) and a fluctuating focus (38 references, 7.36 % coverage of focused awareness) (Additional file 15F).
- Qi awareness - most participants (89 references, 22 % coverage of Qi awareness) perceived Qi as energy (Additional file 15H). The feeling of Qi was described as the sensation of tingling and pulsing, feeling, or touching energy, and effortless action (Additional file 15 H).
- Relational awareness – the majority of entries (281 entries, 63.13 % coverage of the satisfaction and meaning awareness) reported feelings of connection to body, self, nature while some entries reported connection to others, with a small number of entries reporting no connection at all (89 entries, 23.6 % coverage of the relational awareness (Additional file 15I). The experience of connection was described as connection to self, nature, and others, with a number of entries (55 entries, 12.35 % of relational awareness) reporting a sense of unity, being larger than the self, unity of self and universe (Additional file 15I)
- Satisfaction and meaning - The theme of satisfaction and meaning was articulated as an increased sense of satisfaction and wellbeing, self-care, self-empowerment, sense of meaning, gratitude and compassion, improved coping with life. A large number of entries (115 entries and 39.65 % coverage of satisfaction and meaning) reported learning, new understanding and increased curiosity (Additional file 15 J). A small number of entries (23 entries and 7.93 % coverage) reported no change (Additional file 15 J).

3.7. Qualitative data analysis of End of study (EOS) survey text entries

The End of Study questionnaire included the opportunity for participants to list benefits they experienced linked to their practice of LSQ. These include *better physical wellbeing*: improved breathing, less tension, relaxed body, stronger and a more energised core, better balance; *improved mental wellbeing*: feeling calmer, more positive, feeling grounded, experience of peace; more focus; *better relational wellbeing*: better body awareness and connection to self; connection to nature, feeling of being part of a whole bigger than self; *sense of satisfaction and meaning*: sense of achievement, new knowledge, sense of gratitude, improved understanding, and *awareness of qi*; *better overall wellbeing*: improved

quality of life, self-care and health awareness (Additional file 16, "List of benefits generated by Nvivo"). Participants were generally surprised with the benefits they experienced as their prior expectations were mainly restricted to developing new knowledge, having a pleasant experience and willingness to help (Additional file 16).

3.8. End of study (EOS) survey supports the findings from the regular-interval questionnaires and the diary entries

We compared our findings from three different self-evaluation sources consisting of (i) regular-interval questionnaires from all three time points, (ii) text data from the diary, and the (iii) end of study (EOS) survey. The EOS survey was completed by 63 practice group participants. Of these, 59 had sufficient data from all sources: (i) completion of the questionnaires at all three time points, (ii) at least three diary entries, (iii) EOS survey. Some of these participants (15 among 59) did not fall into any of the categories of *Pseudo True Positive* (*PTP*), *Pseudo True Negative* (*PTN*), *Pseudo False Positive* (*PFP*), and *Pseudo False Negative* (*PFN*) as explained in the Methods, but most of them (44 among 59, i.e., 75 %) fitted these categories and were classified according to the {*PTP, PTN, PFP, PFN*} labels (Table 2). The majority (28 among 44, Table 2) were found to reflect a highly positive experience according to their diary entries (entries were in clusters {3,4}) and EOS survey results (a score $>$ 400). Additionally, a significant improvement across time was observed for most of the items queried in the regular-interval questionnaire (RIQ). Hence, we observed consistent improvements and positive feedback from 64 % (28/44) of the practitioners. For example, changes of the RIQ scores of four randomly selected participants among the *PTP* samples (see Methods, Table 2) are demonstrated in Fig. 6A-D, for users with the IDs 56, 100, 102, 157, respectively. Only five practitioners among the 28 highly satisfied participants had previously practiced Qigong to a professional level; the remainder either had no

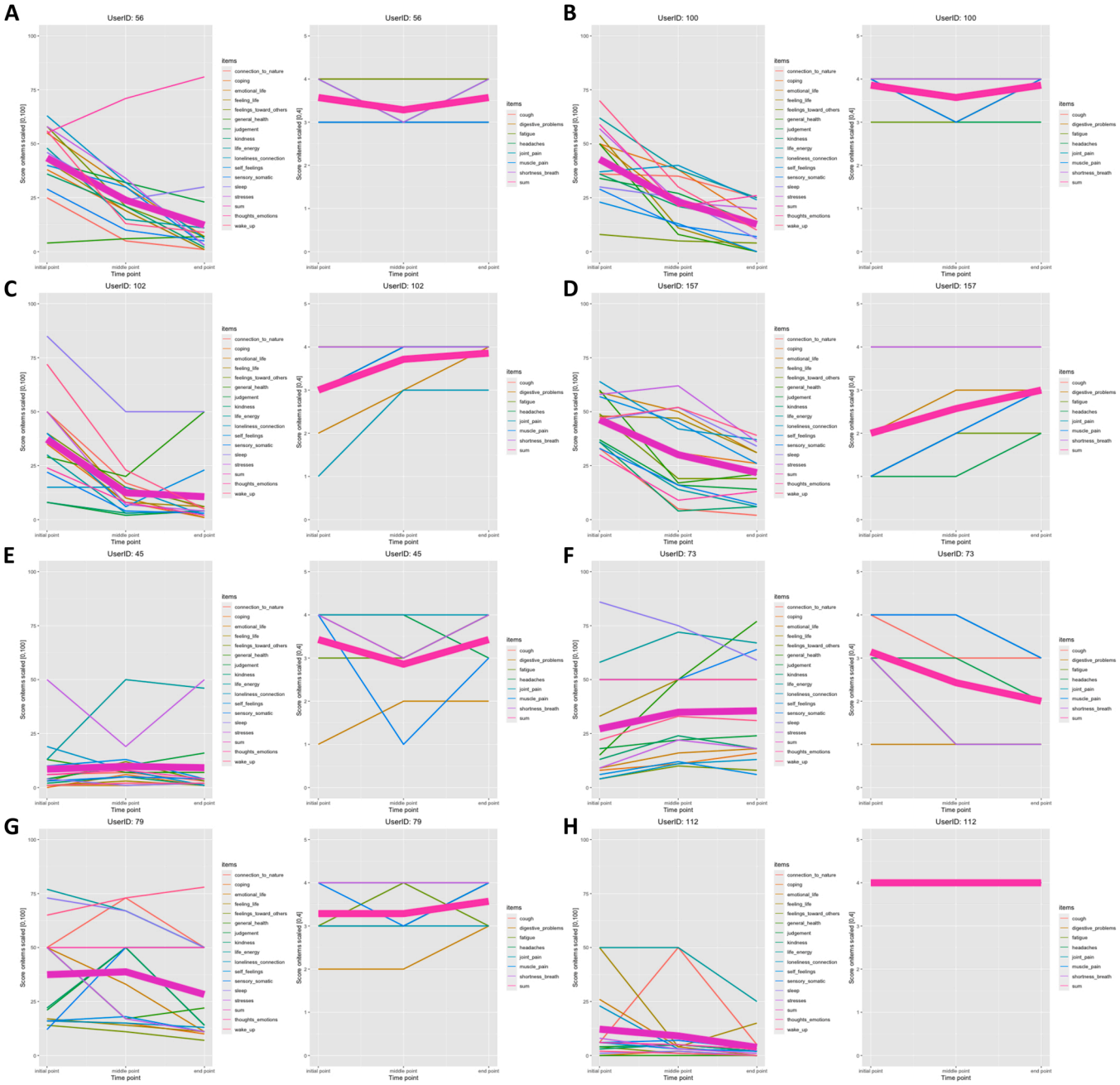

Fig. 6. - Score changes of the regular-interval questionnaire items over time for the participant IDs (A) 56, (B) 100, (C) 102, (D) 157, (E) 45, (F) 73, (G) 79, (H)112.

experience or some prior experience. Only five participants among 44 (11 %) declared low EOS survey scores (< 200) and their entries were consistently clustered in clusters 1 and 2 (no change or low-level change). Furthermore, their RIQ scores were not found to have changed or improved over time. As an example, changes of the RIQ scores of four of the *PTN* samples are demonstrated in Fig. 6E-H, for user IDs 45, 73, 79,112, respectively. Inconsistency between the diary, EOS survey, and questionnaires was observed for a small set of samples. Among 44, only five practitioners (11 %) gave a high EOS survey score while their diary entries reflected no (or low-level) change, which were labeled as *PFN*; whereas six samples (14 %) gave a low EOS survey score while their entries were clustered as reflecting a high level of benefit/changes (*PFPs*). As a result, a majority of the 44 practitioners that could be labeled as one of the classes {*PTP, PTN, PFP, PFN*}, were found to be in the *PTP* class (28/44 =64 %), whose diary entries, regular-interval questionnaires, and EOS survey highlight a consistent and positive improvement and awareness altogether.

4. Discussion

The study rejected all of the null hypotheses stated in H1 (hence, there is self-report-based evidence for improvement in physical, mental, and relational wellbeing of practitioners compared to the control); H2 (thus there is evidence the LSQ program enhances the practitioners' awareness of their environment, body and mental state, and Qi compared to the control); H3 (hence, there is a difference between the non-experienced/beginner and advanced-level practitioners in terms of the benefits highlighted in H1 and H2), and partly H4 (thus, we observed a cohort size difference between the practitioners and control samples [still we could recruit a large number of practitioners compared to previous relevant studies] and only half of practitioners and one-third of the control samples remain until the end of study). We were expecting the rejection of the null hypotheses in H1 and H2 (this was confirmed by the results), meanwhile anticipating a failure of rejection of the null hypotheses in H3 and H4. Still, overall, the rejection of the first three null hypotheses indicates that LSQ is evidently capable of elevating people's wellbeing and their awareness of it. Moreover, the less prior experience with Qigong, the greater the benefits that people are likely to obtain from LSQ. All three sets of data (RIQ, DE, EOS survey), were triangulated to explore these hypotheses. Rejection of the last hypothesis (H4) suggests that the control and practitioner groups can be recruited together and then randomized and split into two equal-sized cohorts in further studies, rather than recruiting the two groups with independent invitations/adverts as performed in the pilot study. Hence, the two groups sizes can be ensured to be compatible. Further precautions should be also taken to avoid discontinuity of the participants during the study (details in Conclusion). We believe that the engagement of practitioners was better than that of the control group because of the regular Saturday live streamed LSQ sessions that practitioners attended.

The RIQ data analysis showed *enhanced physical wellbeing*, i.e., significant improvement in general health, energy, balance, and better undisturbed sleep. In addition, it indicated reduction in joint pain, headaches, fatigue and digestive problems. The EOS data mirrors this with reports of improved breathing and feeling relaxed, stronger, and more energised (Additional file 16). Diary entries of all participants in clusters 3 and 4 show improved physical wellbeing. Only six out of 59 participants reported no or minimal improvement. Our findings of physical improvement as a consequence of LSQ are consistent with the literature. A meta-analysis by [47] showed that Qigong exercise resulted in significantly improved physical ability compared with a control group. Qigong was found to enhance physical strength through the training of specific muscle groups, [48] improve respiratory muscle strength, [19] support immune system, [49] and to reduce inflammation. [50]

Data from the RIQ and the DE also suggests an improvement *in the mental wellbeing* of the participants. The analysis indicates significant reductions in stress, increased positivity, an enhanced ability to cope and improvement in emotional life. Consistently, the same benefits were reported in mental wellbeing: feeling calmer, positive, grounded, and peaceful (Additional file 16). All participants in clusters 3 and 4 reported improved mental wellbeing. This is consistent with the findings from [51] stating that stress reduction and the regulation of emotion are characteristic benefits of Qigong.

The RIQ results show a significant reduction in loneliness and a greater connection to self and others. While the EOS survey shows benefits in relational wellbeing: improved connection to self and nature, being part of a bigger whole (Additional file 16). All participants in clusters 3 and 4 consistently reported improved relational wellbeing. Our findings are similar to those of [52, 53] which emphasized individuals' strengthened sense of control, improved sense of social support and connection to others. *Valence* (kindness versus judgement and acceptance versus resentment) significantly changed over the course of the trial towards a kinder and more accepting attitude to self and others. The research literature supports a correlation between kindness, acceptance and positivity and wellbeing. Neff et al. and Gilbert suggest a link between kindness and compassion to self and others as a mediator for emotional wellbeing and happiness. [54–57]

Furthermore, the EOS survey also demonstrates an *improved sense of satisfaction and meaning*, achievement, development of new knowledge, gratitude, and understanding. A better quality of life, self-care and health awareness were also observed. In the EOS survey, most of the participants (45/63 ~ 71 %) reported a significant improvement in *overall wellbeing* and positivity, and 64 % of participants reported significant improvement in body awareness, awareness of mental activity and improved focus, awareness of Qi, awareness of connection to self and nature, and in satisfaction and meaning. A majority of the participants (64 %) in clusters 3 and 4 reported an increased sense of satisfaction and meaning, and all participants in clusters 3 and 4 reported improved awareness of body and focus. The RIQ results also confirmed a significant increase in *sensory and somatic awareness and in awareness of mental activity*: feelings, thoughts, and images. Our findings are consistent with those of ,[58] which reported that self-connection predicts wellbeing and partially mediates the relationship between awareness and wellbeing. Focused awareness was demonstrated to improve brain function, mental activity, and interpersonal relationships. [28, 44, 59–64] Self-awareness has been found to be consistently correlated with self-regulation. [65]

Another interesting finding is that all participants who reported increased *overall sense of satisfaction and meaning* in the DEs and the EOS survey, also reported an increase in overall wellbeing as measured in the RIQ. There is strong evidence to suggest that meaning helps people establish better relationships, thus boosting relational and mental wellbeing. [66–69] Studies have found that people with a greater sense of meaning had lower toxic levels of stress, as marked by inflammatory cytokines and killer T-cell levels.[70, 71]

Unexpectedly, participants with little or no prior experience of Qigong showed greater improvement in wellbeing than experienced practitioners (as stated in H3). We suggest that the experienced practitioners had already attained a high degree of wellbeing, and thus demonstrated a smaller difference in change in wellbeing experience. To the best of our knowledge, there are no previous studies directly quantifying the magnitude of change in wellbeing for people with prior experience versus people with no prior experience of Qigong. Yet there are a few indicating that less benefit was gained with a reduced amount of practice. [72] In this research we notice that with regard to the observed effect of more prominent change in wellbeing for practitioners with no prior experience, it is likely to be related to: (i)their positive attitude in engaging with a new self-care practice; (ii)a positive, new to them, experience during and after practice; (iii)sustaining the positive emotion space throughout the period of the study. The predominant emotions exhibited by the participants in cluster 4, where most of the participants had little or no prior experience of Qigong, were peace, love and joy.

Research in positive psychology confirms evidence that positive emotional attitude and thought before and during wellness practices, leads to greater wellbeing. [73]

The overall findings of this study are consistent with our definition of wellbeing 'as the human experience of optimum harmonious functioning of body, mind, awareness, and relational processes'. Wellbeing emerges through the integrated functioning of these processes subservient to autopoiesis and nurturing life. [30] Findings in neurobiology suggest that interventions that include integration physical, mental, awareness and relational processes have a higher impact on wellbeing. [32–35, 74] We thus hypothesise that LSQ, by integrating physical relaxation, slow movement, and focused awareness of internal and external experience, contributes to all aspects of wellbeing.

Despite the strengths of the study and the contribution to existing research, there are certain limitations that need to be noted. The data collected was based on the self-evaluation and reflection of the participants rather than measuring physiological markers in this pilot study, which was conducted to prepare for an RCT. We aim to further investigate the impacts of LSQ by integrating perceptual correlates of wellbeing with bio markers such as blood pressure, heart rate variability, respiration, and brain activity. The long-term goal of this pilot study has been to assess the feasibility of investigating the impacts of LSQ practice on both physical and mental wellbeing, by measuring the listed biomarkers using wearable devices. Those biomarkers can then be used to interpret potential clinical/health outcomes, for instance for a cohort suffering from a specific disease.

5. Conclusions

We conducted a pilot study to investigate the impacts of LSQ practice on physical and mental wellbeing. A high number of practitioners (170) and a relatively smaller number of control samples[42] were recruited. Weekly live-streamed LSQ training sessions were released for practitioners. Three different types of self-evaluation data were collected from the users: a regular-interval wellbeing rating questionnaire, an online diary completed after each LSQ practice, and an EOS survey were evaluated by using quantitative and qualitative measures and natural language processing (NLP) tools. From the evaluation of RIQ, we observed a significant improvement in sleep quality, feeling able to cope with life, life energy, and stress levels for LSQ practitioners compared to the control group. Additional data resources (an online diary and EOS survey) collected only from the practitioners confirmed that there is a consistent and sustainable improvement in their wellbeing e.g. 84 % of participants with improving RIQ scores were also clustered in the positively improved practitioner group predicted from an NLP analysis of the online diary. The majority of these users also shared their highly positive experiences in their responses to the EOS survey in both NLP analysis and NVivo-driven qualitative evaluation. We also observed that the majority of the LSQ practitioners who self-reported a positive impact in their wellbeing had no or little prior experience with LSQ, while more experienced practitioners reported less benefit from the practice. We concluded that conducting a cohort study to investigate impacts of LSQ on health has some challenges, e.g. especially in recruiting and keeping continuity of the control group who did not follow the live-streamed LSQ training sessions. However, the continuity ratio of the practitioners was quite satisfactory. Finding volunteers for LSQ training and keeping their interest in the study was found to be easier than for the control group. In this study, only the first 15 control group participants received a small incentive. However, in future work to encourage participation all of them could be offered an incentive to take part (in an ethically proper manner of course, without being coercive or enticing so as not to undermine the voluntary nature of participation). Lastly, we plan to provide a lay summary of our findings from the pilot trial in the recruitment stage of future studies.

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Ethics approval and consent to participate

The data collection process for this study was adhered to the human ethics guidelines and ethical approval for this research was granted by Ethics Committee of the Faculty of Engineering and Environment at Northumbria University, Newcastle upon Tyne, with an approval reference # of 23709. Informed consent was obtained from the participants during registration for the study. Participants were shown the participant information details and were asked to agree to take part before any data was collected (*Related Files – Participant Consent Forms #1 and 2 for practitioner and control samples, respectively, please see Additional Files 6 and 7. Please also find the CONSORT 'Checklist' and 'Flow Diagram' documents for our 'Pilot and Feasibility Trial' on Additional File 17*). We confirmed that any personal information that is collected during the course of the research is kept strictly confidential, held securely, and all data will be anonymised on completion of the study. Due care will be taken that individuals are not indirectly identifiable. Fully anonymised research data may be deposited in a research repository, with the requirements of the UK Data Protection legislation: https://www.gov.uk/data-protection.

Availability of data and material

Anonymised data can be available upon request.

CRediT authorship contribution statement

PS, KK, and ZK conceived the study, with PS responsible for the design of the experimental components, qualitative analysis, KK recruiting participants, arranging live-streamed Qigong sessions and ZK responsible for the design of the statistical and machine learning-based analysis, integration of the data streams. PS led the preparation of the regular-interval questionnaire (RIQ), online diary, end of study survey (EOS) questions, qualitative analysis, SO ran the Nvivo-based qualitative analysis on diary entries (DE). GE designed all of the online screening tools for collecting all different types of data. PS, KK, SO manually read, analyzed and categorized the online DEs from the participants, manually checked all text entries against data-driven clusters predicted by a machine learning approach. ZK and PW ran the statistical analysis on RIQ and EOS. ZK, HX, PW designed and implemented the machine learning-based clustering of the DEs. SST helped revising the results from statistical data analysis and preparation of illustrations. ZK, PS, KK, GE drafted the manuscript, and all authors read, revised, and approved the final manuscript.

Data Availability

Anonymised data can be available upon request.

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Consent for publication

Participants have been asked for their consent prior to using their anonymised data for publication purposes (*Related Files – Participant Consent Forms #1 and 2 for practitioner and control samples, respectively, please see Additional Files 6 and 7*).

Competing interests

The authors declare no competing interests.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ctim.2022.102891.

References

1 Hu S, Duan C. Effect of Qigong on the prevention and treatment of respiratory tract infection in the Elderly. *East Qigong*. 1992;vol. 4:32–33.
2 PA W, KE I, B. VE AJ, JE O. pilot study of qigong practice and upper respiratory illness in elite swimmers. *Am J Chin Med*. 2011;vol. 39(3):461–475. https://doi.org/10.1142/S0192415×11008968.
3 Pinheiro MB, Oliveira J, Bauman A, et al. Evidence on physical activity and osteoporosis prevention for people aged 65+ years: a systematic review to inform the WHO guidelines on physical activity and sedentary behaviour. *Int J Behav Nutr Phys Act*. 2020;vol. 17(1):1–53. https://doi.org/10.1186/S12966-020-01040-4/FIGURES/4.
4 C. K, Y. R. Exploratory studies of Qigong therapy for cancer in China. *Integr Cancer Ther*. 2002;vol. 1(4):345–370. https://doi.org/10.1177/1534735402238187.
5 KM S. Therapeutic benefits of qigong exercises in combination with drugs. *J Alter Complement Med*. 1999;vol. 5(4):383–389. https://doi.org/10.1089/ACM.1999.5.383.
6 Fu J, Fu S, Qin J. Effect of qigong and anticancer body-building herbs on the prognosis of postoperative patients with cardiac adenocarcinoma. *Third World Conf Med Qigong*. 1996.
7 E. Hong, The effect of Yudongkong exercise in fatigue, difficulty of daily activities and symptoms of side effect in advanced gastric cancer patients receiving chemotherapy.," Yonsei University, Seoul, Korea, 2003.
8 S. Lam, A randomized, controlled trial of Guolin qigong in patients receiving tanscatheter arterial chemoembolisation for unresectable hepatocellular carcinoma," University of Hong Kong, Hong Kong, 2004.
9 TI L, HH C, ML Y. Effects of chan-chuang qigong on improving symptom and psychological distress in chemotherapy patients. *Am J Chin Med*. 2006;vol. 34(1):37–46. https://doi.org/10.1142/S0192415×06003618.
10 Manzaneque J, et al. Assessment of immunological parameters following a qigong training program - PubMed. *Med Sci Monit*. 2004;vol. 10(6).
11 MS L, et al. Effects of Qigong on immune cells. *Am J Chin Med*. 2003;vol. 31(2):327–335. https://doi.org/10.1142/S0192415×03001016.
12 MS L, MS L, HJ K, ES C. Effects of qigong on blood pressure, high-density lipoprotein cholesterol and other lipid levels in essential hypertension patients. *Int J Neurosci*. . 2004;vol. 114(7):777–786. https://doi.org/10.1080/00207450490441028.
13 BM C, et al. Randomised controlled trial of qigong in the treatment of mild essential hypertension. *J Hum Hypertens*. 2005;vol. 19(9):697–704. https://doi.org/10.1038/SJ.JHH.1001884.
14 SHW C, HWH T. The beneficial effects of Qigong on elderly depression. *Int Rev Neurobiol*. 2019;vol. 147:155–188. https://doi.org/10.1016/BS.IRN.2019.06.004.
15 So WWY, Cai S, Yau SY, Tsang HWH. The neurophysiological and psychological mechanisms of qigong as a treatment for depression: a systematic review and meta-analysis. *Front Psychiatry*. 2019;vol. 10:820. https://doi.org/10.3389/FPSYT.2019.00820.
16 HW T, KM F. A review on neurobiological and psychological mechanisms underlying the anti-depressive effect of qigong exercise. *J Health Psychol*. 2008;vol. 13(7):857–863. https://doi.org/10.1177/1359105308095057.
17 Zhang X, et al. Healthy lifestyle behaviours and all-cause and cardiovascular mortality among 0.9 million Chinese adults. *Int J Behav Nutr Phys Act*. 2021;vol. 18(1):1–11. https://doi.org/10.1186/S12966-021-01234-4/TABLES/3.
18 Wang F, et al. The effects of qigong on anxiety, depression, and psychological well-being: a systematic review and meta-analysis. *Evid Based Complement Altern Med*. 2013;vol. 2013:16. https://doi.org/10.1155/2013/152738.
19 Wu W, et al. Effects of qigong on late-stage complex regional pain syndrome. *Alter Ther Heal Med*. 1999;vol. 5(1):45–54.
20 LEE MS, KANG C-W, RYU H. Acute effect of qi-training on natural killer cell subsets and cytotoxic activity. *https://doi Org/10 1080/00207450590519580*. 2009;vol. 115(2):285–297. https://doi.org/10.1080/00207450590519580.
21 MS L, HJ L, MS L. Impact of qigong exercise on self-efficacy and other cognitive perceptual variables in patients with essential hypertension. *J Alter Complement Med*. 2004;vol. 10(4):675–680. https://doi.org/10.1089/ACM.2004.10.675.
22 M. K, A. M. Efficacy and feasibility of a combination of body awareness therapy and qigong in patients with fibromyalgia: a pilot study. *J Rehabil Med*. 2004;vol. 36(6):279–281. https://doi.org/10.1080/16501970410031912.
23 Tsujiuchi T, et al. The effect of Qi-Gong relaxation exercise on the control of type 2 diabetes mellitus. *Diabetes Care*. . 2002;vol. 25(1):241–242. https://doi.org/10.2337/DIACARE.25.1.241.
24 B O, et al. The effects of Tai Chi and Qigong on immune responses: a systematic review and meta-analysis. *Medicines*. 2020;vol. 7(7):39. https://doi.org/10.3390/MEDICINES7070039.
25 Hung S-H, Hwang C-Y, Chang C-Y. "Is the Qi experience related to the flow experience? practicing qigong in urban green spaces. *PLoS One*. 2021;vol. 16(1), e0240180. https://doi.org/10.1371/JOURNAL.PONE.0240180.
26 BH N, HW T. Psychophysiological outcomes of health qigong for chronic conditions: a systematic review. *Psychophysiology*. 2009;vol. 46(2):257–269. https://doi.org/10.1111/J.1469-8986.2008.00763.X.
27 P. Sice et al., "An autopoietic approach to assessing the impact of TCM Qigong exercise on wellbeing: A feasibility study," Systemist, vol. 41, no. 1, pp. 108–132.
28 Sice P, Elvin G, Riachy C, et al. Online screening of x-system music playlists using an integrative wellbeing model informed by the theory of autopoiesis. *IEEE Access*. 2020;vol. 8:182307–182319. https://doi.org/10.1109/ACCESS.2020.3029142.
29 Maturana HR, Verden-Zöller G. *The Origin of Humanness in the Biology of Love*. Imprint Academic; 2012.
30 Sice P, French I. Understanding humans and organisations: philosophical implications of autopoiesis. *Philos Manag*. 2004;vol. 4(1):55–66. https://doi.org/10.5840/POM20044114.
31 Varela F. Neurophenomenology: a methodological remedy for the hard problem. *J Conscious Stud*. 1996;vol. 3(4).
32 Varela FJ. Patterns of Life: Intertwining Identity and Cognition. *Brain Cogn*. 1997;vol. 34(1):72–87. https://doi.org/10.1006/BRCG.1997.0907.
33 Porges SW. *The Polyvagal Theory: Neurophysiological Foundations of Emotions, Attachment, Communication, and Self-Regulation (Audio Download): Stephen W. Porges, Joe Hempel, Tantor. Audio: Amazon.co.uk: Books*. New York: W. W. Norton & Company,; 2011.
34 Damásio AR. *The Strange Order of Things: Life, Feeling, and the Making of Cultures*. Pantheon; 2018.
35 Varela F, Lachaux J-P, et al. The brainweb: phase synchronization and large-scale integration. *Nat Rev Neurosci 2001 24*. 2001;vol. 2(4):229–239. https://doi.org/10.1038/35067550.
36 Deco G, Tononi G, Boly M, et al. Rethinking segregation and integration: contributions of whole-brain modelling. *Nat Rev Neurosci 2015 167*. . 2015;vol. 16(7):430–439. https://doi.org/10.1038/nrn3963.
37 Zhang C, Popp FA, Bischof M. *Current development of biophysics: the stage from an ugly duckling to a beautiful swan. [Hangzhou]*. first ed. Hangzhou University Press; 1996.
38 R. Bartlett and C. Milligan, What is Diary Method? Bloomsbury Academic, 2015.
39 D. McDuff, A. Karlson, A. Kapoor, A. Roseway, and M. Czerwinski, "AffectAura: Emotional wellbeing reflection system," in 2012 6th International Conference on Pervasive Computing Technologies for Healthcare and Workshops, PervasiveHealth 2012, 2012, pp. 199–200, doi: 10.4108/icst.pervasivehealth.2012.248727.
40 D. Pavel, V. Callaghan, and A.K. Dey, "From self-monitoring to self-understanding: Going beyond physiological sensing for supporting wellbeing," in 2011 5th International Conference on Pervasive Computing Technologies for Healthcare and Workshops, PervasiveHealth 2011, 2011, pp. 312–315, doi: 10.4108/ICST.PERVASIVEHEALTH.2011.245999.
41 Uher J. Quantitative data from rating scales: an epistemological and methodological enquiry. *Front Psychol*. . 2018;vol. 9(DEC). https://doi.org/10.3389/FPSYG.2018.02599/FULL.
42 Tay L, Jebb AT. Establishing construct continua in construct validation: the process of continuum specification. *Adv Methods Pr Psychol Sci*. . 2018;vol. 1(3):375–388. https://doi.org/10.1177/2515245918775707.
43 Abbey JD, Meloy MG. Attention by design: using attention checks to detect inattentive respondents and improve data quality. *J Oper Manag*. 2017;vol. 53–56:63–70. https://doi.org/10.1016/J.JOM.2017.06.001.
44 N. Depraz, F.J. Varela, and P. Vermersch, On Becoming Aware. A pragmatics of experiencing. John Benjamins Publishing Company, 2003.
45 Braun V, Clarke V. Using thematic analysis in psychology. *Qual Res Psychol*. 2006;vol. 3(2):77–101. https://doi.org/10.1191/1478088706QP063OA.
46 Virtanen P, et al. SciPy 1.0: Fundamental algorithms for scientific computing in python. *Nat Methods*. 2020;vol. 17(3):261–272.
47 PS C, O. B KT, M F. Physical and psychological health outcomes of qigong exercise in older adults: a systematic review and meta-analysis. *Am J Chin Med*. 2019;vol. 47(2):301–322. https://doi.org/10.1142/S0192415×19500149.
48 Liu Y, Hu S. The Effect of Qigong on muscle function of older adults. *J Gerontol*. 1988;vol. 4(228).
49 C. J, et al. Tai Chi Chuan increases circulating myeloid dendritic cells. *Immunol Invest*. 2010;vol. 39(8):863–873. https://doi.org/10.3109/08820139.2010.503766.
50 MR I, et al. Cognitive behavioral therapy and tai chi reverse cellular and genomic markers of inflammation in late-life insomnia: a randomized controlled trial. *Biol Psychiatry*. 2015;vol. 78(10):721–729. https://doi.org/10.1016/J.BIOPSYCH.2015.01.010.
51 Feng F, Tuchman S, Denninger JW, et al. Qigong for the prevention, treatment, and rehabilitation of COVID-19 infection in older adults. *Am J Geriatr Psychiatry*. 2020;vol. 28(8):812–819. https://doi.org/10.1016/J.JAGP.2020.05.012.
52 man Siu JY. Coping with future epidemics: Tai chi practice as an overcoming strategy used by survivors of severe acute respiratory syndrome (SARS) in post-SARS Hong Kong. *Heal Expect*. 2016;vol. 19(3):762–772. https://doi.org/10.1111/HEX.12270.
53 JY S, HC S, WL L. Qigong practice among chronically ill patients during the SARS outbreak. *J Clin Nurs*. . 2007;vol. 16(4):769–776. https://doi.org/10.1111/J.1365-2702.2006.01695.X.

54 Neff KD, Costigan AP. Self-Compassion, Wellbeing, and Happiness. *Psychol Österreich*. 2014;vol. 2(3):114–119.
55 KD N, CK G. A pilot study and randomized controlled trial of the mindful self-compassion program. *J Clin Psychol*. . 2013;vol. 69(1):28–44. https://doi.org/10.1002/JCLP.21923.
56 Gilbert P. *Compassion: Concepts, Research and Applications*. London: Routledge; 2017.
57 P. Gilbert, The Compassionate Mind: A New Approach to Life's Challenges. New Harbinger Publications, 2010.
58 Klussman K, Curtin N, Langer J, et al. Examining the effect of mindfulness on well-being: self-connection as a mediator. *https://doi Org/10 1017/prp 2019 29*. 2020;vol. 14:5. https://doi.org/10.1017/PRP.2019.29.
59 Martinez ME. The process of knowing: a biocognitive epistemology. *J Mind Behav*. 2001:407–426.
60 Llinás RR. Of self and self awareness the basic neuronal circuit in human consciousness and the generation of self. *J Conscious Stud*. 2008;vol. 9:64–74.
61 K.S. Cohen, The Way of Qi Gong: The Art and Science Energy Healing. Wellspring/Ballantine, 2018.
62 Siegel DJ. Mindful awareness, mindsight, and neural integration. *J Humanist Psychol*. 2009;vol. 37(2):137–158.
63 Siegel DJ. An interpersonal neurobiology approach to psychotherapy: awareness, mirror neurons, and neural plasticity in the development of well-being. *Psychiatr Ann*. 2006;vol. 36(4):248–256.
64 Sice P, Bentley E, Rauch L. Ontology, epistemology and the complexity of human neurobiology. *Hum Syst Manag*. 2018;vol. 37(3):353–360. https://doi.org/10.3233/HSM-171795.
65 Verhaeghen P, Mirabito G. When you are talking to yourself, is anybody listening? the relationship between inner speech, self-awareness, wellbeing, and multiple aspects of self-regulation. *Int J Pers Psychol*. 2021;vol. 7:8–24. https://doi.org/10.21827/IJPP.7.37354.
66 M.F. Steger, Meaning and well-being. Handbook of well-being. Salt Lake City, UT, USA: DEF Publishers, 2018.
67 Stillman TF, Lambert NM, Fincham FD, et al. Meaning as magnetic force: evidence that meaning in life promotes interpersonal appeal. *Social Psychol. Person. Sci.* 2010; vol. 2(1):13–20. https://doi.org/10.1177/1948550610378382. http://dx doi Org/10 1177/1948550610378382.
68 Martela F, Ryan RM, Steger MF. Meaningfulness as satisfaction of autonomy, competence, relatedness, and beneficence: comparing the four satisfactions and positive affect as predictors of meaning in life. *J Happiness Stud 2017 195*. 2017;vol. 19(5):1261–1282. https://doi.org/10.1007/S10902-017-9869-7.
69 Martela F, Sheldon KM. Clarifying the concept of well-being: psychological need satisfaction as the common core connecting eudaimonic and subjective well-being. *Rev. Gen. Psychol.* 2019;vol. 23(4):458–474. https://doi.org/10.1177/1089268019880886. https://doi Org/10 1177/1089268019880886.
70 B. JE, K. ME, T. SE, and F. JL, "Finding positive meaning and its association with natural killer cell cytotoxicity among participants in a bereavement-related disclosure intervention," Ann Behav Med, vol. 25, no. 2, pp. 146–155, 2003, doi: 10.1207/S15324796ABM2502_11.
71 Krause N, Hayward RDavid. Religion, meaning in life, and change in physical functioning during late adulthood. *J Adult Dev 2012 193*. 2012;vol. 19(3):158–169. https://doi.org/10.1007/S10804-012-9143-5.
72 Lynch M, Sawynok J, Hiew C, Marcon D. A randomized controlled trial of qigong for fibromyalgia. *Arthritis Res Ther*. 2012;vol. 14(4):1–11. https://doi.org/10.1186/AR3931/FIGURES/5.
73 Lyubomirsky S, Layous K. How do simple positive activities increase well-being. *Curr Dir Psychol Sci*. 2013;vol. 22(1). https://doi.org/10.1177/0963721412469809.
74 F.J. Varela and J. Shear, The View from Within: First-Person Approaches to the Study of Consciousness, no. 5048. Imprint Academic, 1999.