Brief Virtual Reality Exposure Therapy and Its Effects on Negative and Positive Emotions Among Healthy Working Adults: A Feasibility Study

ABSTRACT

Background: The primary purpose of this study is to examine the feasibility of a short-term virtual reality exposure therapy among healthy working adults sample. The secondary aim is to measure the effect of virtual reality exposure therapy on negative and positive emotions by comparing it to the standard stress management program and the wait-list groups.

Methods: We enrolled 67 participants allocated into 3 groups to receive virtual reality exposure therapy, standard stress management, or wait-list group. The virtual reality exposure therapy group received a total of a 30-minute exposure to a virtual reality environment over 2 weeks. The standard stress management group received a stress management program once during the study period.

Results: The results showed a heterogeneous sample, whereby a significantly younger, less-working years, and higher anxiety baseline score were found in the virtual reality exposure therapy group compared to standard stress management and wait-list groups. Nonetheless, the virtual reality exposure therapy group showed a reduction in depression, anxiety, and stress score ($P < .001$). The standard stress management group showed a reduction in anxiety score only ($P = .002$), whereas no significant changes were observed in the wait-list group. For positive emotion, all 3 groups showed significant improvement.

Conclusion: Short-term virtual reality exposure therapy is a feasible intervention for the negative and positive emotions; however, cautious interpretation is needed due to significant heterogeneous sample. Replication of study with comparable groups is recommended.

Keywords: Virtual reality exposure therapy, virtual reality, anxiety, depression, happiness

Introduction

The World Health Organization reported that approximately 300 million individuals suffered from depressive disorder globally, and it is projected to be the main contributor to the overall global burden of disease in 2030. According to a report by Malaysian National Health and Morbidity Survey 2019, the prevalence of depression among adults aged 18 years and above was 2.3%. Excessive stress, anxiety, and depression among adults do not only affect an individual’s mental and physical health but also cause a significant economic impact, owing to its cost of treatments, workplace-related costs, and suicide-related costs.

Studies that applied virtual reality exposure therapy (VRET) on psychiatric disorders were reported as early as 1995, and its application has expanded since then. Virtual reality exposure therapy has been recognized to be an effective treatment for certain anxiety disorders like panic disorder, acrophobia, and post-traumatic stress disorder. The exposure to relaxing virtual environment was demonstrated to be able to induce positive emotion and at the same time reduced anger, anxiety, and negative emotions. Some studies compared virtual reality-based cognitive behavior therapy (CBT) with standard CBT, and they found that...
the former was more effective than the wait-list group and as effective as standard CBT.13

Compared to the traditional psychotherapy that uses direct exposure to the external stimuli, VRET was demonstrated to be equally effective with some advantages such as the ease of delivery, more convenient to both therapists and the clients, and less time-consuming.14 As the cost of the head-mounted display (HMD) was getting more affordable, the VR-based intervention will be more accessible to the end-users, and it will significantly improve the barrier to psychiatric treatment in the future. Virtual reality exposure therapy is also flexible, and therefore, the therapists can manipulate the virtual environment and generate more gradual assignments to the participants while at the same time allowing the similar exposure to be repeated.

While most studies focused on patients with psychiatric disorders, there is little study that focuses on impact of VRET on the negative emotions among healthy adults.15 Furthermore, little is known about the effect of VRET on the positive emotion of the participants. Positive emotion, as described in the Broaden and Build theory by Fredrickson (1998), is an important component in the emotional regulation that influences the resilience factors of an individual and helps them to cope with stress and other psychological issues.16 Positive emotion-based traditional psychotherapy interventions were found to be effective in improving happiness, subjective well-being, and alleviating depressive symptoms.17 Most recent studies exploring the effect of VR-mindfulness-based intervention found a significant improvement in the positive emotion and state mindfulness of the participants.18-19

In addition, the studies that applied VR-based intervention would require either a 30 minutes to 2 hours of exposure per session or multiple sessions ranging from 3 to 12 sessions.10,15 While the long duration of the intervention might be necessary for the treatment of specific psychiatric disorder, the effect of a short-term VRET on the negative and positive emotions among healthy adult population is still unknown.

Therefore, this study was designed to examine the feasibility of a brief VRET and to investigate the effect of brief VRET on negative and positive emotions of healthy working adults by comparing it to the existing stress management program (SSM) and the wait-list groups. To the best of our knowledge, this is the first VR exposure therapy study that was done among healthy adults in Malaysia.

Methods
Research Design
This study was a feasibility study with 3 intervention arms exploring the effect of brief VRET on the level of depression, anxiety, stress, and positive emotions among healthy adults. This study compared the VRET with the SSM workshop and the wait-list groups.

Ethical Consideration
This study was approved by the Universiti Kebangsaan Malaysia Medical Centre (UKMMC) Medical Ethics Committee (Approval No: FF-2016-281, Date: 1.06.2016). The informed consent forms were taken from the participants.

Recruitment, Sample Size, and Randomization
This study was conducted among employees of Tenaga Nasional Berhad Integrated Learning Solution (ILSAS), Malaysia. This center is chosen due to its near location to the research center. Recruitment of the study participants was done via convenient sampling method. The inclusion criteria were age between 20 and 60 years, good command in either English or Malay language, and able to participate with the study schedule. The exclusion criteria included pregnancy, known or had previous psychiatric diagnosis, and those who were at risk of having medical complications following exposure to blinking light such as epilepsy, migraine, or known to have motion sickness issues.

Every participant was given a sealed envelope that contains the randomization code for the intervention group. The randomization codes were generated using the Random Sequence Generator from www.random.org. They were randomized into 3 groups which are VRET group (n = 20), SSM group (n = 24), and wait-list group (n = 23). No masking of intervention condition was done in this study.

Study Procedure
The summary of the study procedure was shown in Figure 1. Following the completion of the baseline questionnaires, the participants who were found to have moderate or higher level of depression, anxiety, or stress were further assessed clinically. Those with a clinical diagnosis of any psychiatric disorder were offered referral, and, upon their consent, were referred to the nearest psychiatric service and subsequently excluded from the study. Upon randomization, separate briefing session was done for each group to explain the study procedure. Each participant in the VRET and SSM groups received the intervention as per study protocol. Meanwhile, the participants in the wait-list group were encouraged to continue their usual practice of managing stress. Postintervention assessment was done following the completion of the sixth session of the VRET and 2 weeks after the SSM workshop, respectively. The participants in the wait-list group were re-assessed after 2 weeks from the initial assessment. Another follow-up assessment was done after 2 months to all participants. Upon completion of data collection, the participants in the wait-list group were offered to receive either VRET or SSM.

Interventions
Virtual Reality Exposure Therapy
The VR system that was used in this study was developed by a team of researchers from Tenaga Nasional University (UNITEN) as part of their student’s research project.20 The main device was the Oculus Rift DK1 HMD with a built-in gyroscope tracker via which the participants would be able to view a full 360° of the virtual environment. The headset Razer Chimaera 5.1 with stereo capability is used to ensure good audio quality and therefore enhancing the level of immersion. The
The virtual environment was run on a desktop PC (Processor: Intel Core i7-3820 CPU 3.6 GHz, installed memory (RAM): 8GB DDR 333MHz and Hard Disk Drive: 240 GB) with a graphic processing unit: Radeon 7970 (2GB DDR5) Vapor-X.

The virtual environment that was used in this study was standardized for all participants. The view started with an entrance to a walkway that was surrounded by trees. The path leads to a garden with colorful flowers where the participant would be able to explore the surrounding. As the view moved forward, the path will lead to waterfall scenery with flowing water running underneath a small bridge. The sound of nature including chirping birds and the soothing sound of water accompanied the view and were adapted accordingly throughout the session. The participants would be able to navigate the virtual environment independently (non-guided option) using the optical mouse or guided by the program. The study took place in a room inside the ILSAS building where the participants would be seated on a couch throughout the exposure. The duration of exposure was designed to be 5 minutes per session. The participants received 6 individual sessions of VRET with a total duration of 30 minutes within 2 weeks. The total duration of VRET in this study was approximately similar to the duration of exposure in the reference study, which was 25 minutes in a single session.15

The participants were allowed to discontinue the VRET at any session if they develop any side effects or worsening of their psychological symptoms.

Standard Stress Management Workshop

The SSM workshop module was adopted from the Healthy Mind Module by the Ministry of Health Malaysia.21 The main content of the workshop includes identifying psychological symptoms of distress, stress management techniques, and anger management. It was divided into a 2-day program which was conducted by a team of psychiatrists and psychiatric trainees from the Department of Psychiatry, Universiti Kebangsaan Malaysia Medical Centre. The participants were encouraged to practice the skills that were acquired during the workshop, and subsequent assessments were done at 2 weeks following the stress management workshop.

Outcome Measures

Depression Anxiety Stress Scale

The Depression, Anxiety, and Stress (DASS-21) scale is a validated, self-rated questionnaire used to assess the severity of self-perceived emotional states in 3 domains: depression, anxiety, and stress.22 The Malay version of DASS-21 has been validated by Ramli et al.23 and the result had shown a good Cronbach’s alpha values of 0.84, 0.74, and 0.79, respectively, for depression, anxiety, and stress domains.

Positive Emotion Rating Scale

This brief instrument covers 6 domains of positive emotions, namely contentment, interest, love, gratification, active, and pride.
version of Positive Emotion Rating Scale (PERS-M) has been validated. It is a self-rated questionnaire that has 8 items on a 5-point Likert scale (1 = never, 2 = seldom, 3 = regularly, 4 = often, 5 = always). The sum of the 8 items represents the total score, with lowest score as 8 and the higher scores representing higher levels of positive emotions. The cut-off score of 30 had demonstrated discriminant validity between depressed and non-depressed subjects (sensitivity = 0.75, specificity = 0.73). The scale has good validity and reliability to measure positive emotion in depressed patients, with high internal consistency (Cronbach’s alpha 0.90). The cut-off point for PERS-M was 32, and it has a good internal consistency with Cronbach’s alpha = 0.89.

**Statistical Analysis**

The data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 24.0 (IBM SPSS Corp.; Armonk, NY, USA). The level of significance (α) value was set at 0.05 and CI was 95%. In this study, the outcome measure scores were found to be non-normally distributed when tested using the Shapiro-Wilk test. The categorical data were reported as numbers and percentages. Pearson’s chi-square test and the Fisher–Freeman–Halton test were used to compare categorical variables. Quantitative data with normal distribution were expressed as mean (standard deviation) and those that did not show normal distribution were expressed as median (min-max). Kruskal–Wallis analysis was used in the analysis of quantitative data. Post hoc Dunn’s test with Bonferroni correction was used to evaluate significant results between the intervention groups. The median of pre- and postintervention score and between pre- and 2-month score for every outcome parameter for each intervention group were measured using Wilcoxon signed-rank test.

**Results**

A total of 67 participants were randomized into 3 groups and completed the interventions. All of the participants in this study were Malay. There was no significant difference in gender, marital status, and qualification among the participants in the 3 groups. The age of participants ranged from 23 to 56 years with mean age of 33.2 (8), with 79.1% (n = 53) of the total participants aged between 20 and 39 years. Age was non-normally distributed, with skewness of 0.72 (standard error, SE = 0.29) and kurtosis of 0.03 (standard error, SE = 0.58). Participants in the VRET group were found to be significantly younger than the SSM and the wait-list group (P = .001). This profile was also reflected by the significant difference in the designation profile (P = .002) and less number of working years in the VRET group (P = .038). Participants’ sociodemographic characteristics were shown in Table 1.

Outcome parameters at pre-, post-, and at 2-months interval were depicted in Table 2. A Kruskal–Wallis H test showed that there was a statistically significant difference in the preintervention anxiety score between the intervention groups (χ²(2) = 14.15; P = .001). A post hoc analysis using Dunn’s test with Bonferroni correction showed that the anxiety score in the VRET group was significantly higher than SSM (P = .013) and wait-list group (P = .001). The other parameters did not show any significant difference in between the group at baseline with depression (P = .534), stress (P = .185), and PERS (P = .263).

Within-group analysis between the median score of the outcome parameters at pre- and postintervention was shown in Table 3. A Wilcoxon signed-rank test revealed that depression scores were significantly lower after the VRET intervention at 2 weeks compared to pre-test median score (Z = 3.661; P < .001). Similarly, significant lower median postintervention anxiety (Z = 3.561; P < .001) and

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**Table 1. Sociodemographic Characteristics of the Participants in VRET Group, SSM Group, and Wait-List Group**

| Variables                  | VRET (n = 20) | SSM (n = 24) | Wait-List (n = 23) | P    |
|----------------------------|--------------|--------------|--------------------|------|
| Age,* median (min-max)     | 27.5 (23-42) | 33.0 (24-47) | 36.0 (24-56)       | .001*|
| Gender; n (%)               | 8 (40)       | 9 (37.5)     | 8 (34.8)           | .939 |
| Male                       | 12 (60)      | 15 (62.5)    | 15 (65.2)          |      |
| Female                     |              |              |                    |      |
| Marital status; n (%)      | 8 (40)       | 16 (66.7)    | 16 (69.6)          | .098 |
| Married Single             | 12 (60)      | 8 (33.3)     | 7 (30.4)           |      |
| Qualification; n (%)       |              |              |                    | 380  |
| Diploma                    | 2 (10)       | 0 (0)        | 3 (13)             |      |
| Administrative staffs      | 6 (30)       | 8 (33.3)     | 5 (21.7)           |      |
| Technicians                | 4 (20)       | 4 (16.7)     | 1 (4.3)            |      |
| Trainees                   | 9 (45)       | 0 (0)        | 5 (21.7)           |      |
| Administrative staffs      | 6 (30)       | 8 (33.3)     | 5 (21.7)           |      |
| Technicians                | 4 (20)       | 4 (16.7)     | 1 (4.3)            |      |
| Trainers                   | 0 (0)        | 3 (12.5)     | 3 (13)             |      |
| Engineers                  | 0 (0)        | 3 (12.5)     | 1 (4.3)            |      |
| Executive officers         | 1 (5)        | 6 (25)       | 8 (34.8)           |      |
| Years of working,* median (min-max) | 3 (1-18) | 6 (1-18) | 14 (1-39) | .038* |

VRET, virtual reality exposure therapy; SSM, standard stress management; SPM, Sijil Pelajaran Malaysia; STPM, Sijil Tinggi Pelajaran Malaysia.

* Kruskal–Wallis test; † chi-square test; ‡ Fisher–Freeman–Halton exact test, * P < .05.

**Table 2. Depression, Anxiety, Stress, and PERS Score at Pre-, Post-, and at 2-Months Interval Displayed in Median (Min-Max)**

| Variables                  | VRET Group (n = 20) | SSM Group (n = 24) | Wait-List Group (n = 23) |
|----------------------------|---------------------|--------------------|--------------------------|
| **Depression**             |                     |                    |                          |
| Preintervention            | 6.0 (0-20)          | 5.0 (0-14)         | 6.0 (0-24)               |
| Postintervention           | 4.0 (0-16)          | 6.0 (0-12)         | 6.0 (0-22)               |
| At 2 months                | 7.0 (0-22)          | 6.0 (0-12)         | 6.0 (0-20)               |
| **Anxiety**                |                     |                    |                          |
| Preintervention            | 14.0 (4-28)         | 9.0 (2-22)         | 8.0 (2-20)               |
| Postintervention           | 10.0 (2-16)         | 6.0 (2-14)         | 8.0 (0-16)               |
| At 2 months                | 12.0 (4-26)         | 8.0 (0-24)         | 6.0 (2-24)               |
| **Stress**                 |                     |                    |                          |
| Preintervention            | 13.0 (2-28)         | 10.0 (2-20)        | 8.0 (2-22)               |
| Postintervention           | 8.0 (2-20)          | 8.0 (4-16)         | 10.0 (2-20)              |
| At 2 months                | 13.0 (4-26)         | 9.0 (0-18)         | 8.0 (0-24)               |
| **PERS**                   |                     |                    |                          |
| Preintervention            | 35.0 (25-39)        | 33.0 (18-40)       | 37.0 (23-40)             |
| Postintervention           | 37.0 (30-40)        | 35.0 (29-40)       | 38.0 (26-40)             |
| At 2 months                | 35.0 (30-40)        | 36.0 (29-40)       | 34.0 (24-40)             |

PERS, Positive Emotion Rating Scale; VRET, virtual reality exposure therapy; SSM, standard stress management.
stress scores ($Z = 3.753; \ P < .001$) were observed. Increase in postintervention median of PERS score for the VRET group was demonstrated ($Z = 3.555; \ P < .001$). However, Wilcoxon signed-rank test comparing between the median score in this group at pre- and 2-months interval revealed no significant difference for every outcome parameter, that is, with depression ($P = .293$), anxiety ($P = .154$), stress ($P = .917$), and PERS ($P = .092$). This could be interpreted as the changes were not sustainable at 2-months duration.

For the SSM group, the comparison between the median score of pre- and postintervention for every outcome parameter revealed that the SSM workshop only showed a significant reduction in the anxiety score ($Z = 3.031; \ P = .002$) and an increase in the PERS median score ($Z = -2.265; \ P = .024$), whereas the depression and stress scores remained unchanged with $P = .158$ and $P = .078$, respectively. Similar to VRET group, analysis using Wilcoxon signed-rank test for the preintervention and score at 2 months within the SSM group revealed no significant difference in all outcome parameters, that is, depression ($P = .247$), anxiety ($P = .182$), stress ($P = .213$), and PERS ($P = .071$).

Meanwhile, analysis for the wait-list group showed that the only significant change in the median postintervention score was observed in the PERS score ($Z = 2.416; \ P = .016$). There was no significant difference in depression ($P = .796$), anxiety ($P = .817$), and stress ($P = .544$) scores when compared at pre- and postintervention. Similarly, no significant changes were seen when comparing baseline scores and scores at 2 months for all parameters in the wait-list group, that is, depression ($P = .074$), anxiety ($P = .336$), stress ($P = .269$), and PERS ($P = .340$).

Between-groups analysis that compared the score difference between pre- and postintervention was presented in Table 4. A Kruskal–Wallis test showed that the interventions had a significant effect on the depression ($P = .001$), anxiety ($P < .001$), and stress scores ($P < .001$). For depression score, a post hoc test using Dunn’s test with Bonferroni correction showed the score reduction was significantly higher in VRET than the wait-list group ($P = .001$), and between VRET and SSM ($P = .032$), but no significant difference between SSM and wait-list group ($P = .735$). For anxiety, post hoc test using Dunn’s test with Bonferroni correction showed the score reduction was significantly higher between VRET and wait-list ($P < .001$), and no difference was observed when comparing between VRET and SSM groups ($P = .136$) and SSM and wait-list group ($P = .061$). For stress score changes, the post hoc test using Dunn’s test with Bonferroni correction showed the significant differences between VRET and wait-list ($p < .001$) and between VRET and SSM ($P = .016$), but no significant difference between SSM and wait-list group ($P = .241$). For positive emotion, even though the Wilcoxon signed-rank test analysis showed that the pre- and postintervention scores improved for all intervention groups, the Kruskal–Wallis test showed that there is no significant difference across the intervention groups ($P = .06$).

### Discussion

There were several issues that have been highlighted from the previous studies of VRET with regard to small sample size, lack of control group, and also high dropout rate. The current study employed a 3-arm design and recruited a larger sample size with at least 20 participants in each group. Stress management workshop was chosen to be the active comparator in this study as it was proven in the previous...

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**Table 3. Within-Group Analysis Comparing the Pre- and Postintervention Median Score Using the Wilcoxon Signed-Rank Test for Depression, Anxiety, Stress, and PERS**

| Outcome Parameters | Group (n) | Preintervention Score, Median (Min-Max) | Postintervention Score, Median (Min-Max) | Z score | P   |
|--------------------|----------|----------------------------------------|-----------------------------------------|---------|-----|
| Depression         | VRET (20)| 6 (0-20)                                | 4 (0-16)                                | -3.611  | <.001** |
|                    | SSM (24) | 5 (0-14)                                | 6 (0-12)                                | -1.413  | .158 |
|                    | Wait-list (23) | 6 (0-22)              | 6 (0-22)                                | -0.258  | .796 |
|                    | VRET (20) | 14 (4-28)                               | 10 (2-16)                               | -3.561  | <.001** |
| Anxiety            | SSM (24) | 9 (2-22)                                | 6 (2-14)                                | -3.031  | .002* |
|                    | Wait-list (23) | 8 (2-20)              | 8 (0-16)                                | -0.232  | .817 |
|                    | VRET (20) | 13 (2-28)                               | 8 (2-20)                                | -3.753  | <.001** |
| Stress             | SSM (24) | 10 (2-20)                               | 8 (4-16)                                | -1.763  | .078 |
|                    | Wait-list (23) | 8 (2-22)              | 10 (2-20)                               | -0.607  | .544 |
|                    | VRET (20) | 35 (25-39)                              | 37 (30-40)                              | -3.555  | <.001** |
| PERS               | SSM (24) | 33 (18-40)                              | 35 (29-40)                              | -2.265  | .024* |
|                    | Wait-list (23) | 37 (23-40) | 38 (26-40)                              | -2.416  | .016* |

PERS, Positive Emotion Rating Scale; VRET, virtual reality exposure therapy; SSM, standard stress management; **P < .001; *P < .05. 

**Table 4. Between-Group Analysis Using Kruskal-Wallis H Test Comparing the Pre- and Postintervention Score Difference for Depression, Anxiety, Stress, and PERS score**

| Outcome Parameters | Group | Score Difference Median (Min-Max) | P     |
|--------------------|-------|----------------------------------|-------|
| Depression         | VRET  | -2 (-6.0 to 0.0)                 | .001* |
|                    | SSM   | -2 (-4.0 to 4.0)                 |       |
|                    | Wait-list | 0 (-2.0 to 2.0)              |       |
|                    | VRET  | -4 (-14 to 2.0)                  | <.001** |
| Anxiety            | SSM   | -2 (-10.0 to 2.0)                |       |
|                    | Wait-list | 0 (-4.0 to 2.0)              |       |
|                    | VRET  | -4 (-12.0 to 2.0)                | <.001** |
| Stress             | SSM   | -2 (-8.0 to 4.0)                 |       |
|                    | Wait-list | 0 (-4.0 to 4.0)              |       |
|                    | VRET  | 4 (-1.0 to 11.0)                 | .060  |
| PERS               | SSM   | 1.5 (-6.0 to 13.0)               |       |
|                    | Wait-list | 2 (-4.0 to 5.0)              |       |

VRET, virtual reality exposure therapy; SSM, standard stress management; PERS, Positive Emotion Rating Scale; **P < .001; *P < .05.
studies to be an effective intervention for psychological symptoms of distress in workplace.\textsuperscript{28}

The present findings supported the findings of the previous studies on VRET effectiveness either as a stand-alone therapy or used in combination with other psychological interventions for anxiety- and stress-related disorders.\textsuperscript{15,29} Virtual reality exposure therapy was also found to be more effective than the wait-list group and as effective as the SSM group in improving the level of anxiety which was in accordance with the findings of the previous studies.\textsuperscript{29} However, the current results required cautious interpretation as there was a significant age, years of working, and baseline anxiety score differences between the VRET and SSM group which may contribute to the larger improvement seen in the VRET as compared to the SSM group.

The strength of the current study relied upon the utilization of a brief and repeated VRET exposure which was for a shorter duration as compared to the usual VRET duration.\textsuperscript{30} This new design is simpler and less time-consuming. It could be reflected in this study whereby all of the participants in the VRET group managed to complete all 6 sessions of VR without any dropout. Therefore, short-duration VRET may be a promising step in the future to provide a quick yet effective gateway for working adults to deal with negative emotions without having them to leave their office. Additional element of exposure to the virtual nature in the current study might also have contributed to the improvement in both positive and negative emotions as shown in another study.\textsuperscript{31} The significant improvement in the positive emotion was observed in all 3 groups of intervention. Further analysis showed that the brief VRET intervention is comparable to the SSM in improving the positive emotion in this study.

With regard to the long-term efficacy, several studies showed that the effects of the VRET on certain treatment conditions were maintained at follow-ups and the sustainability was similar to the conventional psychological interventions.\textsuperscript{32} Mostly, significant long-term improvements were observed in the case of aviophobia and panic disorder/agoraphobia where the VR exposure was more intense and involve anxiety-provoking situation followed by the habituation processes.\textsuperscript{33} For stress management intervention, the long-term effectiveness was also observed in a web-based structured intervention.\textsuperscript{34} However, the follow-up assessment for the current study showed that the positive effects were not sustainable after 2 months. This finding might have emphasized the need to add element of behavioral modification such as narrative of relaxation techniques into the VR relaxation program and also to consider for maintenance VRET to ensure sustainability of the therapy, which could be a good topic in the future research.

There are several limitations in this research study. First, as this is an open-labeled study and the effectiveness of the therapy was measured using the self-rated questionnaire, it may be influenced by response bias. This bias can be minimized in the future study by doing single-blinded study whereby the outcome assessors should be blinded to the type of intervention given to the participants. Another method to minimize the response bias is by assessing the outcomes of this study that include physiological parameters such as blood pressure, pulse, and skin temperature, which the previous study had shown that these parameters improved with VR-based stress management program.\textsuperscript{29} Another limitation of this study was due to baseline heterogeneity of the participants across the intervention groups that could influence the outcome of the study. The potential factors for this heterogeneity were due to the selection bias as a result of convenient sampling methods with volunteer-based participation. Even though randomization process was done after the recruitment to minimize the bias, this issue was only identified during the data analysis phase. In the future, we recommend to use stratified sampling method to ensure equal representation or every subgroup in each intervention arm.

The present study is a feasible psychological intervention for stress, anxiety, and depression. This study also provides further evidence toward exploring the benefits of VRET as a part of positive emotion interventions among healthy adults in the future.

**Ethics Committee Approval:** This study was approved by the Universiti Kebangsaan Malaysia Medical Centre (UKMMC) Medical Ethics Committee ( Approval No: FF-2016-281, Date: 1.06.2016).

**Informed Consent:** Written informed consent was obtained from all participants who participated in this study.

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