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FEASIBILITY OF A BURNOUT PREVENTION MODULE IN A MOBILE APPLICATION FOR INFORMAL CAREGIVERS OF DEPRESSED INDIVIDUALS: AN EEG STUDY

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Abstract

This study evaluates the feasibility of the Burnout Prevention Module called WARM, delivered via a mobile application, based on neurophysiological evidence to assess its impact on informal caregivers of individuals with depression before and after the intervention. A quasi-experimental design was employed, utilizing electroencephalography (EEG) to assess changes in the alpha band power of ten informal caregivers. Alpha band power served as the primary indicator of neurophysiological changes. Pre- and post-intervention assessments measured the effectiveness of WARM in reducing caregiver burnout. The analysis revealed a statistically significant increase in alpha power post-intervention (M = 1.00) compared to pre-intervention measurements (M = 0.39), indicating a reduction in burnout levels. Additionally, significant interactions between brain location, pre/post-test status, and eyes open/closed conditions further demonstrated the positive influence of the intervention on neurocognitive responses. These findings contribute valuable evidence to the literature, demonstrating the effectiveness of mobile applications in supporting informal caregivers—a group often overlooked in mental health interventions. The results highlight the potential of technology-driven psychoeducational approaches to improve mental well-being and suggest that mobile-based interventions could play a crucial role in enhancing caregivers' coping strategies. This research supports future development of similar interventions aimed at promoting caregiver resilience and improving their overall mental health.

Keywords: Alpha Power; Burnout Prevention; Caregivers; EEG; Mobile Application.

INTRODUCTION

The likelihood of experiencing mental health problems is significantly influenced by age, gender, ethnicity, income, marital status, social interactions, and physical health (Samsudin et al., 2023). The COVID-19 pandemic has significantly impacted mental well-being worldwide, with lockdowns and social distancing leading to social isolation, income loss, loneliness, decreased physical activity, limited access to essential services, increased availability of food, alcohol, and online gambling, and weakened family and social support, particularly for vulnerable groups (Moreno et al., 2020).

According to the National Health and Morbidity Survey (NHMS) 2023, 1,000,000 (4.6%) people aged 16 and above have depression and the number indicated that people with depression doubled from 2019 to 2023. There is no recent data on the number of informal caregivers in Malaysia after 2019. In that year, 5.7% of the adult population were identified as informal caregivers. It is believed that this figure has risen, as the number of individuals with depression has doubled between 2019 and 2023. It is crucial to acknowledge that the NHMS 2019 may not fully represent the extent of informal caregiving in Malaysia due to its cross-sectional design, which fails to capture the evolving nature of caregiving, as well as variations in definitions and methodologies that can impact the accuracy and comparability of prevalence estimates across studies (Yusri & Khairudin, 2024). Burnout was first introduced in the 1970s by Herbert Freudenberger to describe the increasing emotional exhaustion and

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decline in motivation he observed among volunteers in aid organisations (Demerouti et al., 2021). Over the years, studies have further defined burnout as physical, emotional, and mental fatigue resulting from prolonged stress and inadequate resources (Maslach & Leiter, 2016). Leng et al. (2018) report that family caregivers of individuals with severe mental illness often experience a reduced quality of life. Carswell et al. (2024) emphasise that informal caregivers regularly face substantial burnout due to the demands of caring for individuals with severe mental illness and chronic conditions, while Fenstermacher et al. (2022) found that the "sandwich generation," responsible for both children and elderly parents, experiences even greater burnout. Challenges for informal caregivers include the demanding nature of caregiving, societal stigma, the emotional toll of witnessing a loved one suffer, and balancing multiple roles. Lu et al. (2019) identified feelings of isolation, mental exhaustion, and a sense of entrapment among caregivers. These findings highlight the substantial challenges caregivers face and the need for targeted support. While not directly focused on caregivers of individuals with depression, this body of literature illuminates the broader spectrum of challenges and burdens experienced by caregivers in analogous contexts. Such studies offer critical insights into the psychological and emotional tolls that caregivers of individuals with depression are likely to encounter, underscoring the universal strain caregiving responsibilities impose across different caregiving scenarios. Zeeshan et al. (2021) pointed out that mothers of children with disabilities, especially those with lower education, multiple disabled children, and those living in joint families, require additional resources to prevent burnout. In Malaysia, Jawahir et al. (2021) demonstrated that caregiving significantly impacts caregivers' health and daily activities, emphasising the need for community and governmental support. Additionally, Lu et al. (2019) found that caregivers of stroke survivors face challenges that harm their well-being, resulting in isolation and emotional exhaustion due to societal expectations and inadequate support. Zhou et al. (2021) highlighted that primary family caregivers with more caregiving knowledge and skills are more likely to adopt positive coping strategies, improving their mental well-being. Finally, Riches et al. (2022) stressed the importance of policymakers and support organisations considering the entire family's needs, not just those of the care recipient.

Examining burnout from a neurocognitive perspective is essential as it offers critical insights into the physiological and neural mechanisms related to this condition. Neurocognition involves the relationship between cognitive processes and brain activity. In neurocognition perspective, burnout was associated with alpha power (De Sousa & Sail, 2021; Golonka et al., 2019; Tement et al., 2015). It has been shown that individuals with burnout showed reduced P300 amplitude, and a lower alpha peak frequency (Van Luijtelaar et al., 2010). The alpha frequency band in electroencephalogram (EEG) pertains to brain wave oscillations occurring between 8 to 12 Hz. This frequency range is commonly observed during periods of relaxed wakefulness and is connected to feelings of calmness and relaxation (Putman, 2000). By exploring the neurocognitive dimensions of burnout, researchers can enhance their understanding of the neural alterations and cognitive functions experienced by individuals facing burnout. The link between burnout and alpha power, as indicated in studies by Tement et al. (2015) and Van Luijtelaar et al. (2010), underscores the significance of investigating brain oscillations in affected individuals. Alpha power, a key frequency range observed in the EEG during calm wakefulness, is found to be reduced in those experiencing burnout, suggesting a change in brain activity that may reflect heightened mental strain and stress. This increased activity of cortisol, a hormone associated with stress, is thought to play a role in the burnout experience. Furthermore, studying the neurocognitive facets of burnout can reveal potential compensatory mechanisms that individuals may develop, with reduced alpha power possibly serving as an adaptive strategy to manage the demanding and stressful circumstances linked to burnout, as indicated by Golonka et al. (2019).

Psychoeducation typically involves providing fundamental information to patients and their families about a specific mental disorder (Sarkhel et al., 2020). To the best of the researcher's knowledge, this is the first study in Malaysia specifically tailored to informal caregivers, utilising a Burnout Prevention Module delivered through a mobile application, which serves as a form of psychoeducation to enhance awareness and understanding of burnout and its prevention strategies. In the current research, a mobile application known as WARM, which includes a Burnout Prevention Module, has been utilised as an intervention or treatment for the experimental group. Leveraging technology within the mobile application offers an innovative approach to connect with informal caregivers, fostering a sense of community and shared experience while addressing the critical issue of caregiver burnout. This study focuses on the following research objective is to evaluate the feasibility of the Burnout Prevention Module delivered via a mobile application by assessing the neurophysiological evidence (alpha power) of Informal Caregivers of Individuals with Depression before and after the intervention. Based on the research objective, two hypotheses have been developed and tested through statistical analysis.

Hypothesis 1: There is a significant interaction effect between the pre/post-test and Experimental/Control Group on the Alpha power

Hypothesis 2: There is a significant interaction effect between location of the brain, pre/post-test, eye opened/closed and Experimental/Control Group on the Alpha power

RESEARCH METHODOLOGY

This study employed a quasi-experimental design, specifically a pre/post-test control group design, to evaluate the feasibility of the Burnout Prevention Module delivered via a mobile application by assessing the neurophysiological evidence (alpha band power) of Informal Caregivers of Individuals with Depression before and after the intervention. The pre-test, administered prior to the intervention or treatment, established a baseline for evaluating initial conditions, whereas the post-test, conducted after the intervention or treatment, measured the module's effects on the caregivers' neurophysiological outcomes. This research design incorporated a pre/post-test to assess any potential changes in alpha power resulting from the treatment, enabling the researchers to evaluate the treatment's impact on the participants. The data was collected using EEG recording. No demographic information was collected from the participants except for their nickname and contact number. The EEG recording for Alpha power was collected pre/post-test. The research obtained permission from the Centre for Research in Psychology and Human Well-being (PsiTra), Faculty of Social Sciences and Humanities, The National University of Malaysia, to conduct the experiment. Feasibility studies typically do not require formal sample size calculations but focus on ensuring the sample reflects the target population and meets inclusion criteria to assess the practicality of the main study

(Thabane et al., 2010). In this research, a purposive sample of 10 participants, consisting of five females and five males, was selected. Purposive sampling was employed, which means that the researcher intentionally and deliberately chose participants among Informal Caregivers of Individuals with Depression. The participants were recruited through Facebook Group. The Facebook Group served as a support group for Depression Sufferers and Survivors, and the researcher utilised this platform to reach out to family members of individuals with depression for recruitment. The decision to approach the support group of depression sufferers was due to the absence of any existing caregivers' support group on Facebook. The participants were screened for eligibility before being invited to participate in the experiment. The inclusion criteria are:

1) Age eligibility requires individuals to be 18 years or older
2) Residing in Klang Valley and willing to commute to UKM for EEG test
3) Providing care to the patient for a minimum of three months is a requirement
4) Sufficient proficiency in the English language is required to comprehend the instructions and interventions effectively

The 10 participants who provided consent by completing the consent form to participate in the experiment were divided into two groups: the experimental group (n=5) and the control group (n=5). The experimental group was enrolled and assigned to receive the intervention. On the other hand, the control group did not receive any treatment. The participant was not informed which group they were assigned to until the end of the experiment. All participants from the Experimental and Control groups were asked to visit UKM Cognitive Lab twice for session 1 (pre-test) and session 2 (post-test) throughout the experiment. Upon agreeing on a date for the EEG recording of the first session in UKM Cognitive Lab, the participants were asked to fill in a consent form, which included a research information sheet. The baseline measure of brainwaves was conducted prior to the intervention treatment using EEG tests. The post-measurements were conducted immediately after the last session for the Experimental Group, which was on day 8th. Similarly, the Control Group was also requested to do a post-test on day 8th, which consisted of EEG tests. The EEG recording included both eyes opened and eyes closed segments. The experimental procedure for EEG recording in both the Experimental and Control Groups was carried out as follows:

1) The experiment was conducted individually in the cognitive lab, which was also locked to minimise any disturbance from outside.
2) The researcher briefly explained the information, procedure, and risks of the experiment.
3) The researcher then explained that there were two parts of the recording. Part 1 involved the first EEG recording where the participant needed to keep their eyes opened for 3 minutes. During the eyes open EEG recording, the participant was asked to look straight at the wall in front of them. Part 2, the second EEG recording, required the participant to close their eyes for 3 minutes. In both parts, the participant was asked to remain calm.

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4) The researcher connected all the EEG electrodes to EASYCAP on the participant's scalp. Eight electrodes were connected, namely F3, F4, P3, P4, Cz, Pz, and FCz (Figure 1.0).
5) Figure 2.0 shows electrodes being connected to participants using NuPrep Skin Prep Gel and cotton swabs to ensure good connectivity between the gel, scalp and electrodes.
6) The EEG recording was conducted using Recorder V-Amp Edition and later analysed using Online Info - Analyzer 2.0.
7) At the end of the recording, the researcher removed all the cotton swabs, electrodes, and the EASYCAP from the participant. The researcher expressed gratitude to the participant for volunteering to participate in the experiment. At the end of the pre-test, the participant was required to book their second session or post-test.
8) The researcher repeated all the above procedures for the second session. At the end of the post-test, the researcher expressed gratitude to the participant and transferred RM 50 to the Experimental Group participant and RM 20 to the Control Group participant via e-wallet as a token of appreciation.
9) Each of the EEG recording sessions would last approximately 30 minutes.

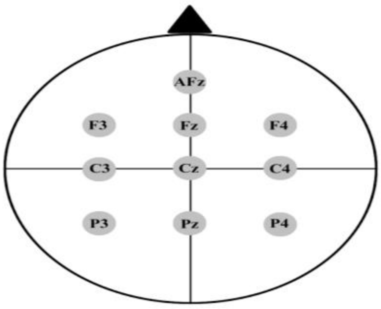

Figure 1.0: Electrode Position on the Scalp

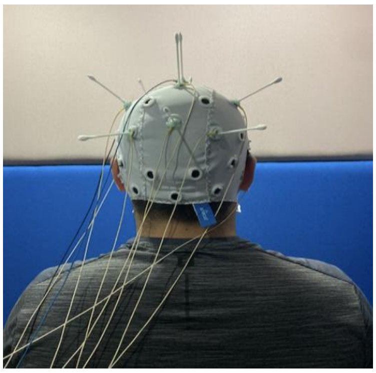

Figure 2.0: Participant AA

Analysis

Upon completion of session 2 (pre/post-test) for both groups (n=10), the collected data was analysed using statistical analysis software, specifically the Statistical Package for Social Sciences 26 (SPSS Version 26). The data from the pre/post-test EEG recordings were analysed separately using inferential analysis. The inferential analysis included Repeated Measures ANOVA and Partial Correlation.

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RESULTS

Hypotheses 1: There is a significant interaction effect between pre/post-test and Experimental/Control Group on the Alpha Power

Wilks' Lambda is a recommended statistical measure to determine whether there are any notable distinctions among the sets of dependent variables arranged in a linear arrangement. If the calculated significance level of Wilks' Lambda is less than 0.05, it indicates that there is a significant difference within the group of dependent variables (Pallant, 2010).

Table 1.0 shows that there was a statistically significant interaction between Pre/Post-test and Group, $F(1, 8) = 8.69$, $p < .0005$, partial $\eta 2 = .52$.

Table 1.0: Repeated Measure ANOVA Analysis of Variance on Pre/Post-test and Group

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Pre/ Post-test and Group	Pillai's Trace	0.52	8.69	1	8	0.02	0.52
	Wilks' Lambda	0.48	8.69	1	8	0.02	0.52
	Hotelling's Trace	1.09	8.69	1	8	0.02	0.52
	Roy's Largest Root	1.09	8.69	1	8	0.02	0.52

Since the result is significant in Repeated Measure ANOVA, post hoc comparison was further conducted in Table 2.0 using Bonferroni test. Bonferroni-corrected *post hoc* tests revealed a statistically significant difference between the pre-test (M = 0.39) and post-test (M = 1.00) of Experiment Group, $p = .05$; but not the pre-test (M = 0.76) and post-test (M = 0.25) of Control Group, $p > .05$. Overall, the results of this study indicate that participants in the Experimental group are more likely to have an increase in Alpha power compared to participants in the Control group.

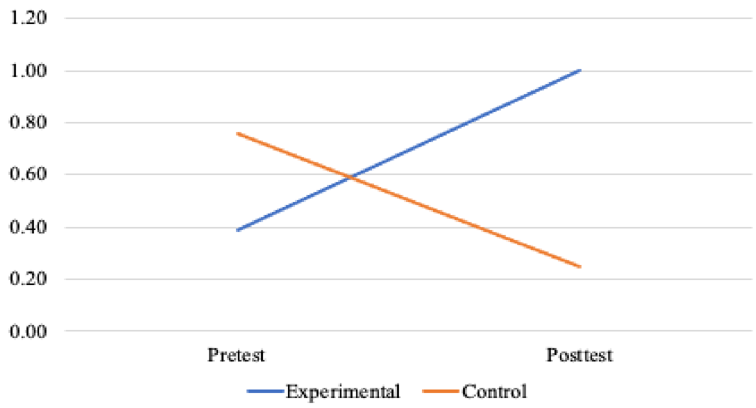

Figure 3.0: Repeated Measure ANOVA Analysis of Variance

Table 2.0: Pairwise Comparisons

Group	(I) Pre/ Post-test	(J) Pre/ Post-test	Mean Difference (I-J)	Std. Error	Sig.
Experimental	1	2	-0.61	0.27	0.05
	2	1	0.61	0.27	0.05
Control	1	2	0.51	0.27	0.10
	2	1	-0.51	0.27	0.10

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Hypotheses 2: There is a significant interaction effect between location of the brain, pre/post-test, eyes opened/closed and Experimental/Control Group on the Alpha Power

Based on Table 3.0, there was a statistically significant difference in Location of the Brain, Pre/Post-test, Eyes Opened/Eyes Closed and Group, F (2, 7) = 6.83, p < .0005, partial η2 = 0.66.

Table 3.0: Repeated Measure ANOVA Analysis of Variance

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Location of the Brain, Pre/Post-test, Eyes Opened/Closed and Group	Pillai's Trace	0.66	6.83	2	7	.02	.66
	Wilks' Lambda	0.34	6.83	2	7	.02	.66
	Hotelling's Trace	1.95	6.83	2	7	.02	.66
	Roy's Largest Root	1.95	6.83	2	7	.02	.66

Since the result is significant in Repeated Measure ANOVA, post hoc comparison was further conducted in Table 4.0. using the Bonferroni test. Bonferroni-corrected *post hoc* tests revealed a statistically significant difference between the Parietal Post-test Eyes Closed (M = 0.26) and Frontal Post-test Eyes Closed (M = 0.94), *p* < .05 of Experimental Group; the Parietal Post-test Eyes Closed (M = 0.26) and Central Post-test Eyes Closed (M = 0.94), *p* < .05 of Experimental Group; and the Parietal pre-test Eyes Closed (M = 0.26) and Central pre-test Eyes Closed (M = 0.94), *p* < .05 of Control Group; but no statistically significant difference for the rest of the location of the brain. Overall, the results of this study indicate that participants in the Experimental group are more likely to have an increase in Alpha power at the Parietal Lobe after Burnout Prevention Module was introduced (intervention) compared to participants in the Control group.

Table 4.0: Pairwise Comparisons

Group	Pre/ Post-test	Eyes Opened and Closed	(I) Location	(J) Location	Mean Difference (I-J)	Std. Error	Sig.
Experimental	Pre-test	Eyes Opened	Frontal	Central	-0.09	0.06	0.60
				Parietal	-0.47	0.19	0.12
			Central	Frontal	0.09	0.06	0.60
				Parietal	-0.38	0.23	0.40
			Parietal	Frontal	0.47	0.19	0.12
				Central	0.38	0.23	0.40
		Eyes Closed	Frontal	Central	-0.46	0.25	0.31
				Parietal	-0.33	0.32	0.97
			Central	Frontal	0.46	0.25	0.31
				Parietal	0.13	0.26	1.00
			Parietal	Frontal	0.33	0.32	0.97
				Central	-0.13	0.26	1.00
	Post-test	Eyes Opened	Frontal	Central	0.19	0.27	1.00
				Parietal	-0.71	0.37	0.27
			Central	Frontal	-0.19	0.27	1.00
				Parietal	-0.90	0.59	0.49
			Parietal	Frontal	0.71	0.37	0.27
				Central	0.90	0.59	0.49
		Eyes Closed	Frontal	Central	0.20	0.13	0.49
				Parietal	-1.05*	0.24	0.01

			Central	Frontal	-0.20	0.13	0.49
				Parietal	-1.24*	0.30	0.01
			Parietal	Frontal	1.05*	0.24	0.01
				Central	1.24*	0.30	0.01
Control	Pre-test	Eyes Opened	Frontal	Central	0.08	0.06	0.70
				Parietal	-0.27	0.19	0.58
			Central	Frontal	-0.08	0.06	0.70
				Parietal	-0.35	0.23	0.49
			Parietal	Frontal	0.27	0.19	0.58
				Central	0.35	0.23	0.49
		Eyes Closed	Frontal	Central	0.14	0.25	1.00
				Parietal	-0.87	0.32	0.07
			Central	Frontal	-0.14	0.25	1.00
				Parietal	-1.02*	0.26	0.01
			Parietal	Frontal	0.87	0.32	0.07
				Central	1.02*	0.26	0.01
	Post-test	Eyes Opened	Frontal	Central	-0.06	0.27	1.00
				Parietal	-0.32	0.37	1.00
			Central	Frontal	0.06	0.27	1.00
				Parietal	-0.26	0.59	1.00
			Parietal	Frontal	0.32	0.37	1.00
				Central	0.26	0.59	1.00
		Eyes Closed	Frontal	Central	-0.21	0.13	0.39
				Parietal	-0.10	0.24	1.00
			Central	Frontal	0.21	0.13	0.39
				Parietal	0.12	0.30	1.00
			Parietal	Frontal	0.10	0.24	1.00
				Central	-0.12	0.30	1.00

DISCUSSION

This research revealed that informal caregivers of individuals with depression in Experimental group experienced an increase in Alpha power after the intervention was introduced, supporting the research hypothesis that there is a significant interaction effect between pre/post-test and Experimental/Control Groups on the Alpha power. To understand the significance of this increase in Alpha power, it is essential to consider the study conducted by Golonka et al. (2019), which analysed the psychophysiological characteristics of burnout syndrome using resting-state EEG. Golonka and colleagues found lower alpha power in individuals with burnout, suggesting alterations in alpha band activity are associated with burnout. Variations in alpha oscillations, especially in the occipital area of the brain, have been observed to differ among individuals and may be linked to their psychological conditions, such as stress and burnout (Minami et al., 2020). However, the increase in Alpha power observed in the experimental group suggests that the intervention may have yielded beneficial outcomes for informal caregivers by alleviating their burden and enhancing their quality of life, underscoring the need for specialized interventions (Wiegelmann et al., 2021).

While the relationship between Alpha power and burnout is complex, the increase in Alpha power observed in the experimental group suggests that the mobile application intervention had a positive impact on the caregivers' emotional well-being. The application being accessible on mobile devices, allows caregivers to access the evidence-based resources they need whenever and wherever they require it (Sala-González et al., 2021). Mobile applications are effective for delivering psychological interventions in university settings, addressing stress, anxiety, and depression among

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students (Oliveira et al., 2021), and systematic reviews affirm that mobile phone-based psychotherapies are feasible, acceptable, and yield positive outcomes for various mental health disorders (Menon et al., 2017). This accessibility empowers caregivers to take charge of their emotional well-being on their own terms and at their own convenience. For example, the app may offer mindfulness exercises, stress reduction techniques and other tools that can be utilised at any time that suits the caregivers' needs and schedule. By having these resources readily available, caregivers can incorporate them into their daily routines and coping strategies. Research indicates that users tend to have a favourable perception of mental health apps, highlighting the significance of usability, content relevance, and privacy in improving user engagement (Chan & Honey, 2021). According to Zhai et al. (2023), interventions delivered through technology may improve caregivers' access to self-care, alleviate their anxiety and depression, enhance quality of life, coping mechanisms, communication strategies, and relationships with care recipients, ultimately benefiting the well-being of both patients and caregivers.

This research revealed that Informal Caregivers of Individuals with Depression in the Experimental groups experienced an increase in Alpha-band power at the Parietal lobe after the intervention was introduced, supporting the second research hypothesis that there is a significant interaction effect between the location of the brain, pre/post-test, eyes opened/closed, and Experimental/Control Groups on the Alpha Power. Alpha waves, which are prominent during daydreaming, relaxation, and difficulty focusing, promote calmness and deep relaxation, while their suppression can lead to anxiety, stress, and insomnia; optimal levels, however, result in a relaxed state (Abhang et al., 2016). Peak Alpha Frequency is regarded as a possible indicator of cognitive deterioration in response to stress (LoMauro et al., 2022). The analysed data aligns with a study conducted by Volodina et al. (2021) that reported similar findings. In both studies, an increase in parietal alpha power was observed during the *relaxed state* (eyes closed) after the intervention was introduced. The stronger the Alpha attenuation, the higher the cognitive load or task engagement (Magosso et al., 2019; Hilla et al., 2020). Conventional theories assign P3a to the frontal lobe and P3b to the parietal lobe; however, the study's results indicated a central-frontal peak for both components, suggesting a more integrated cognitive processing model, while concurrent activation of these regions during cognitive tasks highlights the complexity of attention-related neural activity (Schreiner & Staudigl, 2020). In the context of the WARM app for informal caregivers of individuals with depression, an increase in alpha power at the Parietal lobe observed after the intervention could suggest that the caregivers may experience a more relaxed and less stressed mental state. In contrast, the control group displayed a decrease in Alpha band power from pre-test to post-test. It is important to note that the control group served as a comparison group and did not receive any specific burnout prevention training or interventions. They were not provided with additional support or strategies to manage burnout symptoms. Therefore, any changes observed in the control group's burnout levels during the study period were likely influenced by factors unrelated to the interventions being investigated. As a result, the absence of statistically significant interaction in alpha band power suggests that the lack of training or intervention had little noticeable impact on the control group's burnout levels throughout the study. Nevertheless, the participants in the control group will have the opportunity to receive appropriate interventions after the study concludes.

CONCLUSION

This research demonstrates the feasibility of the mobile application-based Burnout Prevention Module (WARM) as a psychoeducational tool for informal caregivers of individuals with depression. Neurophysiological evidence shows a significant increase in alpha power in the experimental group, with Repeated Measures ANOVA revealing a notable interaction effect between pre/post-test results and control groups. Findings also highlight significant interactions among brain location, pre/post-test status, and eyes opened/closed, supporting the intervention's positive interaction on neurocognitive responses. The WARM application offers an accessible means of supporting caregivers, alleviating feelings of isolation and emotional exhaustion while enhancing mental well-being. Insights into neurocognitive aspects of burnout could guide future interventions aimed at improving caregivers' coping strategies. This research's small sample size (ten participants) limits generalizability, and the lack of demographic data hinders analyses of factors like age and caregiving experience. The quasi-experimental design raises potential bias concerns due to non-random group assignments. Future studies should involve larger, diverse samples and longitudinal designs to assess long-term effects. Incorporating qualitative methods and exploring additional neurocognitive measures could provide deeper insights into burnout dynamics and intervention efficacy.

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