

# Counting Blessings Promotes an Athlete's Sleep Quality Before an Upcoming Competition A Single-Case Study

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## Case report

**Keywords:** elite athletes, gratitude intervention, sleep disturbance, portable EEG, individualized intervention

**Posted Date:** June 2nd, 2021

**DOI:** <https://doi.org/10.21203/rs.3.rs-556903/v1>

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## **Abstract**

## **Background**

Promotion of sleep quality without medication is a critical issue, which may directly or indirectly influence sports performance. This study adopted electroencephalography (EEG) to investigate gratitude intervention for improving elite athletes' sleep quality before the National Games.

## **Case presentation:**

We recruited a 20-year-old elite female Taekwondo athlete as a participant. Before the National Games, the athlete wore a micro EEG device for five days to collect baseline data and then counted her blessings as a gratitude intervention for the subsequent five days. The sleep EEG analysis included the power ratio and the polynomial regression trends in the 0.5-4 Hz band for N3 sleep and in the 0.5-4 Hz and 8–13 Hz bands for all-night sleep. Sleep quality was improved after counting blessing both subjectively and objectively. The polynomial regression curves for the 10 days of recording showed an upward tendency of power in the 0.5-4 Hz band for N3 and a downward tendency in the 8–13 Hz band.

## **Conclusion**

This study describes a useful wearable EEG device for evaluating sleep during the competition preparation period. In addition, the brief gratitude intervention can be applied in practice to enhance sleep quality for elite athletes during periods of high tension.

## **Background**

Sleep is important to human and athletic performance. Fullagar, Skorski (1) reviewed the effects of sleep deprivation and sleep restriction based on athletes' physiological response, cognitive performance, and mood response. Thus, sleep quality is closely related to athletes' optimal performance. In this regard, identifying factors that enhance sleep quality is a critical issue. Previous studies have developed different approaches to improving individuals' sleep quality, such as exercise, mindfulness (2), and cognitive behavioral therapy (3). One novel strategy that has received attention recently is gratitude intervention. Emmons and McCullough (4) found that counting blessings increased hours of sleep in patients with neuromuscular disease. In addition, Digdon and Koble (5) found that a gratitude intervention improved cognitive and somatic pre-sleep arousal and worry and increased total sleep time and sleep quality compared to baseline.

Dispositional gratitude is viewed as a moral affect and not just a personality trait. Weiner (6) explained that gratitude has two steps. People obtain happiness through a positive outcome and then attribute the happiness to external sources, such as others or the surroundings. This kind of happiness is viewed as

gratitude. One study revealed that grateful people are prone to mood stability and tend to exhibit more positive outcomes (4). Hence, some researchers developed a gratitude intervention and found that it can lead to increases in well-being, positive affect, and sleep quality (4). For example, researchers found that dispositional gratitude improved sleep quality because it mediated pre-sleep cognitions by promoting positive pre-sleep cognitions and diminishing negative pre-sleep cognitions to protect sleep quality. (7).

To the best of our knowledge, three studies have directly manipulated gratitude to investigate its effect on individuals' sleep quality. Emmons and McCullough (2003) were the first to use counting blessings to manipulate gratitude, and they found, based on self-report data, that it increased hours of sleep in patients with neuromuscular disease. Furthermore, Jackowska, Brown (8) measured sleep by the Pittsburgh Sleep Quality Index and added several biological measures and found that a brief gratitude intervention could improve sleep quality and decrease diastolic blood pressure. Lastly, Digdon and Koble (5) also used self-report questionnaires and showed that a gratitude intervention resulted in significant changes in pre-sleep arousal, bedtime worry, and sleep quality compared to baseline levels but no significant changes in bedtime thinking, worry, anxiety, or sleep onset latency.

As reviewed above, previous studies have provided evidence demonstrating that gratitude improves an individual's sleep quality. However, there are two obvious weaknesses that need to be further investigated: there is no objective indicator to index the improvement of sleep quality, and the intervention has not been examined in a population that experiences periodic stress, such as athletes anticipating upcoming competitions. Therefore, we used EEG to collect objective indicators to eliminate recall bias, which we believe increases the internal validity of our study. These indicators are the EEG alpha (8–13 Hz) power ratio, EEG delta (0.5–4 Hz) power ratio, and EEG delta (0.5–4 Hz) power ratio in sleep stage N3. The EEG alpha power ratio represents the degree of wakefulness of a subject and is an index of whether the brain is at rest or not. During deep sleep, stage N3 consists of high-voltage ( $> 75 \mu\text{V}$ ) and low-frequency ( $< 2 \text{ Hz}$ ) activity. When it is not in stage N3, the brain still needs to organize memories and information from daily life during sleep. In other words, the brain is only truly resting in stage N3. Therefore, the EEG delta (0.5–4 Hz) power ratio and EEG delta (0.5–4 Hz) power ratio in stage N3 can be used as indices of the deepness of sleep.

We applied a gratitude intervention immediately before the National Games to test the efficacy under extremely competitive conditions. The National Games is the highest and largest comprehensive sports competition in Taiwan, which is held every two years. The authors believe that sport provides the ideal conditions for examining the positive effect of a gratitude intervention because athletes participating in this event are top in their field, and the outcome of the competition determines their future career, whether this is a ticket to the Olympics or a guarantee of recruitment by a top university. It is conceivable that such a stressful situation would disturb sleep quality, especially as the day of the competition nears. Therefore, we chose to conduct research at this time point to examine our hypothesis.

In sum, the aim of the current study was to examine the positive effect of a gratitude intervention on elite athletes' sleep quality. We conducted our experiment before an upcoming competition and adopted

objective indicators of sleep quality to provide new insights for the gratitude literature.

## Case Presentation

### Participant

The participant is a female Taekwondo athlete (20 years old) who reported that she spent approximately 4 to 6 hours per day in training. In addition, she had participated in Taekwondo for 9 years. Our study was approved by the National Taiwan University review board. The athlete was instructed to read the information sheet, and she signed an informed consent form before she began the survey. Therefore, her confidentiality and anonymity were ensured.

### Procedure

We conducted our experiment before the National Games of Taiwan. We asked the athlete to maintain her daily schedule without any changes and to wear a micro EEG when sleeping for five days to establish the baseline information. Then, we gave the following instructions to the athlete: *There are many things in our lives, both large and small, that we might be grateful for. Think back over today and write down on the lines below up to three things in your life that you are grateful or thankful for.* This approach is identical to that used by Emmons and McCullough (2003). The athlete was asked to count her blessings and email the list to the research assistant right before going to bed for five days, and the sleep process was recorded by a micro EEG. Thus, the current experiment involved a baseline step and an experimental step and lasted ten days in total. Our experiment ended five days before the National Games were held because we wanted to minimize interference for the athlete.

To calculate the objective indicator to index the improvement in sleep quality, we used a micro EEG recording system that is worn like an eye mask to record the all-night EEG signal and obtain the all-night sleep stages based on the automatic sleep scoring method that was also proposed in Liang, et al. (2015). (9) The EEG data were filtered with an eighth-order Butterworth bandpass filter with a cutoff frequency of 0.5–30 Hz. The continuous time signals were segmented into nonoverlapping 30 s epochs. Next, the objective indicator must be extracted from the EEG signal.

## Results

The results for the three objective indicators from a ten-consecutive-day sleep EEG analysis, including the power ratio and the polynomial regression trends in the 0.5–4 Hz band during N3 sleep and the 0.5–4 Hz and 8–13 Hz bands during all-night sleep, are shown in Fig. 1 [Figure I near here]. In addition, the polynomial regression trend curves were used to predict the trends of the three objective EEG indicators over the next two days. The X-axis and the Y-axis represent the values of the objective indicators and the recorded days, respectively. The solid line represents the indicator value as a function of the date, and the dashed lines represent the polynomial regression trend curves. The polynomial regression curves showed an upward power trend in the 0.5–4 Hz band during N3 and all-night sleep and a downward trend in the 8–

13 Hz band (see Fig. 1). This means that the objective index of the deepness of sleep showed an increasing trend and the objective index of the degree of wakefulness showed a decreasing trend after counting blessings.

## Discussion And Conclusions

The current study demonstrated that counting blessings improved athlete sleep quality before an upcoming competition. We found increased 0.5-4 Hz waves across days in N3 stage sleep and all-night sleep. This means that deepness of sleep and the amount of time that the brain spent in a true resting state showed increasing trends. In addition, all-night 8–13 Hz waves decreased across days, indicating that the athlete fell asleep more easily and may have had a decreased sleep onset time.

This research makes two main contributions: first, it provides objective indicators of sleep quality, and second, it examines a gratitude intervention in an acute stress context. To the best of our knowledge, this is the first study to use objective data to evaluate sleep quality in an athlete sample. Adopting EEG data as objective indicators gives this work several advantages over previous studies (5, 7, 10), such as reduced memory bias. Our study used EEG technology to quantify sleep quality, leading to a more reliable conclusion than in prior research. In addition, EEG data could serve as a benchmark for comparisons of results across studies because they exhibit less variation by race, culture, and language. Thus, the use of such data would promote communication between scholars. Furthermore, EEG records the entire sleep process, which facilitates the development of individualized gratitude interventions. We can provide gratitude interventions to those who have a low EEG delta power ratio and EEG delta power ratio in stage N3. Finally, our eye-mask EEG device is convenient and comfortable to use, increasing participants' willingness to cooperate with the researcher. This increases our ability to monitor athletes with sleep disturbance and provide individualized suggestions for them in the early stage of competition to enhance their athletic performance.

This study revealed that a brief gratitude intervention could improve sleep quality even in high-stress situations. Nearly all previous studies tested gratitude interventions in general daily life (5, 7, 10). This raised doubts about whether this method was suitable for high-stress contexts such as sports competitions. Obviously, our study demonstrated that a gratitude intervention can be applied in practice directly, implying high ecological validity. In addition, it should be noted that the current study was conducted in an acute stress situation and differed from a previous study focusing on patients with chronic stress (4). Thus, we have contributed new knowledge to the literature by demonstrating that a gratitude intervention can improve sleep quality under acute stress as well as chronic stress conditions.

## Limitations and future directions

Some researchers might criticize the small sample size in our study. From a practical perspective, however, it is extremely difficult to recruit athletes to participate in experiments when they are preparing for an important competition since their performance is directly related to future rewards. Thus, a case

report might be the most appropriate method in the current situation. More clearly, it is our intention to remind researchers that no single method can fit all situations. Second, we only explored sleep before a single event. The effect of gratitude interventions under different stressful conditions, like jet lag, injury, or during competition, needs to be further explored. Finally, the current study provided a more convenient approach for monitoring and manipulating sleep processes that could be applied in a variety of contexts, such as military training and musical performance. In doing so, individuals' stress might be alleviated, and their sleep quality and performance can be improved.

## Conclusion

This research demonstrated that a gratitude intervention enhanced an athlete's sleep quality under an acute stress situation based on objective evidence obtained via EEG. Therefore, it is an important reference for future studies seeking to explore brief, effective, and directly applicable non-drug interventions to improve sleep quality in sports.

## List Of Abbreviations

EEG: electroencephalography

## Declarations

**Ethic approval and consent to participate:** All procedures performed in studies involving human participants were in accordance with the ethical standards of the Institutional Reviewer Board of National Taiwan University (201712ES027) and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual adult participants included in the study.

**Consent for publication:** Not applicable

**Availability of data and materials:** The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

**Competing Interest:** The authors declare no competing interests.

**Funding:** This study was supported by Ministry of Science and Technology (MOST 107-2410-H-179 -005 -MY3, 108-2221-E-035 -064 & 109-2634-F-006 -013), Taiwan, R.O.C.

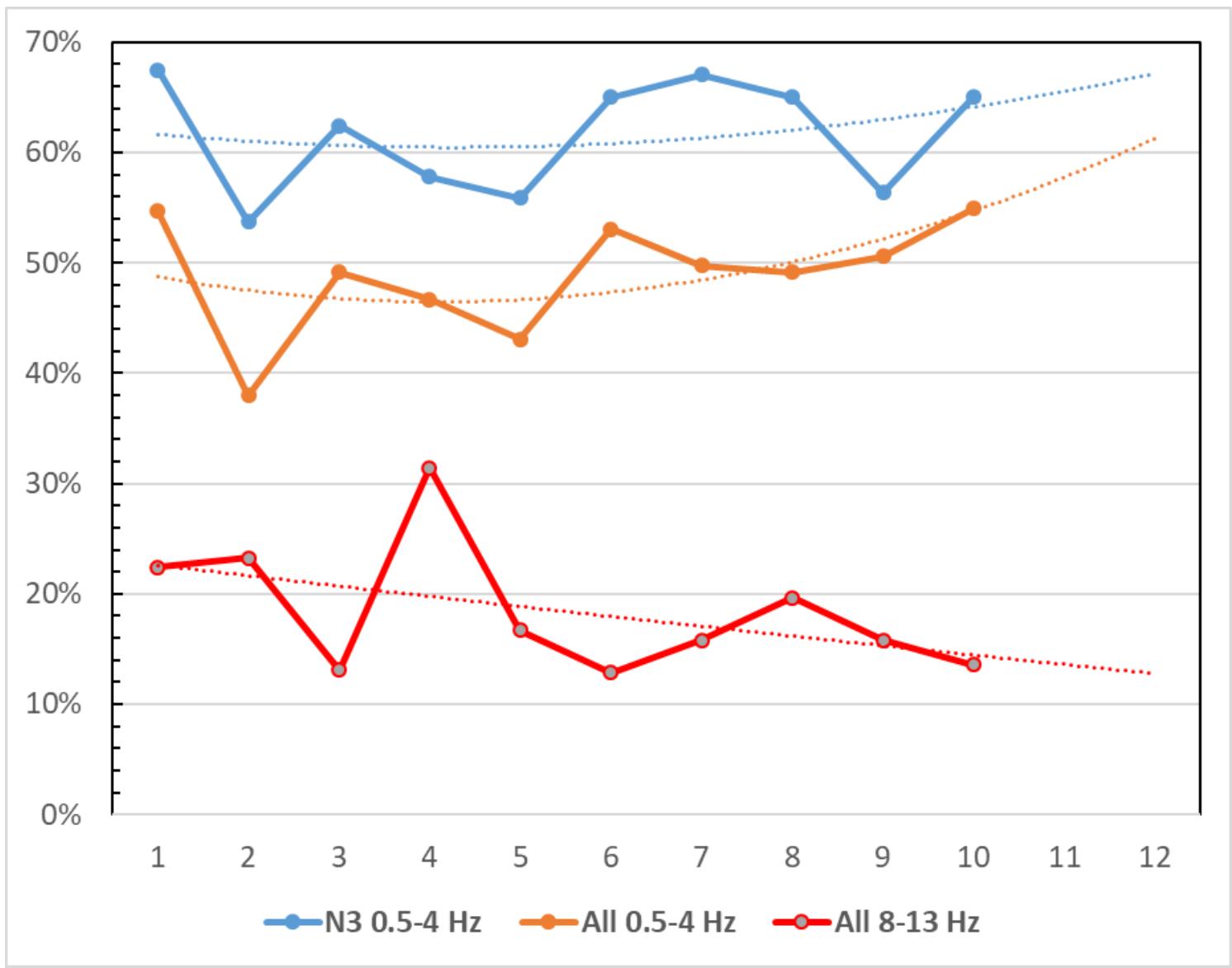
**Authors' contribution:** JHC was major contributor in writing this article, CEK analyzed and interpreted the brain wave data, LHC constructed and performed this study and also reviewed the full article content.

**Acknowledgements:** Not applicable

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## Figures



**Figure 1**

The power ratio and polynomial regression trend curve of N3 0.5-4 Hz, All 0.5-4 Hz, and All 8-13 Hz, respectively. The X-axis represents the values of the objective indicators and the Y-axis represents the recorded days. The solid line represents the indicator value as a function of date and the dashed lines represent the polynomial regression trend curve.