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Wild Nutrition's Food-Grown® Magnesium Supplementation Increases Sleep Quality and Sleep Duration and Reduces Stress in a Healthy Adult Population: A Double-Blind, Randomised, Placebo-Controlled Study

David Briskey[1,2], Jane Erickson[2], Chelsie Smith[2], Amanda Rao[2]

[1]School of Human Movement and Nutrition Sciences, University of Queensland, Brisbane, Australia
[2]RDC Clinical, Brisbane, Australia
Email: amanda@rdcglobal.com.au

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Abstract

Background: Magnesium, an essential mineral crucial for various bodily functions, has been shown to positively influence sleep patterns. This study aimed to evaluate the efficacy of Food-Grown® magnesium in enhancing sleep quality and duration, as well as overall well-being. **Methods**: Eighty participants were randomly assigned to receive either 80 mg of Food-Grown® magnesium or a placebo (microcrystalline cellulose) daily for 8 weeks. Participants completed questionnaires assessing sleep quality, daytime drowsiness, quality of life, anxiety, and stress levels. Additionally, participants maintained daily sleep diaries and wore wrist-worn actigraphy devices. The primary outcome measured was the change in sleep quality and duration. **Results**: Seventy-one participants fulfilled all study requirements (35 in the active group and 36 in the placebo group). Magnesium supplementation significantly improved reported sleep quality, with the active group showing a 32% increase compared to 16% in the placebo group ($p = 0.034$). Moreover, magnesium supplementation led to a decrease in reported stress scores at week 8 compared to the placebo group (3.7 ± 2.6 vs. 5.5 ± 3.1, respectively). Both the magnesium and placebo groups exhibited significant increases in reported sleep duration and reductions in time to fall asleep, sleep disturbance, sleep latency, sleep medication usage, and total Pittsburgh Sleep Quality Index score at week 8 compared to baseline. **Conclusion**: Magnesium supplementation notably enhanced sleep quality and reduced stress levels compared to the placebo group. These findings highlight the potential of magne-

sium as a beneficial supplement for improving sleep quality and overall well-being.

Keywords

Magnesium, Sleep Quality, Sleep Duration, Stress, Food-Grown

1. Introduction

Magnesium is an essential mineral involved in numerous metabolic processes within the body. Magnesium is important for the physiological function of the heart, brain, and skeletal muscle, [1] which includes muscle contraction and relaxation, and neurotransmitter release [2]. Magnesium acts as a cofactor in the activation of enzymatic processes including energy metabolism and protein synthesis [3] [4]. Magnesium is primarily stored in muscle, bone, and soft tissue [5]. Of all ingested magnesium, approximately 30% is absorbed within the intestines [1]. Most magnesium supplements available contain one of two sources of elemental magnesium, either organic salts, or inorganic [1]. The current recommended daily intake (RDI) of magnesium is 400 - 420 mg for adult males, and 310 - 320 mg of adult females. In addition to the RDI, the recommended upper intake level (UL) for magnesium supplementation is 350 mg [6].

Sleep health, which is defined as both the quality and duration, has been shown to be important for health and well-being [7]. The quality and duration of sleep is affected by cultural, social, behavioural, psychological, and environmental factors, and changes to society, including longer working hours and shift work, have seen people having fewer hours of sleep per day [8]. Reported symptoms include tiredness, sleepiness during the day, and general fatigue. Physiological impacts have been shown to affect metabolic, endocrine, and immune pathways [8]. Studies have shown that those who sleep less than 7 hours per night have an increased risk for coronary heart disease and diabetes compared with those getting more than 7 hours [9]. Therefore, it is important to find aids that can assist in improving sleep quality and duration.

Magnesium has often been used as an aid to assist in sleep quality, however, there are some inconsistencies as to whether it is effective in improving the quality and duration of sleep. A recent study examining the longitudinal association of magnesium intake showed that there was an association between those taking magnesium and the quality and duration of their sleep [10]. A different study that followed participants magnesium dietary intake over a 5-year period found that there was no difference in sleep disorder symptoms at baseline except for sleep duration and falling asleep in women [11]. Similarly, a study conducted on adults over 51 years old with poor sleep quality was unable to show definitively whether magnesium supplementation was able to improve sleep quality using the Pittsburgh Sleep Quality Index (PSQI) [12].

Whilst there is some evidence that improvements in sleep may be caused by magnesium supplementation, further research is required to substantiate these results. Based on this, the current study aims to assess the effectiveness of Wild Nutrition Food-Grown® Magnesium on sleep quality and duration in healthy adults. It is hypothesised that those in the active treatment group would show improvement in their sleep quality and duration.

2. Methods

This study was conducted as a randomised, double-blind, placebo controlled parallel clinical trial with an 8-week treatment intervention conducted between April 2023 and October 2023. Potential participants were screened against the full inclusion and exclusion criteria and given a full explanation of the trial and their requirements. Following screening, participants signed an electronic consent form to indicate their understanding of the study and willingness to be included.

Participants were included in this study if they were 18 years or older, able to provide informed consent, agreed not to change their current diet or exercise, agreed not to use medication or supplements for sleep or anxiety other than the test product during the study period, agreed not to participate in another clinical trial while enrolled in this study, experienced disturbed sleeping pattern (defined as difficulty falling asleep, waking up during the sleep cycle or waking up too early and being unable to fall back asleep) and otherwise healthy.

Participants were excluded if they had an unstable or serious illnesses (e.g., renal, hepatic, gastrointestinal, cardiovascular, diabetes, thyroid gland function), history of renal function impairment, regular sleeping patterns, current malignancy (excluding BCC) or chemotherapy or radiotherapy treatment for malignancy within the previous two years, received or prescribed coumadin (Warfarin), heparin, dalteparin, enoxaparin, or other anticoagulation therapy, and received or prescribed sleep or anxiety medications or aids. Other exclusion criteria included those with sleep apnea, diagnosed or consistent gastrointestinal issues that disrupted sleep, active smokers, nicotine use, or drug abuse, chronic past and/or current alcohol use (>14 drinks per week), allergic to any of the ingredients in the active or placebo formula, people with serious mood disorders (such as depression, anxiety, and bipolar disorder), night-shift employment and were unable to have a normal night's sleep, people suffering from any neurological disorders (e.g., MS), pregnant or lactating women, participated in any other clinical trial in the past month and any other sleep trial in the previous 6 months, clinically significant acute or chronic inflammation, or connective tissue disease or arthritis, history of infection in the 1 month prior, regularly consumed stimulants (e.g., coffee, caffeine supplements, caffeine containing beverages) 2 hours before bed, disturbed sleeping patterns caused by external factors (e.g., children, partner, noises), and any condition which in the opinion of the investigator made the participant unsuitable for inclusion.

Once enrolled, participants were randomised into one of two groups (magnesium or placebo) in a 1:1 ratio based on a randomisation code generated by random allocation software (sealedenvelope.com). All products were packed such to appear identical in appearance. All study participants, investigators conducting the study, and the statistician analysing the data were blind to which product participants received. Both groups were instructed to consume two capsules with water 1 hour before sleep. The magnesium group consumed a total of 80 mg of magnesium, and those in the placebo group consumed an equivalent amount of microcrystalline cellulose.

The primary outcome measure for this study was a change in sleep quality and duration as recorded in the participant's sleep diary, where duration of sleep was defined as the collective amount of sleep obtained each night. Secondary outcome measures included change in quality of life (SF-36 questionnaire), change in anthropometry (height, weight, BMI), change in sleep onset time [Pittsburgh Sleep Quality Index (PSQI), sleep diary, Polar A370 wrist actigraphy (Polar, Australia)], change in sleep pattern disturbance (PSQI, wrist actigraphy), change in daytime sleepiness [Epworth Sleepiness Scale (ESS)], restless leg symptoms (Restless Leg Syndrome Questionnaire), and anxiety and stress (DASS-21). Other measures included adverse events, change in medication use, and compliance. Each time data was recorded using the wrist actigraphy device, it was worn for 3 consecutive nights and a sleep diary was kept for the corresponding nights the device was worn.

Prior to starting on their allocated trial product, all participants undertook baseline measurements of the primary (recorded 3 days of sleep diary) and all secondary outcomes (SF-36, height, weight, BMI, PSQI, wrist actigraphy, ESS, DASS-21, and Restless Leg Syndrome Questionnaire). Once all baseline requirements were met, participants could start taking their allocated study product.

One week after starting supplementation, participants wore the wrist actigraphy device and complete a sleep diary for 3 consecutive nights. Four weeks after starting supplementation (mid-point), participants wore their wrist actigraphy device and completed sleep diaries, the PSQI, ESS, and Restless Leg Syndrome Questionnaire. Eight weeks after starting supplementation (end of study), participants repeated all baseline measures again. Throughout the study, participants were monitored for any adverse events/unusual effects, change in medication use and study compliance.

Power calculations determined a minimum of thirty participants per group were required to detect a 30% change between groups for the collective amount of sleep achieved each night (duration). Therefore, 40 participants were enrolled to allow for dropouts and maintain power. Statistical analysis was conducted by comparing each group to another using either GraphPad Prism 8.0 or SPSS 25 or later. All results were first tested for normality before any other test was conducted. Based on the distribution of the data, the appropriate statistical tests were used. In a parametric scenario, tests that were used were t-tests,

ANOVA/RMANOVA and ANCOVA to analyse between group differences. In a non-parametric scenario, tests that were used were the Kruskal-Wallis or Mann-Whitney test. General linear mixed modelling was also performed on participant data to compare the group dynamics. Results were considered statistically significant if $p < 0.05$.

This study was conducted according to the guidelines in the Declaration of Helsinki and all procedures involving human subjects were approved by National Institute of Integrative Medicine, approval number 0110E_2022. This trial was registered with the Australian and New Zealand Clinical Trial Registry (NCT05825209).

3. Results

Of the 80 participants enrolled in the study, 71 completed all study requirements and were thus included in the analysis (active group, n = 35; placebo group, n = 36). Among the 9 participants who withdrew, 6 did so due to adverse events. In the active group, adverse events included headache, nausea, heartburn, a salty taste left in the mouth, and light-headedness (n = 5), while in the placebo group, it was increased bowel movements (n = 1).

There were no differences observed between groups in baseline demographics, indicating that both groups were well matched (Table 1). Throughout the study duration, there were no significant differences between groups in terms of caffeine or alcohol consumption. Moreover, supplement compliance was similar between the active and placebo groups (91.5 ± 6.4% and 92.5 ± 6.75%, respectively). Additionally, no significant changes in medication use were reported by any participant in either group throughout the study.

Table 1. Participant demographics.

	Active (*n* = 35)	*Placebo* (*n* = 36)
Age (years)	44.3 ± 12.9	40.3 ± 12.0
Males (n)	12	9
Females (n)	23	27
Completed (n)	35	36
Height (m)	1.67 ± 0.07	1.66 ± 0.10
Weight (kg)	72.6 ± 12.7	70.1 ± 8.3
BMI (kg/m^2)	26.0 ± 4.5	25.3 ± 5.1

There were no differences observed in reported (sleep diary) sleep quality or duration between the groups at baseline or week 4. However, by week 8, the reported total sleep quality showed a statistically significant increase compared to the placebo group, with the score in the active group increasing by 32% compared to 16% in the placebo group (p = 0.034).

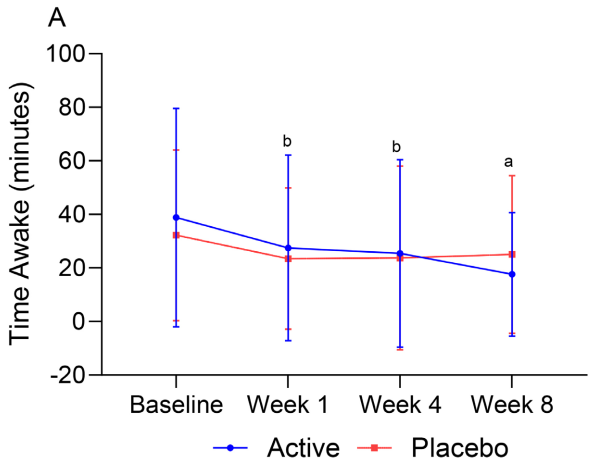
At week 1, three out of ten sleep diary measures were significantly different from baseline in the active group, while six out of ten were different in the placebo group. By week 4, five out of ten sleep diary measures were significantly different from baseline in the active group, compared to two out of ten in the placebo group. At week 8, four out of ten sleep diary measures were significantly different from baseline in the active group, while five out of ten were different in the placebo group (see Table 2 and Figure 1).

Table 2. Average scores for 7 out of 10 sleep diary parameters from 3 consecutive days of recording at baseline, week 1, 4 and 8.

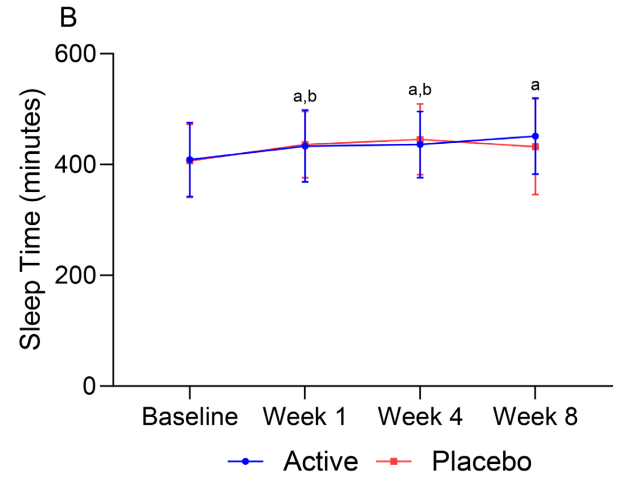
	Active (n = 35)				Placebo (n = 36)			
	Baseline	Week 1	Week 4	Week 8	Baseline	Week 1	Week 4	Week 8
Feeling rested (score)	2.6 ± 0.8	2.9 ± 0.8[a]	3.0 ± 1.1[a]	3.0 ± 1.1[a]	2.5 ± 0.8	2.7 ± 0.9	2.9 ± 0.7[b]	2.7 ± 0.9
Awakenings (n per night)	2.4 ± 2.0	1.9 ±1.7[a]	1.7 ± 1.7[a]	1.6 ± 1.6[a]	2.7 ± 1.6	2.1 ± 1.6[b]	1.6 ± 1.8[b]	1.9 ± 1.8[b]
Time trying to get back to sleep (minutes)	15.9 ± 22.8	11.8 ± 20.1	17.2 ± 24.9	9.7 ± 12.1	19.0 ± 17.1	15.0 ± 20.4	18.4 ± 34.2	16.5 ± 23.8
Time awake earlier than planned (minutes)	22.1 ± 45.7	14.4 ± 25.7	16.7 ± 28.7	10.7 ± 22.1	18.7 ± 20.2	16.4 ± 19.6	11.4 ± 16.3	17.8 ± 25.4
Sleep latency—time to get to sleep (minutes)	27.5 ± 19.2	27.2 ± 21.7	26.6 ± 35.9	22.1 ± 19.6	32.6 ± 19.0	24.5 ± 19.7[b]	25.1 ± 30.4	24.8 ± 19.7[b]
Daytime naps (n)	0.1 ± 0.3	0.2 ± 1.2	0.0 ± 0.1	0.1 ± 0.2	0.2 ± 0.4	0.0 ± 0.1[b]	0.1 ± 0.3	0.1 ± 0.3
Nap time (minutes)[#]	1.2 ± 3.9	2.7 ± 9.8	0.9 ± 3.8	3.8 ± 9.3	2.7 ± 8.2	0.9 ± 4.4	3.1 ± 11.7	3.2 ± 8.7

a = significant change ($p < 0.05$) from baseline for active group; b = significant change ($p < 0.05$) from baseline for placebo group; [#]Due to the low number of people reporting taking naps during the study, there is a lot of variability in the nap time data, and statistical analysis was possible.

At baseline, only five individuals reported taking a nap in the placebo group and four in the active group. This number reduced to two in the active group and three in the placebo group throughout the study. Data from wrist actigraphy supported the findings of the sleep diary, showing no significant differences between the groups (Table 3).



(a)



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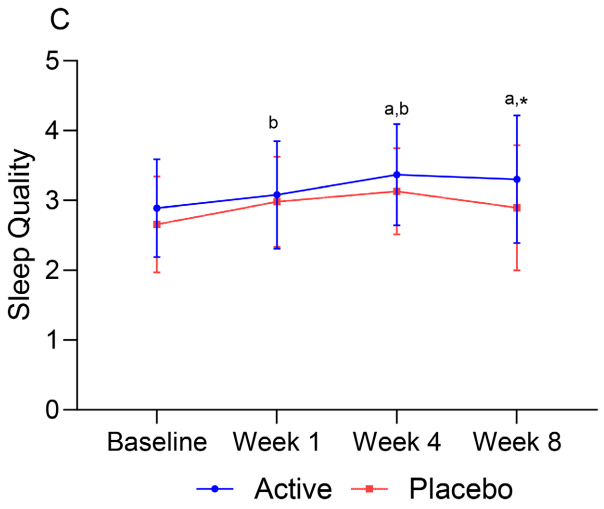

(c)

Figure 1. Average scores for 3 of 10 sleep diary parameters from 3 consecutive days of recording for baseline and week 1, 4 and 8. (a) time spent awake, (b) Total sleep time and (c) Sleep Quality. a = significant change ($p < 0.05$) from baseline for active group; b = significant change ($p < 0.05$) from baseline for placebo group; * = significant change ($p < 0.05$) between groups.

Table 3. Average wrist-worn actigraphy data from 3 consecutive days of recording at baseline, week 1, 4 and 8.

	Active ($n = 12$)[#]				Placebo ($n = 19$)[#]			
	Baseline	Week 1	Week 4	Week 8	Baseline	Week 1	Week 4	Week 8
Total sleep (minutes)	464.2 ± 50.6	461.6 ± 45.5	456.2 ± 72.3	453.5 ± 52.8	480.8 ± 63.4	465.3 ± 74.4	472.3 ± 72.4	468.8 ± 52.8
Asleep time (minutes)	427.9 ± 45.9	438.2 ± 434.4	421.7 ± 67.2	418.0 ± 45.2	452.2 ± 60.8	434.4 ± 53.0	453.5 ± 75.3	429.7 ± 62.8
Interruptions (minutes)	36.4 ± 8.7	33.7 ± 8.3	34.7 ± 10.1	35.8 ± 12.0	29.8 ± 8.4	30.5 ± 10.8	27.6 ± 9.7	28.9 ± 12.6

[#]Due to equipment limitations, only a subgroup of people were able to be provided with a wrist-worn actigraphy.

There were no significant differences observed between groups for any parameter reported from the PSQI. However, both groups showed a significant decrease in time to fall asleep, hours of sleep, as well as in components 1, 2, 3, 7, and total score at week 8 compared to baseline scores (see Table 4).

Table 4. PSQI scores recorded for Baseline, week 4 and 8.

	Active (n = 35)			Placebo (n = 36)		
	Baseline	Week 4	Week 8	Baseline	Week 4	Week 8
Time to fall asleep (minutes)	39.6 ± 33.9	30.7 ± 40.3[a]	23.7 ± 29.1[a]	43.3 ± 37.8	31.1 ± 29.7[b]	27.3 ± 24.9[b]
Hours of sleep (hours)	6.24 ± 0.94	6.66 ± 0.86[a]	6.91 ± 1.22[a]	6.10 ± 1.32	7.07 ± 1.07[b]	6.83 ± 1.17[b]
Component 1	1.94 ± 0.64	1.24 ± 0.50[a]	1.31 ± 0.68[a]	1.89 ± 0.52	1.32 ± 0.47[b]	1.37 ± 0.49[b]
Component 2	1.74 ± 1.04	1.38 ± 0.99	1.03 ± 0.66[a]	2.17 ± 0.85	1.49 ± 0.95[b]	1.37 ± 1.03[b]
Component 3	0.86 ± 0.77	0.44 ± 0.70[a]	0.57 ± 0.70[a]	0.97 ± 0.91	0.40 ± 0.69[b]	0.54 ± 0.89[b]
Component 4	0.83 ± 0.86	0.65 ± 0.77	0.60 ± 0.77	0.69 ± 0.75	0.57 ± 0.78	0.51 ± 0.74
Component 5	1.37 ± 0.60	1.21 ± 0.41	1.29 ± 0.46	0.57 ± 1.01	1.23 ± 0.49[b]	1.37 ± 0.49
Component 6	0.57 ± 1.01	0.24 ± 0.74	0.26 ± 0.74	0.31 ± 0.67	0.06 ± 0.24	0.14 ± 0.55
Component 7	1.51 ± 1.25	0.97 ± 0.94[a]	0.71 ± 0.86[a]	1.78 ± 1.02	1.26 ± 0.82[b]	1.03 ± 0.86[b]
Total score	8.83 ± 3.23	6.12 ± 2.73[a]	5.77 ± 2.64[a]	9.33 ± 2.19	6.29 ± 2.35[b]	6.34 ± 2.95[b]

a = significant change ($p < 0.05$) from baseline for active group; b = significant change ($p < 0.05$) from baseline for placebo group.

No significant differences were seen between groups for daytime sleepiness (ESS score) at any time point. Both groups reported significantly lower ESS scores at both week 4 and week 8 compared to baseline scores (Figure 2).

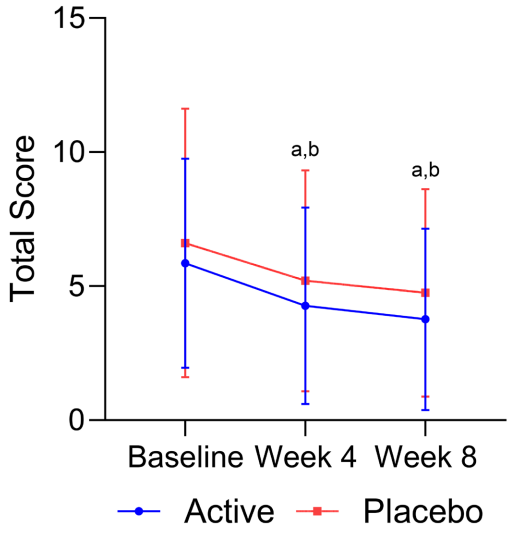

Figure 2. Daytime sleepiness as recorded by the ESS. a = significant change ($p < 0.05$) from baseline for active group; b = significant change ($p < 0.05$) from baseline for placebo group.

There was no significant difference between groups for the number of people (active: n = 12 and placebo: n = 18) or severity of reported restless legs at night throughout the study. At week 4, both groups reported a significant improvement in restless legs score compared to baseline. No significant differences were seen at week 8 to baseline or week 4 scores (Figure 3).

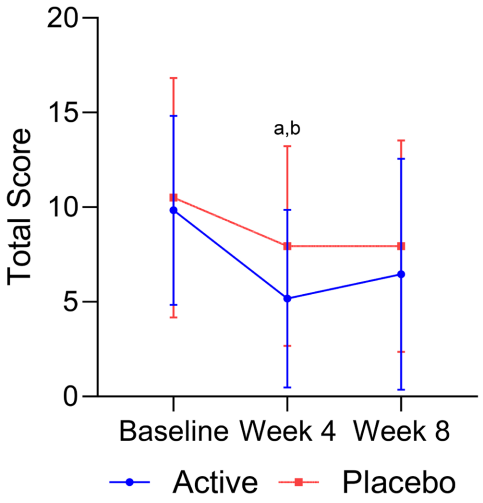

Figure 3. Restless legs at night scores for participants reporting symptom. a = significant change ($p < 0.05$) from baseline for active group; b = significant change ($p < 0.05$) from baseline for placebo group.

There were no significant differences between groups for any parameter of the SF-36 throughout the study period. All participants scored within normal value range on the SF-36 for each domain (data not shown).

There was no significant difference between groups for stress, anxiety, or depression scores at baseline. Reported stress scores were lower in the active group compared to the placebo group at week 8. Reported stress, anxiety, and depression scores were lower in the active group at week 8 compared to baseline. Depression scores were lower in the placebo group at week 8 compared to baseline.

4. Discussion

The aim of this study was to assess the effectiveness of Food-Grown® magnesium on sleep quality and duration in otherwise healthy adults over an 8-week treatment period. Both study groups demonstrated good healthy, as evidenced by the SF-36 data, and were demographically matched with no significant differences between them (Table 1). To mitigate the influence of external factors on the outcomes, participants were instructed to record their alcohol and caffeine consumption throughout the study. Both groups reported consuming equivalent amounts of both alcohol and caffeine, therefore these stimulants likely had no overall effect on the study outcomes. The primary outcome measure was a change in sleep quality and duration from baseline to week 8. Overall, the results showed both groups improved in a range of reported sleep related parameters

throughout the 8-week study period. The main finding of the study was a significant increase in sleep quality (Figure 1(c)) and reduction in stress levels at week 8 (Figure 4(a)) in the active group compared to the placebo group.

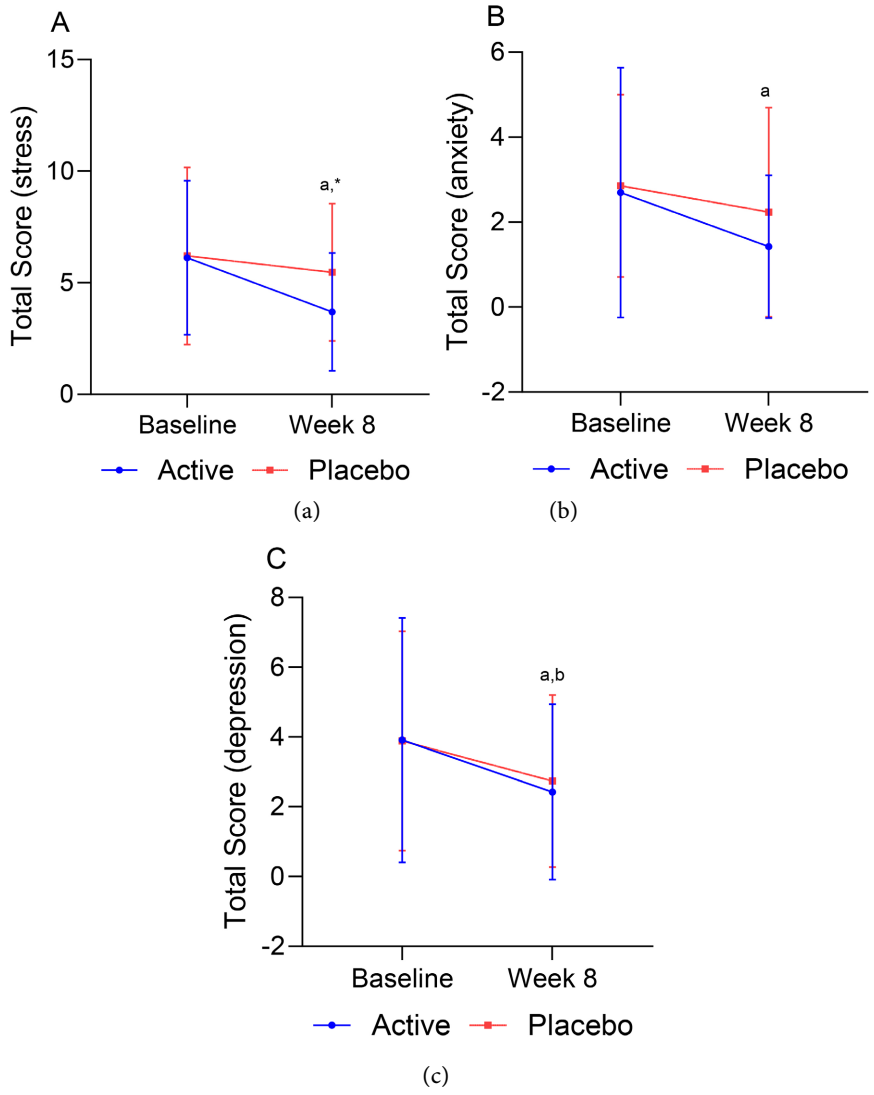

Figure 4. DASS-21 stress, anxiety and depression scores. (a) Stress scores, (b) anxiety scores, (c) depression scores. a = significant change ($p < 0.05$) from baseline for active group; b = significant change ($p < 0.05$) from baseline for placebo group; * = significant change ($p < 0.05$) between groups.

The findings of our study are corroborated by a longitudinal investigation conducted by Zhang and colleagues [10], examining the relationship between magnesium intake and sleep quality and duration. Their study demonstrated a positive correlation between magnesium intake and sleep quality. Additionally, individuals with higher magnesium intake were found to be less likely to experience less than 7 hours of sleep per night [10]. One proposed mechanism through which magnesium influences sleep is its ability to enhance melatonin secretion by stimulating serotonin N-acetyl transferase activity, a crucial enzyme in mela-

tonin synthesis. Moreover, magnesium plays a role in the hypothalamic-pituitary-adrenal system, contributing to sleep regulation. The rhythmic oscillation of magnesium ions in the body can also influence circadian rhythms, thereby assisting in the regulation of gene expression [13].

The recent study also revealed various sleep parameters impacted by both magnesium and the placebo, including time awake, total sleep time, sleep quality, and DASS-21 scores. The parallel effects observed in both groups suggest a potential placebo effect. The fact that participants in both groups experienced enhancements in scores implies that psychological factors, such as participant expectations, likely influenced perceived sleep parameters. Examination of **Figures 1-4** indicates a consistent trend in the sleep data, with an initial improvement followed by sustained progress in the active group, while the placebo group tends to plateau or even regress by week 8. Extending the study by an additional 4 weeks might have elucidated any lingering placebo effects and potentially uncovered further significant findings. This underscores the importance of employing a robust control group to discern between treatment effects and those resulting from a placebo. The findings advocate for a longer-term investigation to evaluate the potential efficacy of magnesium or any prospective treatment for enhancing sleep quality, thereby mitigating potential placebo effects.

A recent study conducted by Saba and colleagues (2022) involved supplementing heart surgery patients with 500 mg of magnesium for five days and evaluating its impact on anxiety, depression, and sleep quality [14]. Their findings demonstrated that magnesium supplementation significantly reduced anxiety and depression levels while also improving average sleep quality [14]. Similarly, our study revealed an amelioration in reported stress, with anxiety improving solely in the active group and showing a notable trend towards significance between groups ($p = 0.06$), alongside depression improvements observed in both groups.

Magnesium may not directly reduce stress but could be involved in physiological pathways that indirectly mitigate its effects. Neurotransmitters like serotonin play a crucial role in mood regulation [15], and low magnesium levels may disrupt serotonin balance, potentially increasing feelings of stress [16]. Additionally, magnesium can modulate neurological pathways by inhibiting the release of catecholamines and glucocorticoids, as well as regulating glutamatergic transmission, while enhancing GABA activity [17] [18]. This multifaceted action can contribute to stress reduction and promote a sense of calm.

Furthermore, magnesium helps regulate hormone pathways, including cortisol, thereby assisting in maintaining cortisol balance and alleviating chronic stress [17]. Its muscle relaxant properties [19] aid in reducing muscle tension, facilitating relaxation and stress alleviation [16]. Moreover, the relaxation of muscles by magnesium directly contributes to improved sleep quality [20]. These pathways operate bidirectionally; for instance, stress or anxiety can disrupt sleep, while poor sleep quality can exacerbate stress and anxiety levels.

Therefore, addressing one symptom, such as stress, can have a cascading effect on others, potentially ameliorating overall well-being.

The efficacy of magnesium in alleviating anxiety remains uncertain, as evidenced by the inconsistent findings across studies. A review conducted by Boyle and colleagues (2017) analysing eight studies revealed that only four demonstrated a positive effect of magnesium on anxiety scores [21]. However, it's worth noting that magnesium was often administered in combination with other compounds in these studies, making it challenging to isolate the specific impact of magnesium alone [21]. Another limitation of prior research lies in their study designs; unlike the current study, many lacked a placebo control and standardized questionnaires for assessing anxiety and stress [21].

Magnesium exerts its potential anxiolytic effects through various neurological pathways. By inhibiting NMDA receptors, magnesium reduces the activity of excitatory neurons, thereby mitigating anxiety symptoms [21]. Additionally, magnesium enhances the availability of GABA, a neurotransmitter known for its calming effects, by decreasing the release of presynaptic glutamate, which acts on mGluRs receptors [21]. These mechanisms offer insights into how magnesium may modulate anxiety, but further well-controlled studies are necessary to elucidate its precise role in anxiety management.

Although the study revealed improvements in stress, depression, and anxiety scores, it's notable that these values remained within the normal classification range. While this suggests there may be limited clinical significance, it's essential not to disregard these findings. Individuals with mild sleep or mood disorders may progress to more severe conditions over time [22]. Thus, magnesium supplementation could potentially serve as a preventive measure against the development of more serious disorders [23].

Future investigations could focus on examining the effects of magnesium supplementation specifically in individuals reporting values falling within the mild to moderate category. This targeted approach would help determine whether supplementation yields clinical benefits in this subgroup. By identifying those who might benefit most from magnesium intervention, researchers can better tailor treatment strategies and optimize outcomes for individuals at risk of developing more severe sleep or mood disorders.

Restless Leg Syndrome (RLS) is another condition speculated to potentially benefit from magnesium supplementation. Although the exact cause of RLS remains elusive, magnesium's influence on neurotransmitters and its muscle-relaxing properties suggest a potential therapeutic effect [20]. In this study, participants were evaluated for RLS using the Restless Leg Syndrome Questionnaire. Initially, the active group demonstrated a significant improvement in RLS scores; however, this effect was not sustained through week 8.

Several factors could account for the lack of sustained effect. Firstly, a placebo effect may have contributed to the initial perceived improvement among participants. Secondly, heightened awareness of symptoms and increased accuracy in

scoring at weeks 4 and 8 compared to baseline could have influenced the results. Lastly, the relatively low number of participants reporting RLS—12 in the active group and 18 in the placebo group—might have compromised statistical power, limiting the ability to detect significant differences.

Future studies would benefit from targeted recruitment of individuals specifically reporting RLS symptoms to better evaluate the potential efficacy of magnesium supplementation in this population. By ensuring an adequate sample size and employing rigorous study designs, researchers can more effectively elucidate the role of magnesium in managing RLS and optimize treatment strategies for affected individuals.

Future studies may also benefit by monitoring participants for a period after the supplementation period has ended. This would enable research to establish if sleep patterns return to what they were pre-intervention, or if they can be maintained post-intervention even in the absence of magnesium supplementation.

One limitation of this study was the restricted availability of wrist-worn actigraphy devices. With only 30 devices available for the study and a significantly higher than expected level of interest in the study, not all participants could be provided with a device. Consequently, the data collected from the actigraphy watches may have been limited. Additionally, upon comparison with data from sleep diaries, it appears that the actigraphy watches may have overestimated sleep duration. This discrepancy suggests that the watches may encounter challenges in accurately distinguishing between periods of being awake and asleep while in bed. In future studies, more sensitive devices may be necessary to improve the quantification of participants' sleep patterns.

Despite this limitation, the study demonstrated that magnesium supplementation can enhance both the quality and duration of sleep, while also improving stress and anxiety levels in healthy adults. These positive findings suggest that magnesium could be a potential intervention for individuals experiencing poor sleep and mild stress or anxiety symptoms. However, further research is warranted to fully understand the comprehensive benefits of magnesium on sleep quality and duration. Continued investigation will help to establish the efficacy of magnesium supplementation as a viable approach for addressing sleep-related issues and mental well-being.

Authors' Contributions

A. Rao: Conceptualization, Methodology, Software, Formal analysis, Resources, Data Curation, Writing—Review & Editing, Visualization, Supervision, Project administration and Funding acquisition; **J. Erickson:** Investigation, Project administration, Writing—Review & Editing. **C. Smith**: Data Curation, Investigation, Writing—Review & Editing; **D. Briskey**: Conceptualization, Methodology, Data Curation, Writing—Original Draft, Writing—Review & Editing, Visualization, Supervision and Project Administration.

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Institutional Review Board Statement

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects/patients were approved by the National Institute of Integrative Medicine ethics board (Reference number 0110E_2022).

Informed Consent Statement

Written informed consent was obtained from all subjects involved in the study.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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