



EggPro-Sleep PM: Egg protein pm for improved sleep during perimenopause

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A report for Australian Eggs Limited
by Dr D.L. Hamilton and Dr L. Convit

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This report summarises preliminary findings from an ongoing research project. Full methodological details, statistical analyses, and complete results will be presented in a forthcoming peer-reviewed scientific publication.

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In submitting this report, the researcher has agreed to Australian Eggs Limited publishing this material in its edited form.

The appendix is the submitted manuscript which cannot be published until it is published by a peer reviewed journal.

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Foreword

This project was conducted to investigate whether the timing of egg consumption (morning versus evening) influences sleep outcomes in peri-menopausal women undergoing a structured sleep hygiene intervention. The peri-menopausal transition is associated with significant disruptions to sleep quality and duration, driven by hormonal changes and altered circadian regulation. Nutritional strategies that may support sleep represent a practical, scalable approach to improving health and wellbeing in this population. Eggs provide a high-quality protein source containing essential amino acids, including tryptophan, alongside micronutrients that may support sleep-related physiological processes, making them a relevant whole-food intervention to examine within this context.

This project was funded from industry revenue which is matched by funds provided by the Australian Government.

This report is an addition to Australian Eggs Limited's range of peer reviewed research publications and an output of our R&D program, which aims to support improved efficiency, sustainability, product quality, education and technology transfer in the Australian egg industry.

Most of our publications are available for viewing or downloading through our website:

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Lead co-investigator – Dr Lilia Convit

Dr Convit is an Associate Research Fellow at Deakin University within IPAN. Her research focuses on hydration, thermoregulation, and applied nutrition, with a particular emphasis on female physiology and responses to environmental and physiological stressors. Her work also explores the role of whole foods and targeted nutritional strategies in supporting sleep, recovery, and metabolic health across the female lifespan. She has experience conducting both laboratory and field-based studies and is committed to translating research findings into practical, evidence-based strategies for athletes and occupational settings, including heat-exposed environments.

Co-investigator – Dr Spencer S. H. Roberts

Dr Roberts is an Alfred Deakin Postdoctoral Research Fellow at Deakin University. His research examines novel approaches for mitigating the risks and consequences of concussive and non-concussive head impacts in sport. This includes projects testing the efficacy of novel approaches (e.g. sleep architecture analysis) for diagnosing and managing brain injuries, as well as projects examining the influence of lifestyle factors, such as sleep, on the risk of sport-related concussions. Since completing his PhD in 2020, Dr Roberts has authored 40 peer-reviewed publications in leading sports medicine and sleep journals. Dr Roberts is also a consultant with Fatigue Management and Sleep Solutions Australia (FMSSA), where he consults directly with industry on fatigue risk management and sleep optimisation.

Co-investigator – Dr Rhiannon M.J. Snipe

Dr Snipe is an Accredited Practising Dietitian, Advanced Sports Dietitian and Senior Lecturer in Sports Nutrition at Deakin University. She is an active member of the Centre for Sport Research within IPAN, as well as the Women in Sport and Exercise Network, reflecting her commitment to interdisciplinary and equity-focused research in sport and health. Dr Snipe's research program centres on the complex interaction between nutrition and exercise, with a particular emphasis on how hormonal fluctuations across the female lifespan influence health, performance, and adaptation to training. Her work aims to improve understanding of sex-specific and life-stage-specific considerations in sports nutrition,

contributing to the development of evidence-based strategies to support women in physical activity, sport, and exercise across adolescence, adulthood, and later life.

Co-investigator – Dr Sze-Yen Tan

Dr Tan is an Advanced Accredited Practising Dietitian (AdvAPD), Registered Nutritionist (RNutr), and Associate Professor in Nutrition Science at Deakin University. He is also an active researcher and the co-coordinator of the ‘Preventing and Managing Chronic Conditions’ research domain at IPAN. Dr Tan has over 15 years of experience in conducting nutrition research using various study designs, spanning from nutrition epidemiology to clinical trials to systematic reviews. His research aims to identify simple, pragmatic, and effective dietary strategies that can address national and international health priorities, including metabolic diseases and ageing-related chronic conditions.

Co-investigator – Dr Samantha M. Hoffmann

Dr Hoffmann is a Senior Lecturer and Accredited Sport Scientist (ASpS2) at Deakin University. She is an active mid-career researcher working in the Centre for Sport Research within IPAN. Dr Hoffmann’s research focuses on identifying physiological predictors of performance and refining the methods used to assess them. She has a specific focus on female-specific demands and considerations related to the menstrual cycle, pregnancy, and postpartum. Her work is strongly applied in nature, driven by collaborative partnerships with the sports industry. These collaborations ensure her research aligns with industry priorities and delivers meaningful, real-world impact.

Co-investigator – Dr Dominique Condo

Dr Condo is a Senior Lecturer and Accredited Practising Dietitian at Deakin University, and a researcher within IPAN. Her research focuses on sports nutrition, dietary assessment, and the role of nutrition in supporting health and performance in athletic and general populations. She has extensive experience in applied research and industry collaboration, with a strong emphasis on translating evidence-based nutrition strategies into practice.

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Abbreviations

6-SMT	6-sulfatoxymelatonin
DEXA	Dual-Energy X-ray Absorptiometry
IPAN	Institute for Physical Activity and Nutrition
PSQI	Pittsburgh Sleep Quality Index

Executive Summary

This project investigated whether the timing of egg consumption (morning versus evening), when combined with sleep hygiene education, influences sleep outcomes in peri-menopausal women experiencing poor sleep quality (PSQI >5). Twenty-two women completed a 9-week randomised crossover trial, consuming two eggs daily either in the morning or evening, alongside a structured sleep hygiene program. Sleep was assessed using both objective wearable technology and validated subjective questionnaires, alongside measures of peri-menopausal symptoms and a biomarker of melatonin production.

The primary finding was that the timing of egg consumption did not significantly influence sleep outcomes. There were no meaningful differences between morning and evening intake for objective measures (including total sleep time, sleep efficiency, and wake after sleep onset), subjective sleep quality, or urinary melatonin metabolite levels. Importantly, there was also no evidence that evening egg consumption adversely affected sleep, with outcomes comparable to morning intake across all measured parameters.

Although the study was not designed to formally test non-inferiority, these findings suggest that consuming eggs in the evening does not appear to impair sleep in peri-menopausal women, including those with pre-existing sleep disturbance. From an applied perspective, this indicates that eggs may represent a practical and well-tolerated pre-bed food option, allowing individuals to consume protein intake later in the day without evidence of negative impacts on sleep under the conditions tested.

Despite the absence of effects on sleep, some modest, timing-specific differences were observed in selected peri-menopausal symptoms. For example, evening consumption was associated with small improvements in backache and joint pain compared to baseline (no egg intake). These findings were secondary outcomes and should be interpreted cautiously but suggest that egg consumption may influence certain aspects of perimenopause symptom experience independent of sleep.

Overall, the results indicate that egg consumption, whether in the morning or evening, does not meaningfully alter sleep outcomes over a three-week period when combined with basic sleep hygiene education. However, the findings provide important translational insight by demonstrating that evening egg consumption is unlikely to negatively impact sleep, supporting its potential use as a convenient, nutrient-dense, protein-rich pre-bed snack. Future research may explore whether longer interventions or combination approaches are required to meaningfully improve sleep outcomes and peri-menopausal symptoms in this population.

Overall Conclusions

This study found that the timing of egg consumption (morning versus evening), when combined with sleep hygiene education, did not result in differences in sleep outcomes in peri-menopausal women with poor sleep quality. Across both objective and subjective measures, evening egg consumption produced comparable sleep outcomes to morning intake.

Importantly, there was no evidence from this study that consuming eggs in the evening adversely affected sleep under the conditions tested. These findings indicate that eggs can be consumed at different times of the day, including in the evening, without evidence of negative effects on sleep in this population.

Some small, timing-specific differences were observed in selected peri-menopausal symptoms. For example, evening egg consumption was associated with lower reported joint pain compared to baseline (no egg intake); however, these were secondary outcomes and should be interpreted with caution.

Overall, the findings suggest that altering the timing of egg consumption alone is unlikely to meaningfully influence sleep outcomes in peri-menopausal women. Further research is required to determine whether longer-term dietary strategies, alone or in combination with other interventions, can improve sleep or symptom outcomes in this population.

1 Background

The peri-menopausal transition, defined as the period preceding the final menstrual cycle, typically occurs during midlife and represents a critical stage for influencing long-term health in women (Santoro, 2016; El Khoudary et al., 2019). This life stage is frequently accompanied by a high prevalence of sleep disturbances, with approximately 40–60% of women reporting difficulties with sleep initiation, maintenance, or continuity (Troia et al., 2025; Baker et al., 2018). Across the lifespan, women also exhibit a greater risk of insomnia compared to men, with disparities becoming more pronounced with advancing age (Mallampalli and Carter, 2014). These disturbances are thought to be partly driven by hormonal fluctuations associated with reproductive ageing (Harlow et al., 2012).

Sleep disruption during perimenopause often coexists with vasomotor, psychological, and physical symptoms (Santoro, 2016). Poor sleep may exacerbate fatigue, mood disturbances, cognitive impairment, metabolic dysregulation, and altered appetite regulation (Hillman and Lack, 2013; Haufe et al., 2022; Taulikar, 2022; Ruediger et al., 2021; Spiegel et al., 1999; Niwa et al., 2018). Consequently, sleep disturbance is increasingly recognised as a key contributor to reduced quality of life and may have implications for long-term health and healthy ageing.

The mechanisms underlying sleep disruption during this transition are multifactorial. Hormonal fluctuations in oestrogen and progesterone may influence thermoregulation, circadian rhythms, and neurochemical pathways involved in sleep regulation (Troia et al., 2025; Haufe and Leeners, 2023; Taulikar, 2022; Prior, 2018). These physiological changes can contribute to symptoms such as night sweats and sleep fragmentation.

Current management strategies typically prioritise non-pharmacological approaches, including sleep hygiene education (Chen et al., 2010). However, while these strategies are widely recommended, their effectiveness is often modest, particularly when underlying physiological factors remain unaddressed (Drake et al., 2019). As a result, there is increasing interest in complementary approaches, including nutrition, to support sleep health (Polasek et al., 2024), although evidence specific to peri-menopausal populations remains limited (Baker et al., 2018).

Nutrition has been identified as a potentially modifiable factor influencing sleep, with attention given to dietary composition, protein intake, and meal timing (Pattnaik et al., 2022b). Nutrients such as tryptophan, vitamin D, and choline have been linked to processes involved in sleep regulation (Cheon and Kim, 2022b; Ikonte et al., 2019b; Muscogiuri et al., 2019). However, the extent to which whole-food dietary strategies influence sleep outcomes in perimenopausal women is not well established.

Eggs are a nutrient-dense food providing high-quality protein alongside vitamins and minerals relevant to overall health (Carnovale et al., 1973; Daly et al., 2022; Tan et al., 2014). Given their nutritional profile and accessibility, eggs represent a practical protein-based snack option. However, there is limited evidence examining whether egg consumption, or the timing of intake, influences sleep or related symptoms in peri-menopausal women.

In addition to sleep disturbances, perimenopause is associated with changes in appetite regulation, energy balance, and body composition (Porada et al., 2023; Marlatt et al., 2022). Higher protein intake has been proposed as a strategy to support appetite control and metabolic health (Simpson et al., 2022; Dhillon et al., 2016; Martens et al., 2013). Eggs provide a convenient nutrient package with high quality dietary protein and key micronutrients, although the impact of egg supplementation on health outcomes in peri-menopausal populations remains unclear.

Taken together, these factors highlight the need to better understand the role of practical, food-based

strategies such as supplementing the diet with eggs, in supporting sleep, symptom management, and overall health during the peri-menopausal transition.

2 Study Design and Methods

2.1 Study design

This study used a randomised crossover design comprising two 3-week intervention periods separated by a washout phase. Participants consumed two eggs daily either in the morning or evening during each intervention period while maintaining their usual diet and lifestyle. All participants (Twenty-two peri-menopausal females, with PSQI scores >5) received a brief sleep hygiene education session at the start of the study and were encouraged to apply these strategies throughout. Sleep outcomes were assessed using wearable technology and validated questionnaires. Additional measures included peri-menopausal symptoms, dietary intake, and selected physiological markers. The study also assessed adherence and acceptability of egg consumption at different times of the day.

3 Results

3.1 Participant Characteristics and Adherence

Twenty-two peri-menopausal women completed the study. All participants met criteria for poor sleep quality at baseline. Adherence to the egg consumption protocol was high, with most participants consuming the prescribed intake consistently across both conditions.

3.2 Sleep Outcomes

No meaningful differences in sleep outcomes were observed between morning and evening egg consumption. Measures of sleep duration, sleep efficiency, wake after sleep onset, and subjective sleep quality were comparable across both conditions. Sleep outcomes also did not show clear improvement over the course of the study.

3.3 Melatonin Biomarker

Urinary melatonin metabolite levels were similar between conditions, with no consistent differences observed between morning and evening egg consumption.

3.4 Peri-menopausal symptoms

Some small, timing-specific differences were observed in selected symptoms. Evening egg consumption was associated with lower reported backache and joint pain compared to baseline, while morning intake was associated with lower reported dry vaginal symptoms.

These findings were modest and based on secondary analyses and should be interpreted with caution.

3.5 Dietary intake

Overall dietary intake remained broadly consistent across conditions, indicating that the addition of eggs did not substantially alter participants' habitual diet at the group level across the two 3-week

intervention periods. Further analyses are underway to examine whether the timing of egg consumption influenced appetite and day-to-day dietary patterns at the individual level. These findings will be reported separately.

3.6 Acceptability and feasibility

Egg consumption was well tolerated, with participants reporting that incorporating eggs into their daily routine was practical and acceptable across both morning and evening conditions.

4 Discussion

This study examined whether the timing of egg consumption influences sleep outcomes in peri-menopausal women. The findings indicate that consuming eggs in the morning or evening resulted in comparable sleep outcomes, with no meaningful differences observed across objective or subjective measures.

These findings suggest that, under the conditions tested, the timing of egg intake is unlikely to meaningfully influence sleep in this population. This aligns with broader evidence indicating that individual dietary components may have limited effects on sleep outcomes when used in isolation (Wirth et al., 2023; Polasek et al., 2024).

Although eggs contain nutrients associated with sleep-related processes, the amounts typically consumed as part of a standard diet may not be sufficient to produce measurable changes in sleep over short intervention periods. In addition, variability in individual physiology, lifestyle, and underlying sleep disturbance may influence responsiveness to dietary interventions.

The absence of improvement in sleep outcomes over time also suggests that brief sleep hygiene education alone may not be sufficient to meaningfully improve sleep in peri-menopausal women with established sleep disturbance, consistent with previous research (Drake et al., 2019).

Some small differences were observed in selected peri-menopausal symptoms, particularly in relation to joint pain and backache. While these findings may indicate potential timing-related effects, they were secondary outcomes and modest in magnitude and therefore should be interpreted cautiously.

Importantly, the study demonstrated high adherence and acceptability of egg consumption across both conditions. This supports the feasibility of incorporating eggs into daily dietary patterns and highlights their flexibility as a protein-based snack that can be consumed at different times of the day, not just for breakfast.

Overall, the findings suggest that simple dietary timing strategies are unlikely to meaningfully influence sleep outcomes when applied in isolation. However, the high adherence to the intervention and the acceptability of egg consumption across both timepoints demonstrate that eggs are a practical and well-tolerated whole-food intervention in peri-menopausal women. These findings support the feasibility of future research using eggs in this population to investigate other clinically relevant outcomes, such as musculoskeletal adaptations in response to exercise training or vitamin D-related outcomes. In addition, the observed differences in selected pain-related symptoms warrant further investigation in more targeted studies designed to evaluate perimenopausal pain as a primary outcome.

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Plain English Summary

Project Title:	EggPro-Sleep PM: Egg protein pm for improved sleep during perimenopause
Australian Eggs Limited Project No	GROW023
Researchers Involved	L. Convit, S.S. Roberts, S-Y Tan, S.M. Hoffmann, D. Condo, R.M. Daly, R.M. Snipe and D.L. Hamilton.
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Objectives	To investigate whether the timing of egg consumption (morning versus evening), alongside sleep hygiene education, influences sleep outcomes in peri-menopausal women with poor sleep quality. The study also explored effects on perimenopausal symptoms and the tolerability of incorporating eggs into daily dietary patterns.
Background	Many women experience sleep disturbances during the peri-menopausal transition, which can impact overall health and quality of life. While sleep hygiene strategies are commonly recommended, their effectiveness can be limited. Nutrition has emerged as a potential area of interest, but there is limited research on whether whole foods, such as eggs, or the timing of food intake can influence sleep or related symptoms in this population.
Research	Twenty-two peri-menopausal women completed a 9-week study in which they consumed two eggs daily either in the morning or evening for 3 weeks under each condition, in a counterbalanced crossover design, alongside sleep hygiene guidance. Sleep was assessed using wearable devices and questionnaires, and participants also recorded perimenopausal symptoms and dietary intake.
Outcomes	The timing of egg consumption did not result in differences in sleep outcomes. Sleep measures were similar whether eggs were consumed in the morning or evening. There was no evidence that evening egg consumption negatively affected sleep. Some small differences were observed in selected symptoms, such as joint pain, but these were secondary findings and require further investigation. Egg consumption was well tolerated, with high adherence across the study.
Implications	These findings suggest that eggs can be consumed at different times of the day, including in the evening, without negatively affecting sleep in peri-menopausal women under the conditions tested. The high acceptability and adherence observed in this study support the feasibility of using eggs as a practical whole-food intervention in this population. The results also support further research exploring eggs in relation to other health outcomes, such as musculoskeletal health, vitamin D status, and symptom management.

Key Words	Perimenopause; sleep; egg consumption; meal timing; protein intake; women's health; dietary intervention; sleep hygiene; symptoms; nutrition
Publications	Convit, L., Nicola, C.M., Urwin, C.S., Roberts, S.S., Tan, S.Y., Hoffmann, S.M., Condo, D., Daly, R.M., Hamilton, D.L. and Snipe, R.M., 2025. <i>Eggs as a Nutrient-Rich Food with Potential Relevance to Sleep Metabolic Health, and Well-Being During the Menopausal Transition: A Narrative Review</i>. Nutrients. Link here. Lilia Convit, Spencer S. H. Roberts, Rhiannon M.J. Snipe, Sze-Yen Tan, Samantha M. Hoffmann, Dominique Condo, Robin M. Daly, Ashwin K.V. Mruthunjaya, Angel A.J. Torriero and D. Lee Hamilton. <i>Timing of Egg Consumption and Sleep Outcomes in Perimenopausal Women with Poor Sleep Quality: A 9-week Randomised Crossover Trial</i>. Under review at Nutrition Journal.